COTTON PESTS

SCENARIO DURING LAST DECADE IN INDIA

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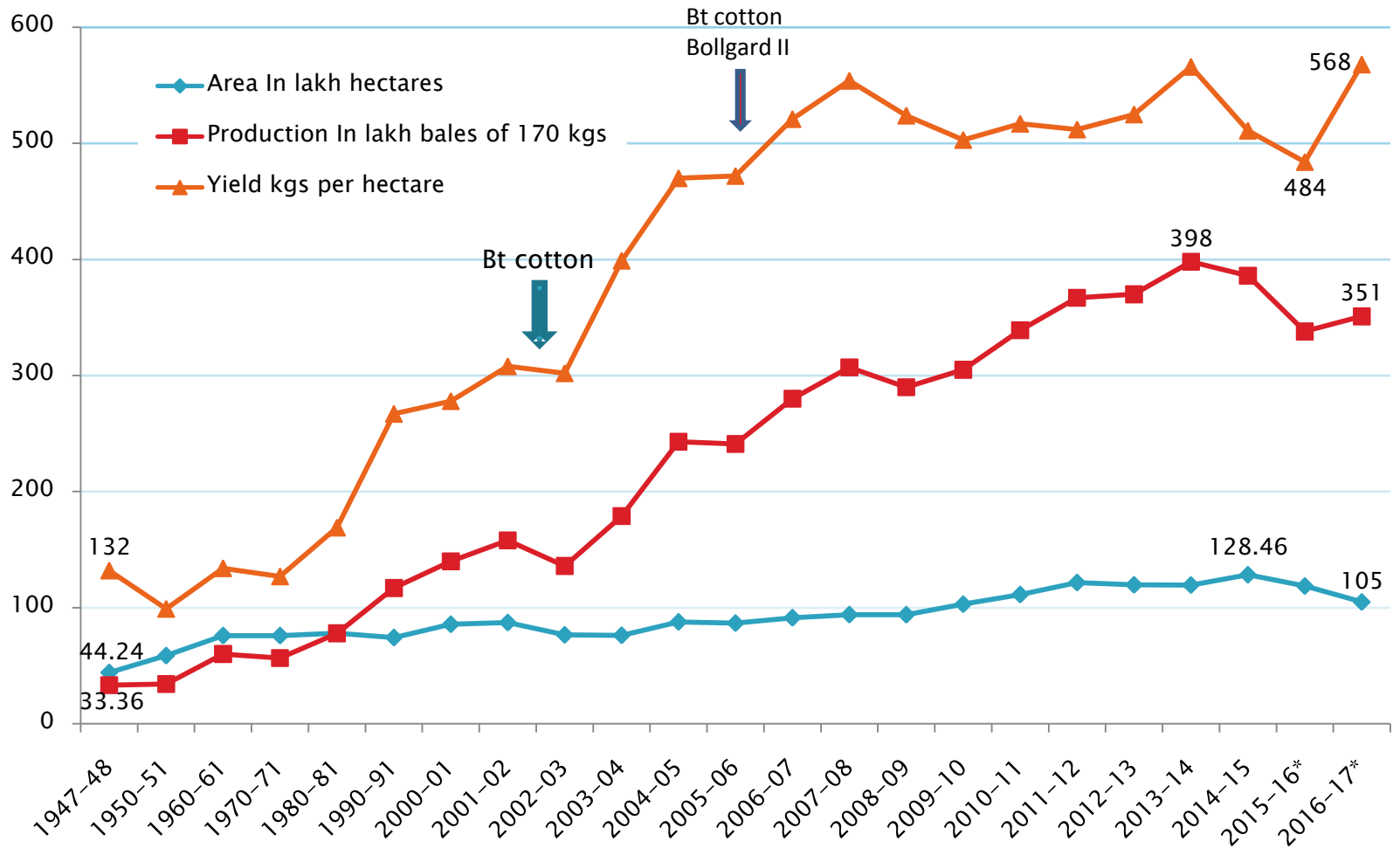
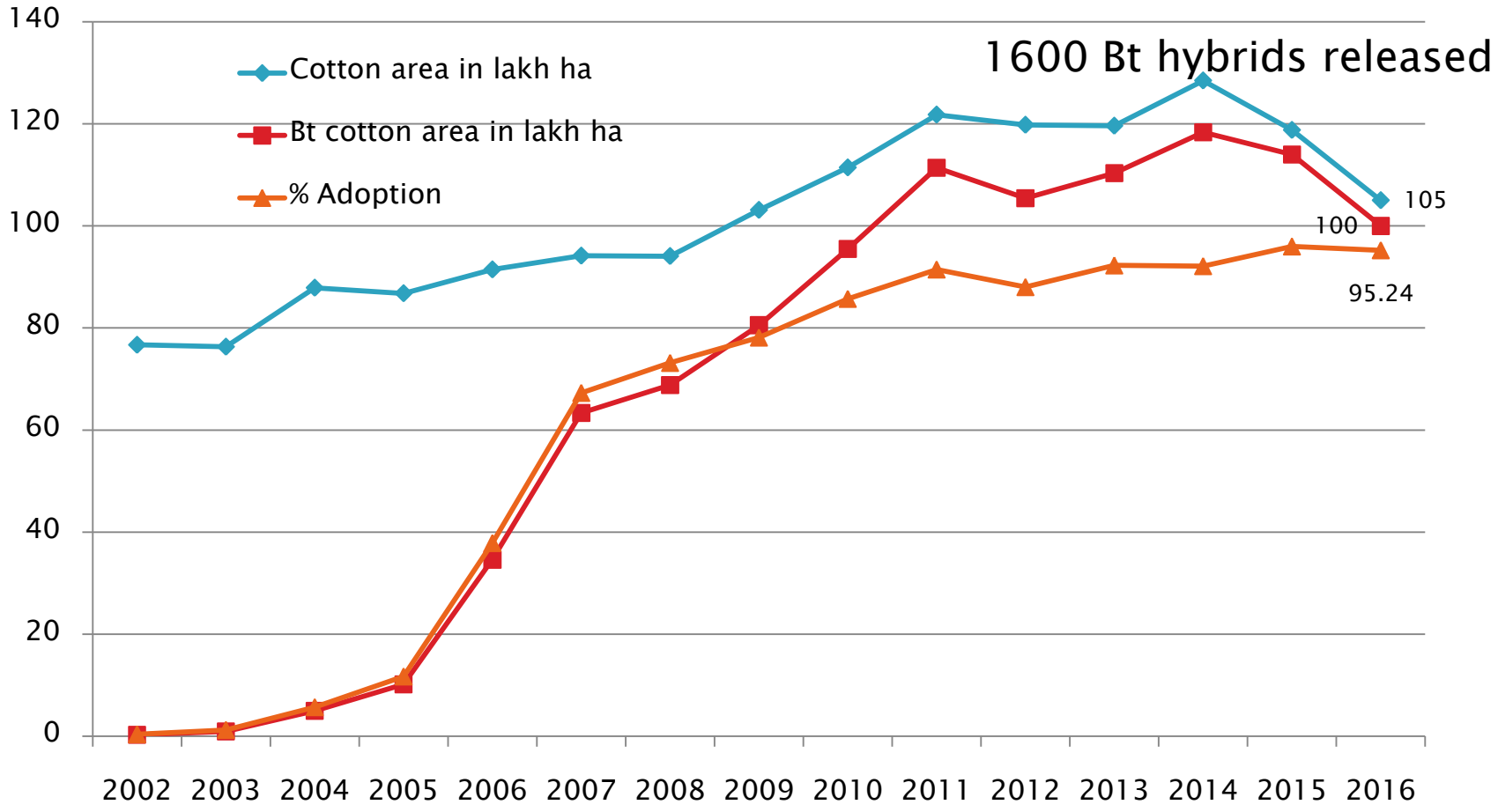
Area, production and productivity of cotton in India



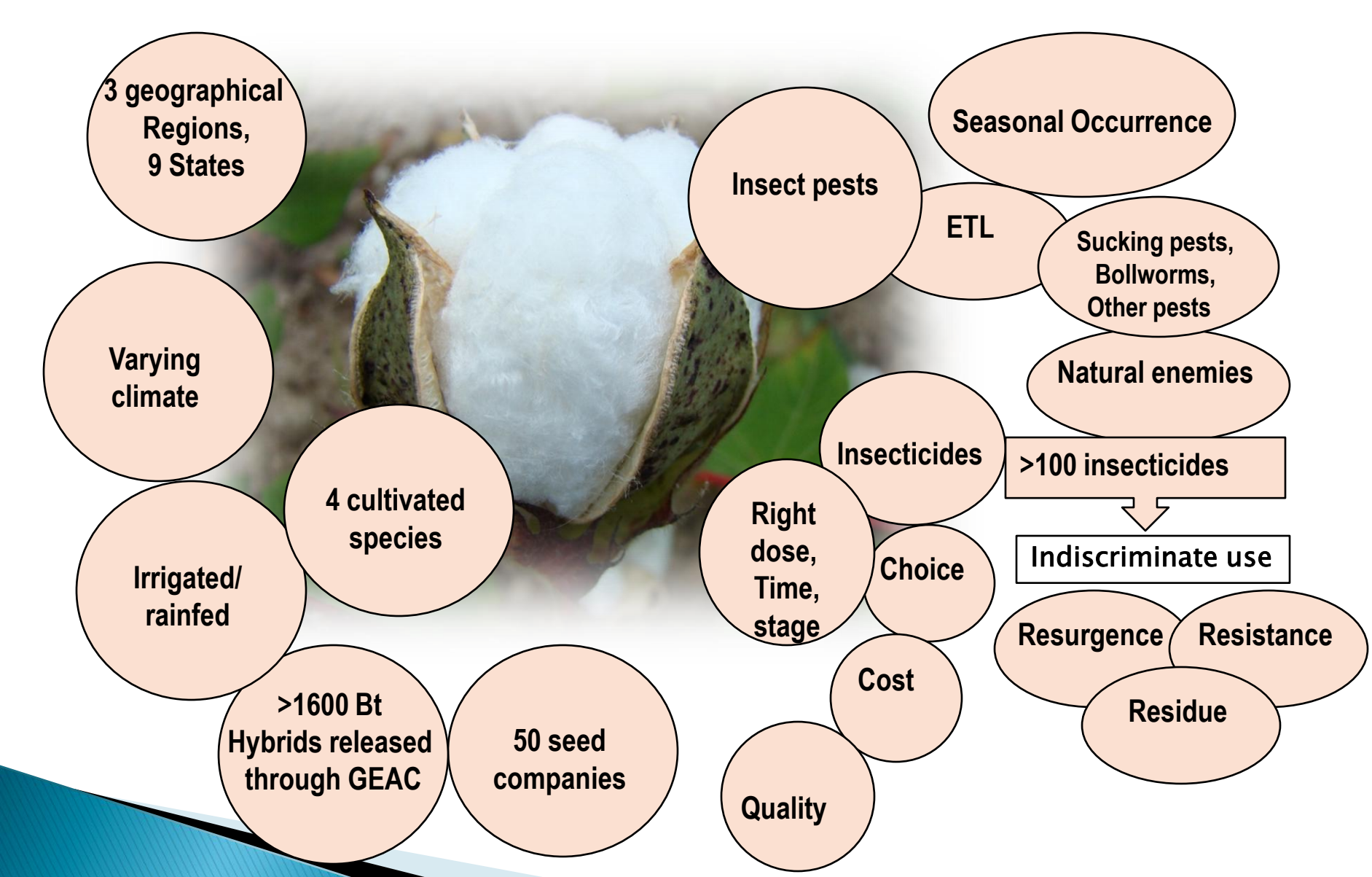
*Source: Cotton Advisory Board(CAB)

Adoption of Bt cotton in India



Source DAC

Cotton Pests and their Management



Target pests of Cotton

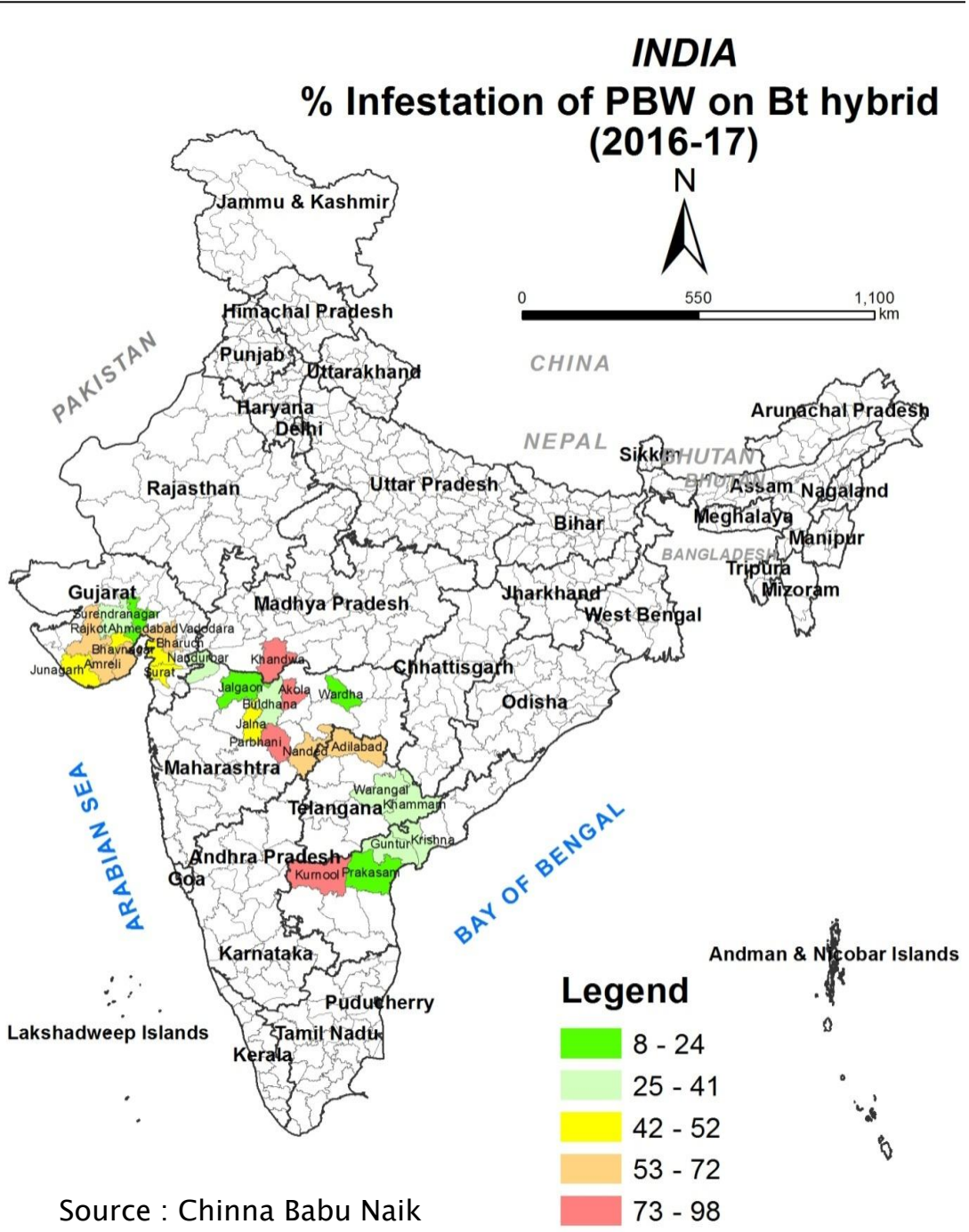
Bollworms

Sucking pests

Other pests

Resistance development

Bollgard (Cry 1AC)	**Tabashnik and Carrière, 2010; Dennehy et al 2010**
Bollgard II (Cry 1AC + Cry2Ab)	**Kranthi 2015, 2016; CICR 2016**



Source : Chinna Babu Naik

Reasons for Pink Bollworm Occurrence On BGII

- Extending crop beyond time.
- Non-compliance of refugia non-Bt cotton.
- Lack of timely and appropriate management initiatives
- Large number of hybrids
- Cultivation of long duration hybrids.
- Long term storage of raw cotton
- Gujarat PBW developed resistance to Cry1Ac and Cry2Ab together.
- The segregating seeds in bolls of F-1 hybrid plants accelerate resistance development

Pink bollworm larval recovery(%) from Green bolls collected from BGII and Non-Bt genotypes at different intervals in North Zone during 2012-17

S.N.	Locations	Entries	2012-13				2013-14				2014-15				2015-16				2016-17			
			120 DAS*	140	160	175	120	140	160	175	120	140	160	175	120	140	160	175	120	140	160	175
1	PAU Bathinda, Punjab	Bt	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Non-Bt	-	-	-	-	-	-	-	-	-	-	-	-	18.67	17.69	17.69	15.39	0.00	0.00	0.00	4.7
2	ARS, Faridkot, Punjab	Bt	-	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Non-Bt	-	7.33	4.17	6.67	0.00	11.00	17.15	-	14.35	18.75	19.55	12.50	8.24	13.03	18.03	22.67	0.00	0.00	0.50	5.00
3	ARS, Sri Ganaganagar	Bt	-	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Non-Bt	-	9.33	7.33	14.68	7.00	12.65	17.30	-	11.35	15.40	17.70	21.70	15.57	17.76	22.50	33.39	0.00	0.00	4.67	6.68
4	CICR, RS, SIRSA	Bt	-	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Non-Bt	-	5.33	6.00	20.67	0.00	11.67	14.35	-	4.65	16.90	21.75	21.65	10.24	13.04	13.60	30.67	0.00	0.00	2.24	7.24
5	HAU, Hissar	Bt	-	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Non-Bt	-	**4.00**	**7.44**	**8.84**	**0.00**	**13.30**	**18.85**	-	**8.30**	**16.25**	**12.50**	**16.65**	**10.24**	**15.14**	**18.60**	**31.34**	**0.00**	**0.00**	**11.34**	**7.80**

* DAS= Days after sowing

Source: Rishi Kumar

MITOCHONDRIAL DNA PART A, 2016
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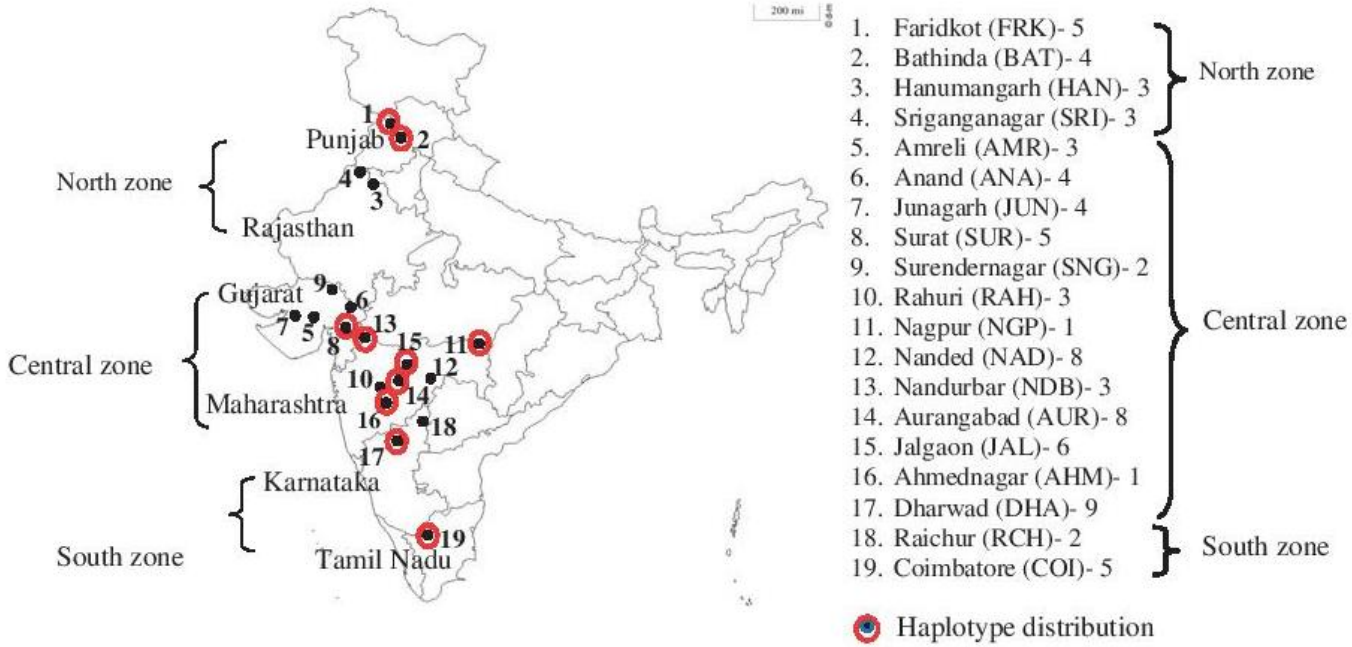
RESEARCH ARTICLE

Population genetic structure of cotton pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) using mitochondrial cytochrome oxidase I (*COI*) gene sequences from India

J. Sridhar[a], V. Chinna Babu Naik[b], A. Ghodke[b], S. Kranthi[b], K. R. Kranthi[b], B. P. Singh[a], J. S. Choudhary[c] and M. S. R. Krishna[d]



- There is no isolation distance effect among the Indian populations of PBW.
- A low genetic diversity among PBW populations of India.

American bollworm

- *H. armigera* infestation reduced significantly in the last decade and it rarely exceeded economic threshold levels in majority of the cotton growing regions of India.

- The obvious reasons were introduction of Bt-cotton, change in insecticide use pattern, decrease in pyrethroids, increase in the new chemistries insecticides etc.

- In the 2012 crop season, *H. armigera* was found to infest non Bt cotton cultivated under HDPS with straight hirsutum varieties crossing ETLs in many demonstration fields in the Vidarbha region.

American bollworm (*Helicoverpa armigera*)

Cry 1Ac susceptibility in *H. armigera* (in ppm)

Locations & Generation	Crop	Subjects	LC50	EC50
Sirsa F1	Okra	400	1.101	0.04
Sirsa F1	Pigeon pea	400	22.89	0.053
Nagpur F1	Cotton	300	0.998	0.122
Wardha F1	Cotton	300	1.005	0.147
Hyderabad F1	Chickpea	300	6.592	0.074
Yavatmal	Cotton	300	2.21	0.101

Cry 2Ab susceptibility in *H. armigera* (in ppm)

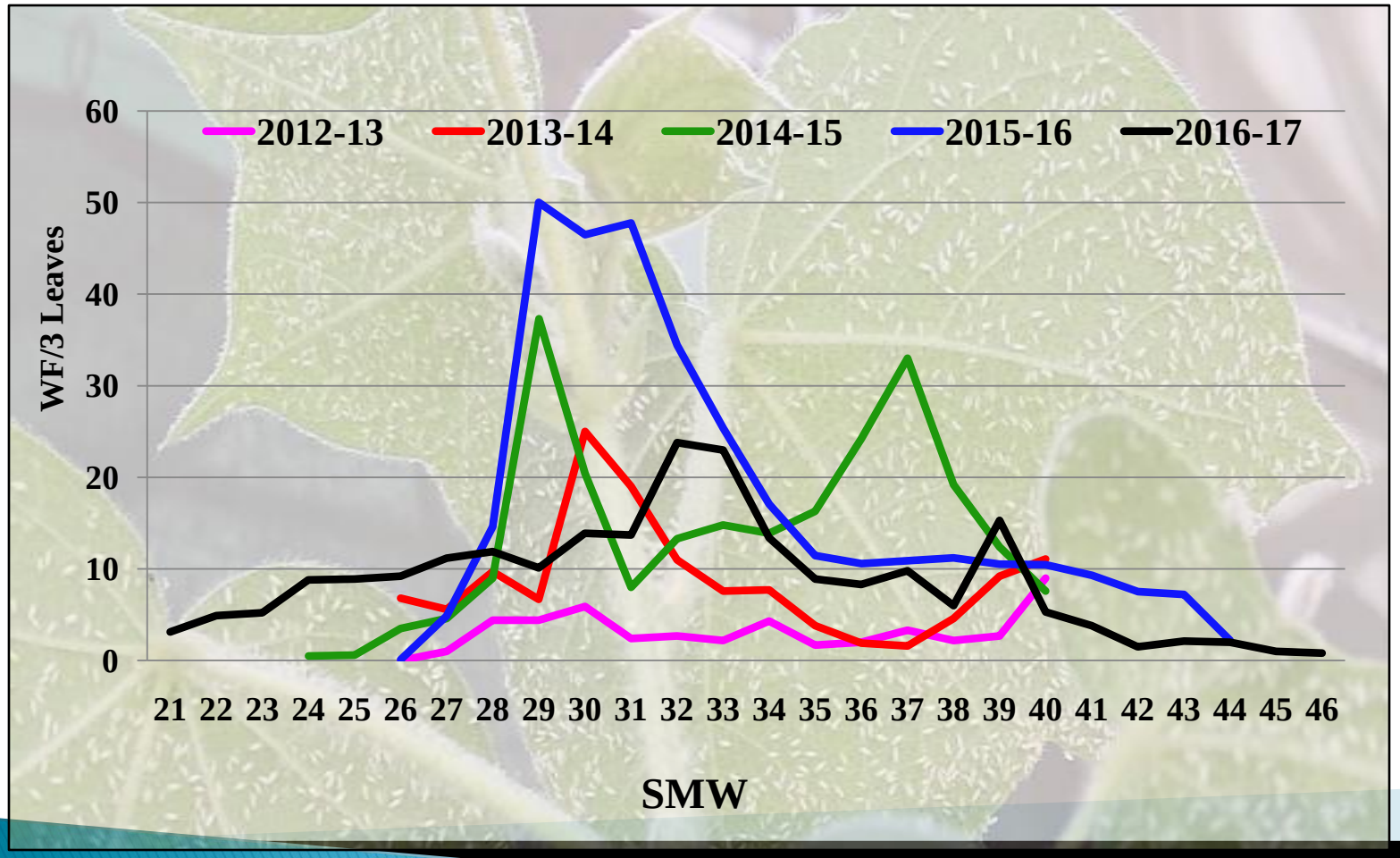
Locations & Generation	Crop	Subjects	LC50	EC50
Sirsa F1	Okra	400	9.462	5.477
	Cotton	400	84.83	2.542
Wardha F1	Cotton	300	7.88	3.077
Hyderabad F1	Chickpea	400	24.98	1.184
Yavatmal F2	cotton	300	9.22	0.062

Kranthi S.

Spotted bollworm

E. vittella is seen in South and Central India while *E. insulana* is predominant species in North India, on cotton. Presently not much concern across India.

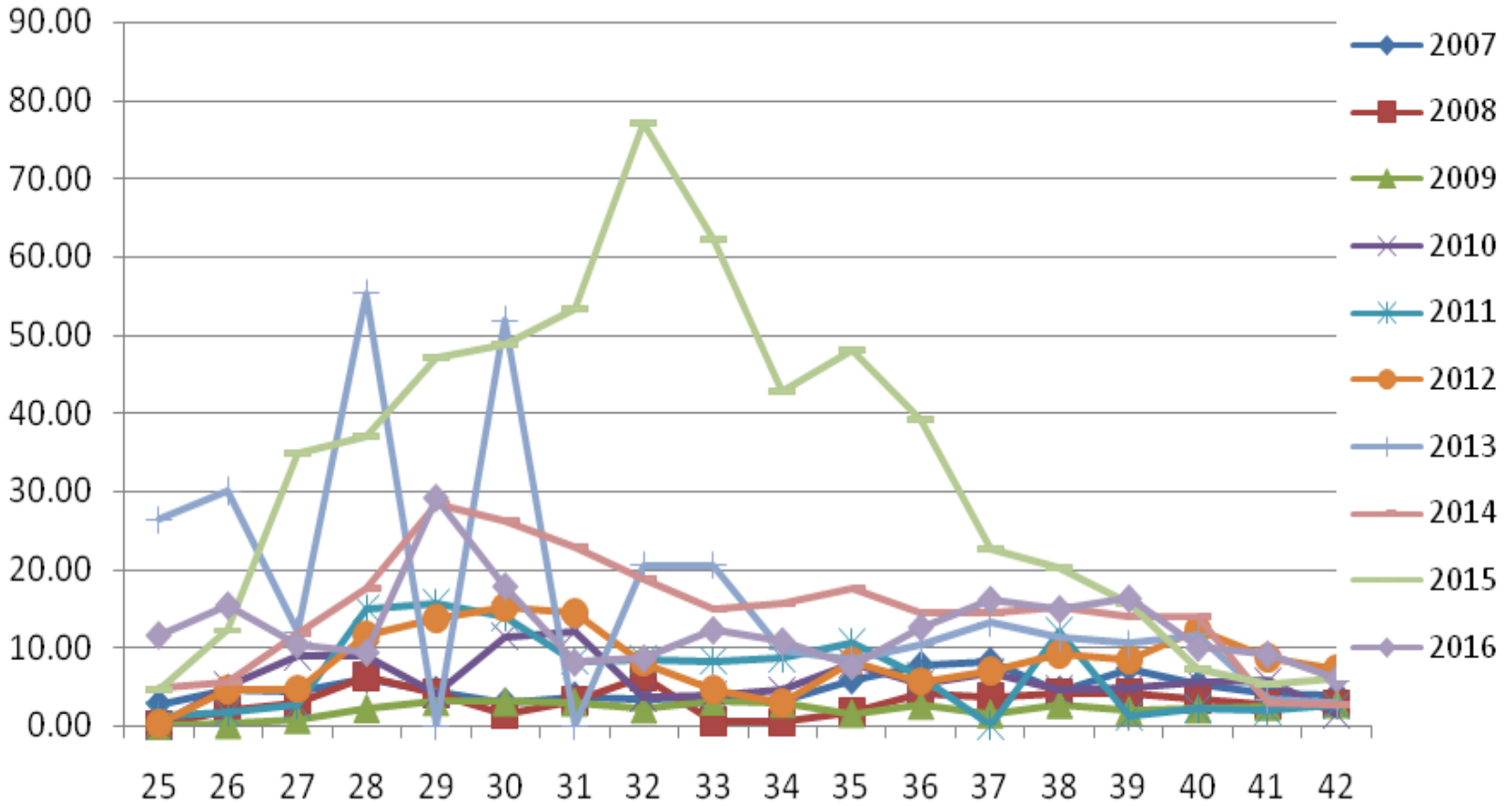
Population of whitefly recorded under unprotected conditions at Sirsa



During 2015-16, outbreak of whitefly in Punjab, Haryana and Rajasthan states of north India witnessed the crop loss estimated to be 40-50 per cent of the total or 1.5 to two million bales.

(Rishi Kumar)

Whitefly dynamics over the years in Punjab (BT)



CAUSES OF OUBREAKS IN NORTH INDIA

- Susceptible hybrids
- Hairy or bushy genotypes
- late sowing
- High nitrogenous fertilizers
- Indiscriminate use of pyrethroids, acephate, fipronil and mixtures
- Whitefly resistance to insecticides
- Scant regard for proper choice of control measures
- Improper spray
- Application methods
- Favourable weather

North India Whitefly population developed resistance to insecticides

Name of insecticide	Resistance in North India whitefly population (fold)
Bifentrin 10%EC	98-1400
Dinotefuron 20%SG	14-137
Acephate 75%SP	60-131
Acetamiprid 20%SP	21-331
Fipronil 5%SC	153-340
Triazophos 40%EC	371-2237
Buprofezin 25%SC	51-706
Imidacloprid 17.8%SL	9-512
Diafenthiuron 50%WP	40-347
Chlorpyriphos 20%EC	2-19
Thiamethoxam 30%FS	1-2
Clothianidin 50%WDG	2-7
Pyriproxifen 10%EC	2-23
Flonicamid 50%WG	1-6

- North India whitefly (*Bemisia tabaci* (Gennadius)) population infesting cotton developed resistance to almost all insecticides.
- Out of four locations studied (Sirsa, Sriganganagar Hisar and Mansa), the Hisar population was found highly resistance.
- These insecticides are most commonly used against whitefly on cotton and are with label claim.
- The study was conducted by taking adult population from different locations of north cotton-growing zone of India during 2015-16.
- Whitefly population from Nagpur was taken as susceptible population since it was not exposed to these insecticides during the season.

Diversity of mealybug species on cotton

1	Cotton mealybug *Phenacoccus solenopsis* Tinsley
2	Papaya mealybug *Paracoccus marginatus* Williams and Granara de Willink
3	Spherical mealybug *Nipaecoccus viridis* (Newstead)
4	Pink hibiscus mealybug *Maconellicoccus hirsutus* (Green)
5	Striped mealybug *Ferrisia virgata*
6	Mango mealybug *Rastrococcus iceryoides* (Green)
7	Ber Mealybug *Perissopneumon tamarindus* (Green)

Phenacoccus solenopsis

Paracoccus marginatus

R. iceryoides

P. tamarindus

Nipaecoccus viridis

Ferrisia virgata

M. hirsutus

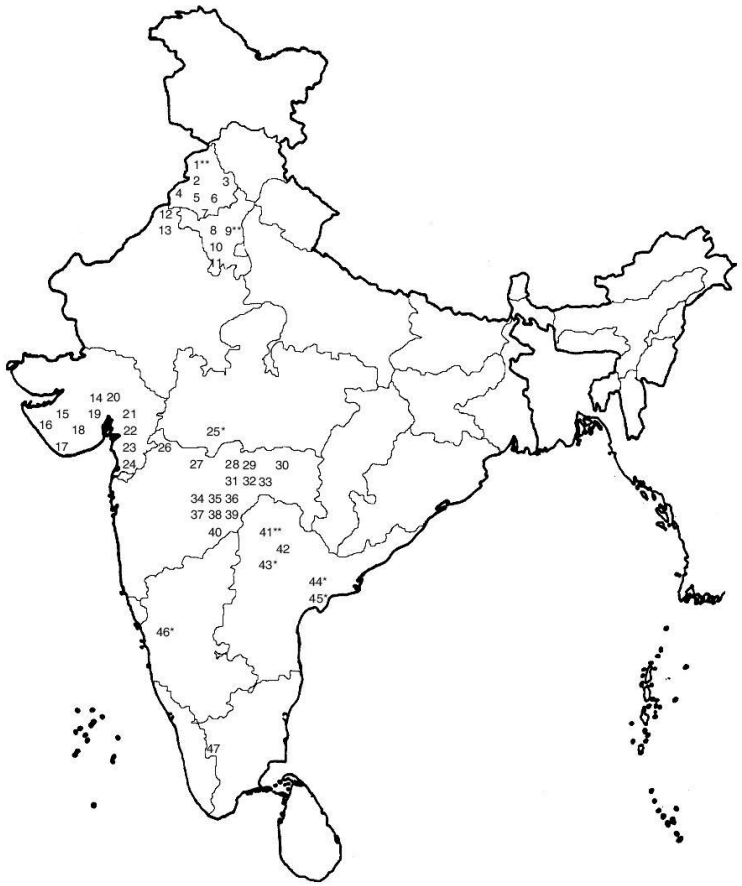


Fig. 1. Map of India indicating locations of insect collection.

* *M. hirsutus*; ** both *P. solenopsis* and *M. hirsutus* while remaining numbers show *P. solenopsis*.

Numbers in the map (in parenthesis below) indicate the following mealybug collection sites. Punjab: Firozpur (1), Faridkot (2), Ludhiana (3), Muktsar (4), Abohar (5), Bathinda (6), Mansa (7), Haryana: Fatehabad (8), Sirsa (9), Hisar (10), Bhiwani (11), Rajasthan: Sriganganagar (12), Hanumangarh (13), Gujrat: Surendranagar (14), Rajkot (15), Porbandar (16), Junagarh (17), Amreli (18), Bhavnagar (19), Ahmedabad (20), Anand (21), Vadodara (22), Bharuch (23), Surat (24) Madhya Pradesh: Khandawa (25), Maharashtra: Dhule (26), Buldhana (27), Akola (28), Amaravati (29), Nagpur (30), Washim (31), Yavatmal (32), Wardha (33), Aurangabad (34), Jalna (35), Hingoli (36), Bid (37), Parbhani (38), Nanded (39) Latur (40) Andhra Pradesh: Karimnagar (41) Warangal (42), Hyderabad (43), Amravathi (44), Guntur (45) Karnataka Dharwad (46). Tamil Nadu: Coimbatore (47).

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Widespread infestation of the exotic mealybug species, *Phenacoccus solenopsis* (Tinsley) (Hemiptera: Pseudococcidae), on cotton in India

V.S. Nagrare*, S. Kranthi, V.K. Biradar, N.N. Zade, V. Sangode, G. Kakde, R.M. Shukla, D. Shivare, B.M. Khadi and K.R. Kranthi

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Mealybug species	Infestation on cotton
 *Nipaecoccus viridis* (Newstead)	 Cotton plant infested *by N. viridis*
 *Ferrisia virgata* (Cockerell)	 Cotton plant infested by *F. virgata*
 *Maconellicoccus hirsutus* (Green)	 Cotton branch infested by *M. hirsutus*
 *Rastrococcus iceryoides* (Green)	 Cotton branch and boll infested by *R. iceryoides*
 *Perissopneumon tamarindus* (Green)	 Cotton stem infested by *P. tamarindus*

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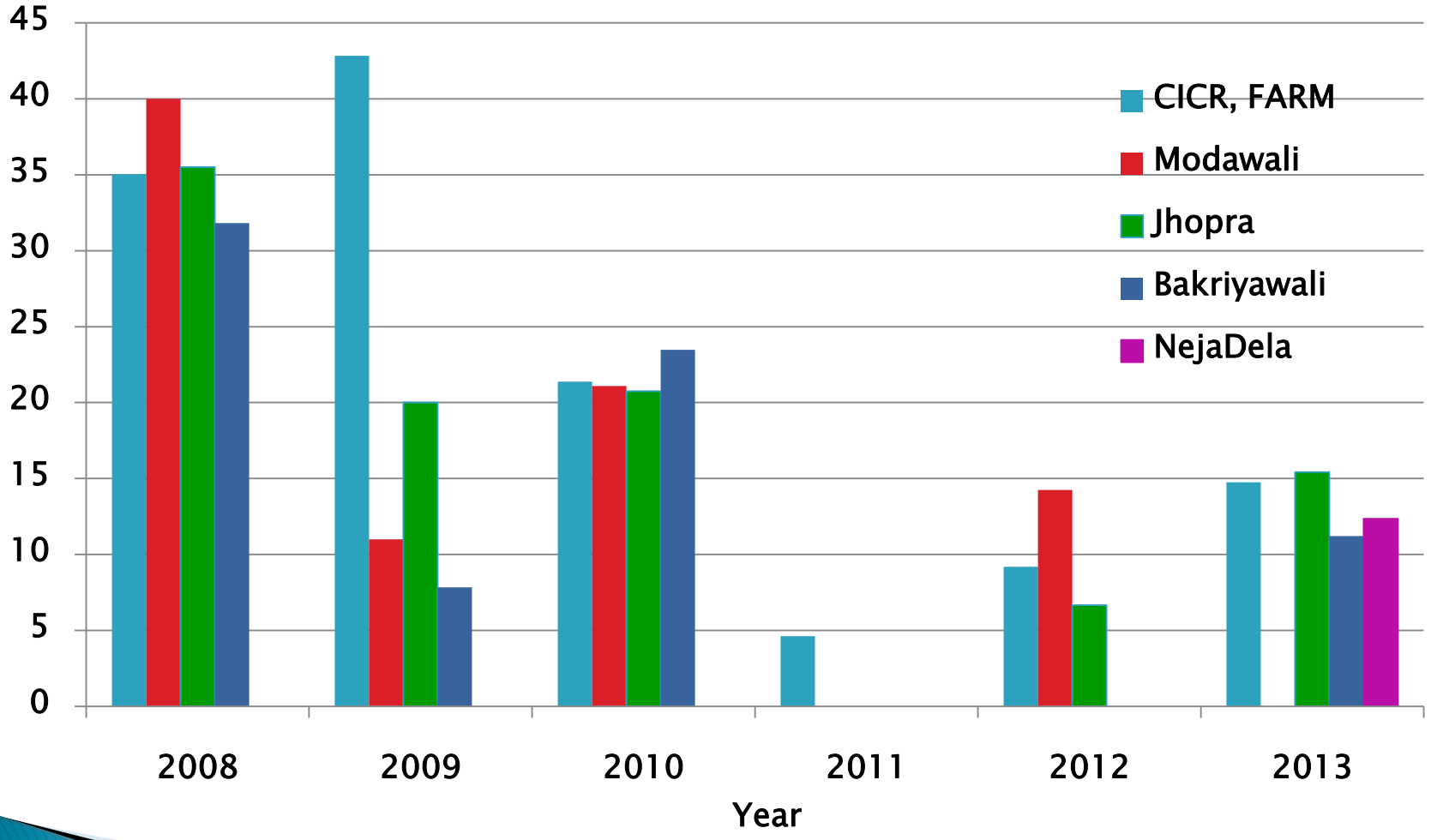
A record of five mealybug species as minor pests of cotton in India

V. S. Nagrare, Rishi Kumar, B. Dharajothi

Fig 1: Distribution of five mealybug species as minor pests of cotton in India
in the map (in parenthesis) indicate sites **Haryana:** Sirsa (1), **Maharashtra:** Amaravati (2), Nagpur (3), Wardha (4), **Tamil Nadu**: Salem (5), Coimbatore (6).
species composition: A *Nipaecoccus viridis*, B *Ferrisia virgata,* C *Maconellicoccus hirsutus,* D *Rastrococcus iceryoides,* E *Perissopneumon tamarindus*

Mealy bug incidence (%) in North India



Mirid diversity

Adult *Creontiades biseratense*

Nymph *C.biseratense*

C. biseratense was the most predominant in cotton-pulse/maize cropping system in the south zone

Campylomma livida

Nymph *C.livida*

Campylomma livida Reuter and Hyalopeplus lineifer Walker were found in the central and north zones in cotton- wheat and cotton+ pigeonpea intercropping system.

Hyalopeplus lineifer

Nymph *H. lineifer*

Mirid bug *Creantiades biseratense*

Month/ Fortnight		Mirid bugs per 100 squares± S.D.												
		Shiggaon		Savanur		Ranebennur			Hirekerur		Hanagal		Haveri	
		Bisanalli	Kabanur	Hattimattur	Hiremagadur	Kakol	Ankasapur	Belur	Rattihalli	Hiremorab	Adur	Akkialur	Aladakatti	Totad Yellapur
Aug 2010	I FN	0	0	0	0	0	0	0	0	0	0	0	0	0
	II FN	0	0	0	0	0	0	0	0	0	0	0	0	0
Sept 2010	I FN	9	23	45	29	20	19	17	56	52	12	16	47	42
	II FN	33	56	114	65	54	49	53	109	103	31	48	91	84
Oct 2010	I FN	64	101	140	84	82	90	80	155	137	49	67	144	135
	II FN	114	153	198	147	124	115	118	218	203	117	102	195	184
Nov 2010	I FN	207	170	261	234	154	242	151	281	270	175	155	258	242
	II FN	191	217	332	318	272	310	280	390	341	247	231	367	341
Dec 2010	I FN	143	187	263	215	151	160	178	323	303	159	180	272	259
	II FN	109	133	163	156	116	131	146	225	243	114	104	195	173
Jan 2011	I FN	53	63	115	97	64	74	81	141	144	69	68	127	117
	II FN	34	36	58	59	40	51	56	66	72	35	37	58	42
Feb 2011	I FN	9	12	13	21	15	16	18	23	26	11	14	18	13
	II FN		-	-	-	-	-	-	-	-	-		-	-
Mar-2011	I FN	-	-	-	-		-	-	-	-	-	-	-	-
	II FN	-	-	-	-		-	-	-	-	-	-	-	-
Apr-2011	I FN	-	-	-	-		-	-	-	-	-	-	-	-
	II FN	-	-	-	-		16*	13*	-	-	-	-	-	
May-2011	I FN	-	-	-			68*	59*	-	-	-	-	-	-
	II FN	-	-	-	-		125*	122*	-	-	-	-	-	-
June -2011	I FN	-	-	-	-		223*	208*	-	-	-			
Mean±S.D.		87.8± 70.2	104.6± 71.3	154.7± 100.7	129.1± 94.0	99.3± 75.4	105.9± 81.7	108.3± 77.0	180.4± 115.6	172.2± 106.7	95.5± 80.5	92.6± 70.5	164.5± 108.3	148± 103.2

* Summer crop FN- Fortnight

Manohar et al. 2012

C. biseratense is appearing in Karnataka since 2005 and posing a threat to the Bt cotton cultivation in several parts of Karnataka, Tamil Nadu, Andhra Pradesh and Maharashtra (Patil *et al., 2006,* Surulivelu and Dhara Jothi, 2007; Udikeri *et al. 2010).*

Amrasca biguttula biguttula Resistance to Imidacloprid

	n	LC_{50}	LL	UL	LC_{90}	Slope	SE	ChiSq	RR
Bhatinda	600	**0.00002**	0.00001	0.0001	**0.007**	0.49	0.09	2.17	**1**
Hisar	600	**0.00005**	0.00001	0.0003	**0.003**	0.7	0.13	5.01	**2.5**
Nagpur	473	**0.0001**	0.00001	0.0003	**0.0017**	1.1	0.28	0.426	**6**
Coimbatore	400	**0.0001**	0.00001	0.0004	**0.0028**	0.98	0.23	0.87	**7**
Adilabad	309	**0.001**	0.00048	0.0016	**0.015**	1.09	0.17	1.01	**50**
Rajkot	750	**0.0025**	0.0003	0.007	**0.913**	0.502	0.08	0.87	**125**
Yavatmal	316	**0.003**	0.0005	0.01	**0.196**	0.74	0.08	8.66	**150**
Jamnagar	900	**0.0065**	0.001	0.016	**0.1**	1.07	0.066	27.29	**325**
Junagarh	900	**0.007**	0.0036	0.013	**0.082**	1.23	0.07	15.99	**350**
Akola	124	**0.008**	0.0046	0.013	**0.07**	1.37	0.23	2.78	**400**
Warangal	305	**0.011**	0.0009	0.042	**0.362**	0.86	0.1	17.4	**550**
Jalgaon	325	**0.0114**	0.0015	0.0247	**0.085**	1.46	0.16	3.38	**570**
Amaravati	327	**0.015**	0.007	0.026	**0.156**	1.27	0.13	3.03	**750**
Indore	330	**0.0158**	0.002	0.041	**0.163**	1.26	0.13	9.51	**790**
Surendranagar	750	**0.016**	0.0001	0.054	**0.45**	0.89	0.08	27.44	**800**
Jalna	475	**0.036**	0.015	0.075	**0.021**	0.95	0.08	10.7	**1800**
Wardha	108	**0.109**	0.056	0.236	**2.77**	0.91	0.19	1.53	**5450**

Jassid developed resistance to some of the widely used insecticides like Imidacloprid, Thiomethoxam, Acephate, Monocrotophos up to 5040, 2500, 110 and 54 fold respectively (CICR, 2010)

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RESEARCH ARTICLE

Mitochondria COI-based genetic diversity of the cotton leafhopper *Amrasca biguttula biguttula* (Ishida) populations from India

Sandhya Kranthi[a], Amol Bharat Ghodke[a], Raghavendra K. Puttuswamy[a], Madhumita Mandle[a], Ritu Nandanwar[a], Usha Satija[a], Rishi Kumar Pareek[b], Himanshu Desai[c], Shashikant S. Udikeri[d], Dhara Jothi Balakrishna[e], Bheemanna M. Hugar[f], Dilip Monga[b] and Keshav R. Kranthi[a]

- Genetic divergence analysis of leaf hopper population across India confirmed the presence of single species.
- Thirty haplotypes, in total, were determined across different regions of India.
- Population from North India was dominated by single haplotype,
- South and central Indian populations show dispersion of different haplotypes across the region.

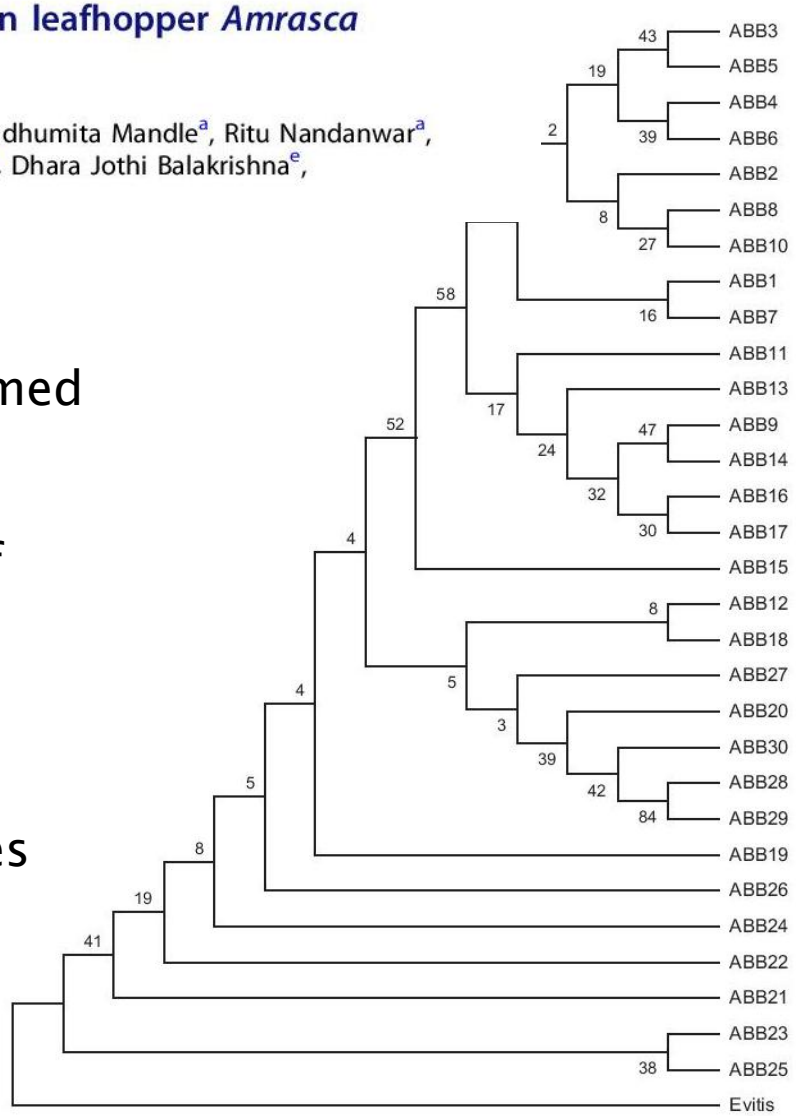
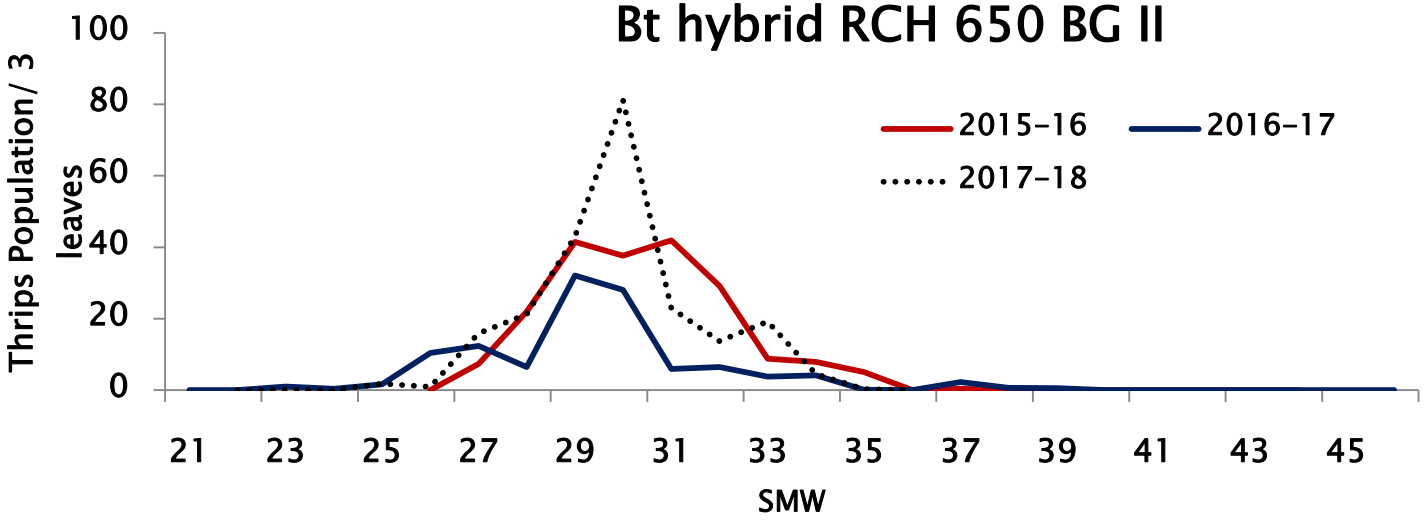
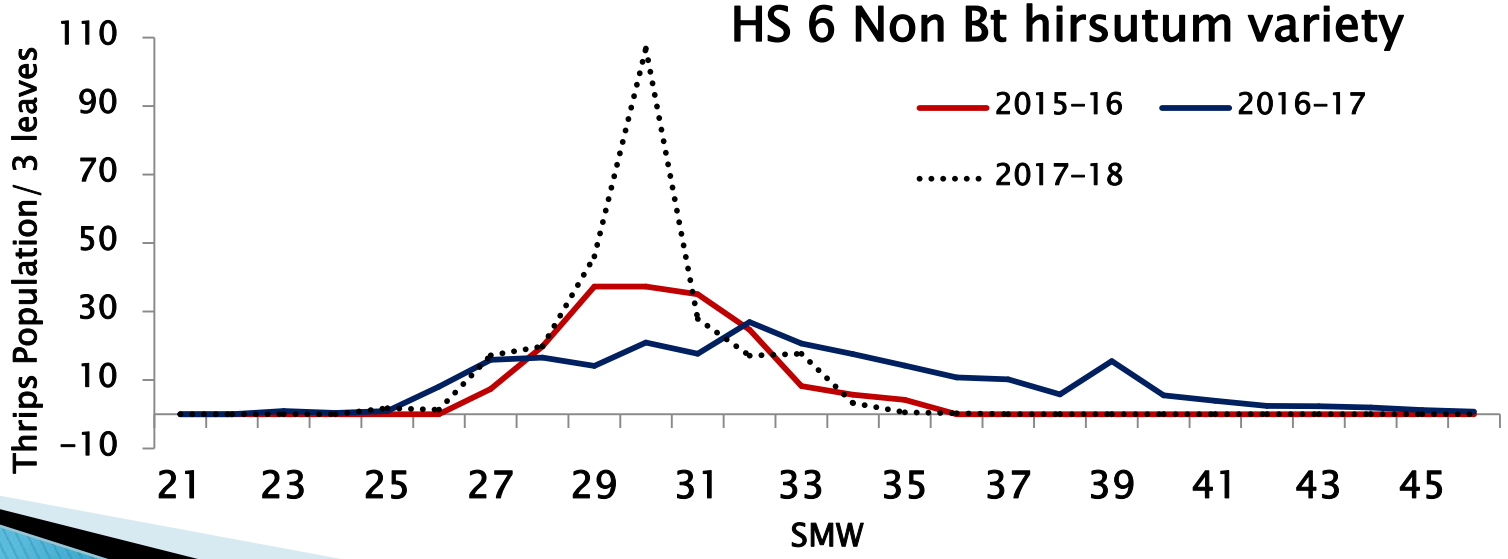


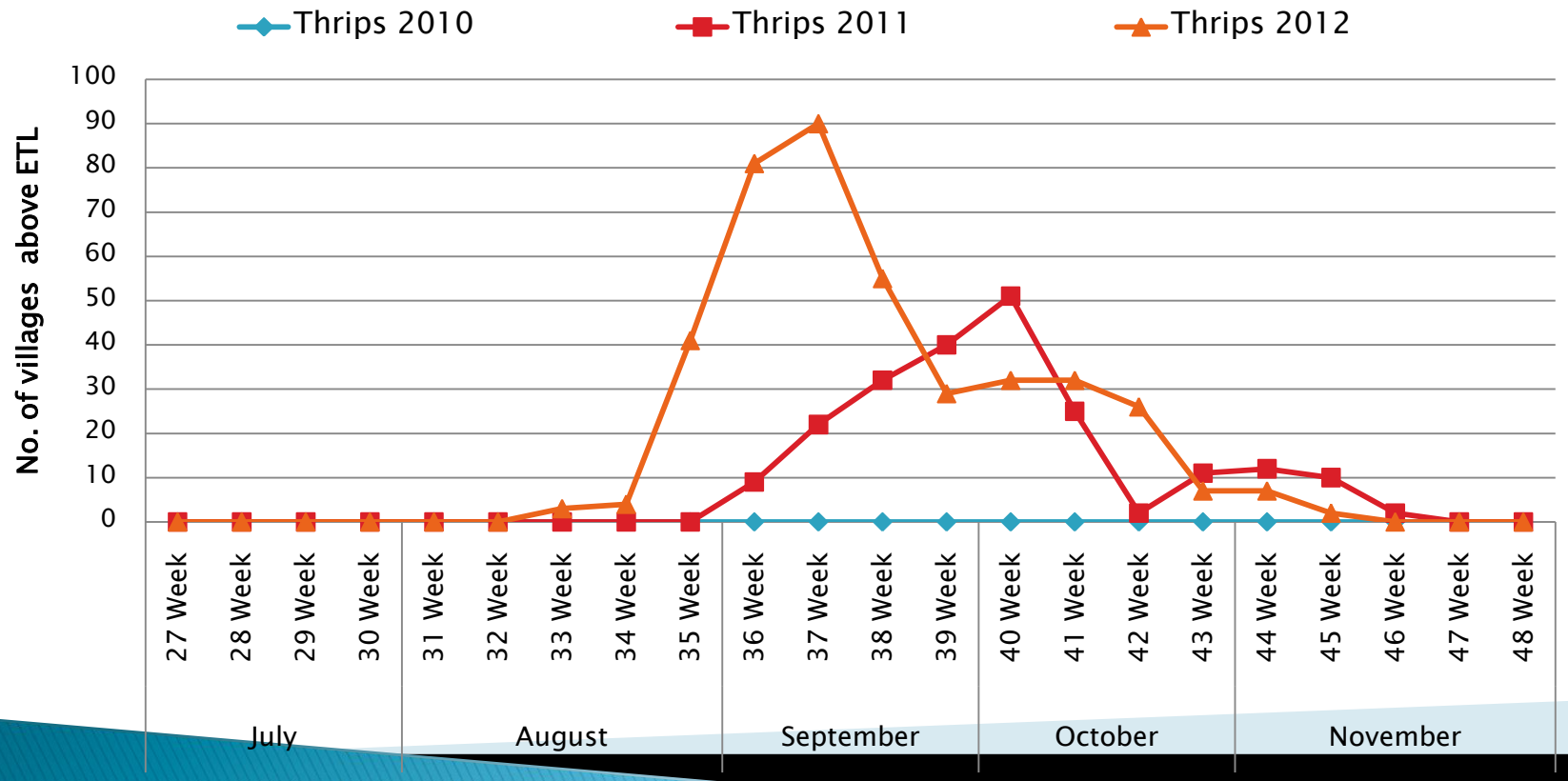
Figure 3. Phylogenetic tree of the 30 mtCOI DNA haplotypes in the *A. biguttulla biguttulla*.

Incidence of thrips in North India (unprotected conditions)



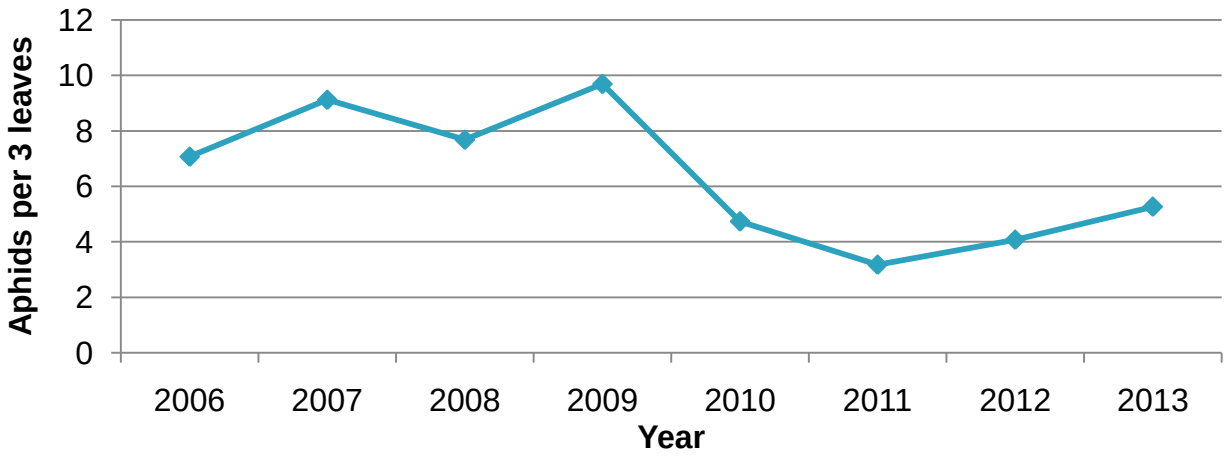


Scenario of Thrips in Maharashtra



Viral diseases like TSV in cotton transmitted by *T. tabaci* have been recorded in Warangal district of Andhra Pradesh during the months of September and October.

Aphid scenario in central India (Nanded)



New Disease Reports (2012) 25, 22. [doi:10.5197/j.2044-0588.2012.025.022]

New Disease Reports

First report of *Polerovirus* of the family *Luteoviridae* infecting cotton in India

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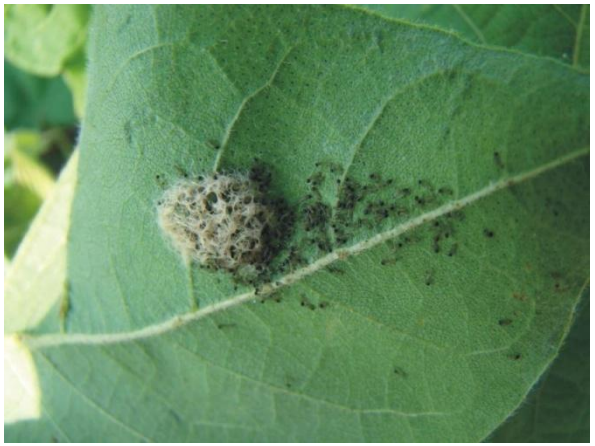
Tobacco leaf eating caterpillar


- Two species occur on cotton in India- *S. litura* and *S. exigua* and intra-specific variation exists in their tolerance to cry toxins with *S. exigua* being more susceptible as compared to *S. litura.*
- Bt cotton harboring *cry1Ac* gene does not offer protection against this lepidopteran pest as *Spodoptera* larvae do not have receptor sites for the binding of *cry1Ac* (Lalitha *et al.,* 2012).
- Bollgard II that harbors the *cry1Ac* and *cry2Ab* genes is moderately effective against *Spodoptera*.

T Mosquito bug *Helopeltis bradyi* Waterhouse



- Both the nymph and adults of the species suck cell sap from foliage, squares and bolls.
- Leaves get rolled at the edge.
- Cankers develop on green bolls.
- Linear scars with white papery layer appear in tender shoots.
- The affected plant's growth retards.
- Rottening of bolls takes place
- Prominent in Karnataka &Tamil Nadu.

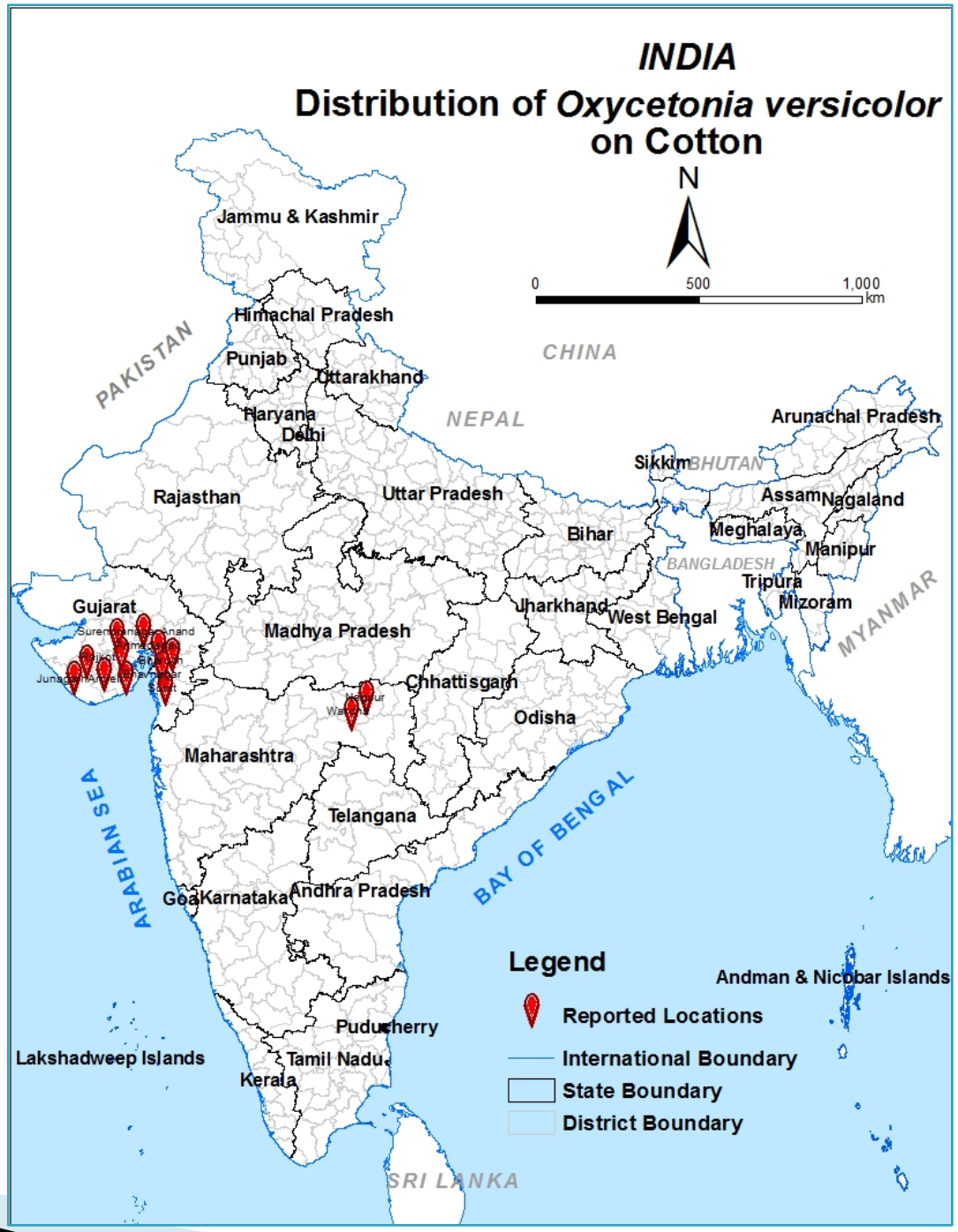
Flower bud maggot

Dasineura gossypii Fletcher

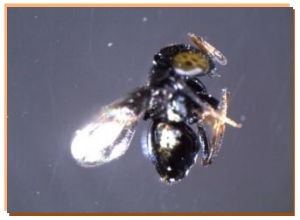
- The maggots are the damaging stage feed on anthers and stamenal column
- The infested flower buds fail to grow normally.
- Flower dies due to degradation of flower organs.
- Squares do not develop into bolls.
- Drying of tissue or death of flower
- The bolls do not to reach normal size.
- The pest was reported from Tamil Nadu.

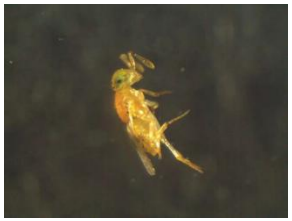
Red cotton bug & Dusky cotton bug

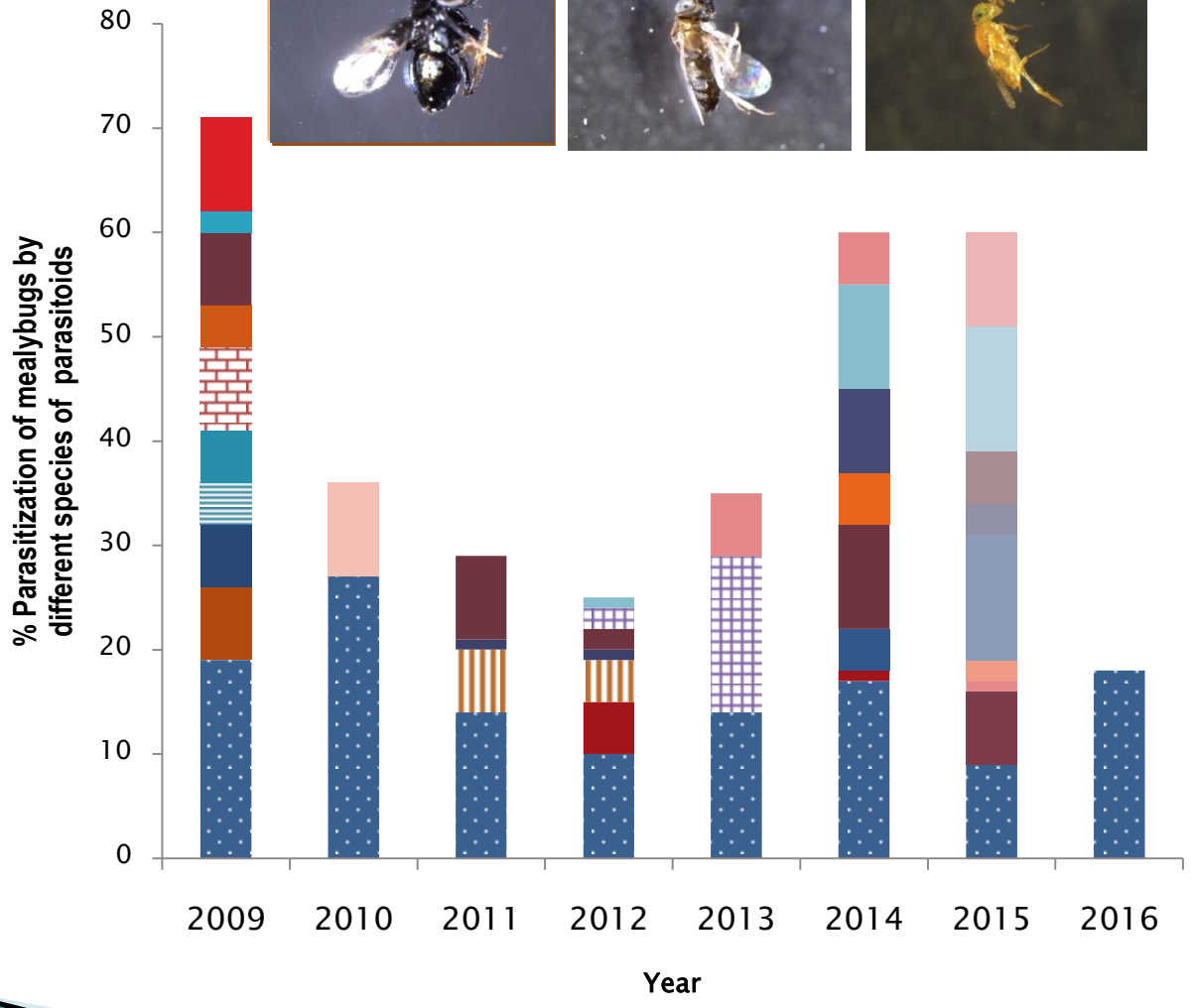
(Chinna Babu Naik et al in press)



Mealybug Parasitoid diversity during 2009 to 2016





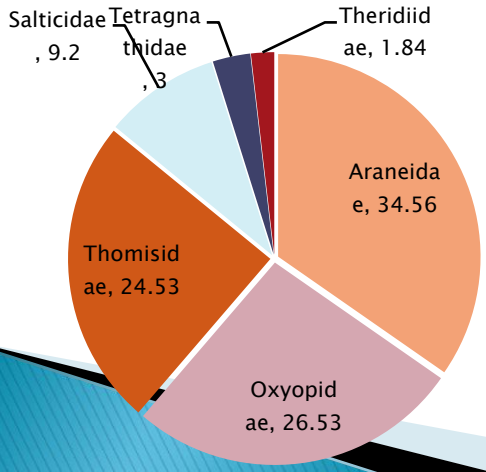


- *M. hirsutus- A. kamali*
- *R. icerodes -P. unifasciativentris*
- *R. icerodes -P. mexicana*
- *R. icerodes -A. kamali*
- *P. marginatus -P. unifasciativentris*
- *P. marginatus -P. mexicana*
- *P. marginatus -Aprostocetus spp.*
- *P. marginatus -A. papayae*
- *N. viridis-P. unifasciativentris*
- *N. viridis-P. mexicana*
- *N. viridis-P.albiniculus*
- *N. viridis-A. kamali*
- *N. viridis-Aprostocetus spp.*
- *P. solenopsis-Prochiloneurus pulchellus*
- *P. solenopsis-Pachyneuron leucopiscida*
- *P. solenopsis-P. unifasciativentris*
- *P. solenopsis-P.albiniculus*
- *P. solenopsis-Metaphycus*
- *P. solenopsis-Homalotylus albiclavatus*
- *P. solenopsis-Encyrtus aurantii*
- *P. solenopsis-Chartocerus kerrichi*
- *P. solenopsis-Aprostocetus spp*
- *P. solenopsis-Aprostocetus bangaloricus*
- *P. solenopsis-Anagyrus mirzai*
- *P. solenopsis-Anagyrus dactylopii*
- *P. solenopsis-A. kamali*
- *P. solenopsis-A. arizonesis*

16 parasitoid and 8 predators.

Spider diversity in Cotton agro-ecosystem

Sr. no	Common name	Scientific name	Family
1	Orb weavers	*Neoscona theisi* (Walckenaer,1841)	Araneidae
2		*Eriovixia excelsa* (Simon,1889)	
3		*Leucauge decorata* (Blackwall,1864)	Tetragnathidae
4	Lynx spider	*Oxyopes pankaji* (Gajbe &Gajbe,2000)	Oxyopidae
5	Crab spider	*Thomisus spectabilis* (Doleschall, 1859)	Thomisidae
6		*Thomisus species* (Walekenaer ,1805)	
7		*Lysiteles catulus* (Simon,1895)	
8		*Diaea sp.* (Thorell,1869)	
9		*Thomisus okinawensis* (Strand,1907)	
10	Jumping Spider	*Bianor species* (Peckham & peckham,1886)	Salticidae
11		*Thyene imperialis* (Rossi,1846)	
12		*Phintella vittata* (C.L.Koch,1846)	
13		*Phlegra species* (Simon,1876)	
14	cob web spiders	*Theridula gonygaster* (Simon,1873)	Theridiidae
15		*Romphaea sp.*	



Per cent distribution of spiders in to families


Neoscona theisi


Thomisus sp.


Thomisus spectabilis


Leucauge decorata


Diaea species


Lysiteles catulus


Oxyopes pankaji


Phintella vittata


Thyene imperialis


Bianor sp.


Phlegra sp.


Theridula gonygaster


Romphaea sp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Thank you