

Pink bollworm menace on *Bt*-cotton in India

critical insights and way forward

Keshav Kranthi

Head, Technical information Section



International Cotton
Advisory Committee





16 Nov 2017

Pink bollworm may eat up half of Maharashtra's cotton crop

<http://www.thehindu.com/news/cities/mumbai/pink-bollworm-may-eat-up-half-of-states-cotton-crop/article20493492.ece>

22 Nov 2017

Pink bollworm tears into the very fibre of Maharashtra's cotton growers

<https://www.thehindubusinessline.com/economy/agri-business/pink-bollworm-tears-into-the-very-fibre-of-maharashtras-cotton-growers/article9969934.ece>

23 Nov 2017

India cotton exports to drop as pink bollworms eat crop

<https://www.reuters.com/article/india-cotton-exports/india-cotton-exports-to-drop-as-pink-bollworms-eat-crop-idUSL3N1NT1ZS>

24 Jan 2018

Maharashtra cuts cotton forecast on worm infestation

<http://www.newindianexpress.com/business/2018/jan/24/maharashtra-cuts-cotton-forecast-on-worm-infestation-1762730.html>

7 Feb 2018

6 debt ridden farmers commit suicide in Marathwada

<http://kashmirage.net/2018/02/07/6-debt-ridden-farmers-commit-suicide-marathwada/>

21 Feb 2018

To Bt or not to Bt: 60 lakh cotton farmers or a handful of vested interests?

<http://indianexpress.com/article/india/to-bt-or-not-to-bt-60-lakh-cotton-farmers-or-a-handful-of-vested-interests-5073403/>



8 Feb 2018

74 have farmers committed suicide in Marathwada region since beginning of 2018: Govt statistics

<http://www.uniindia.com/74-have-farmers-committed-suicide-in-marathwada-region-since-begining-of-2018-govt-statistics/states/news/1131639.html#UG126MGXjXrqLrOk.99>

14 Feb 2018

35 pink bollworm pest affected farmers arrested after police foil their bid to immolate themselves in Aurangabad

<https://news.webindia123.com/news/Articles/India/20180215/3276875.html>

14 Feb 2018

Farmers demand compensation against boll worm

<https://timesofindia.indiatimes.com/city/aurangabad/farmers-demand-compensation-against-boll-worm/articleshow/62921711.cms>

15 Feb 2018

In Maharashtra, vicious cycle of cotton farmers' woes continues

<https://www.hindustantimes.com/mumbai-news/in-maharashtra-vicious-cycle-of-cotton-farmers-woes-continues/story-DkbE5YfkOKGc0YcYBVzBuK.html>

15 Feb 2018

After pink bollworm attack, Maharashtra to promote short duration varieties of cotton

<http://www.financialexpress.com/industry/after-pink-bollworm-attack-maharashtra-to-promote-short-duration-varieties-of-cotton/1066557/>



PINK BOLLWORM

Infestation

Why did it resurface after 30 years
Why is it on a rampage?

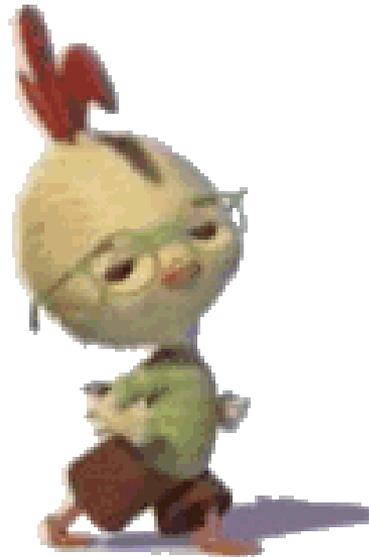
Resistance

Why did it adapt so fast?
Why did this happen only in India?



Infestation

Why did it resurface after 30 years



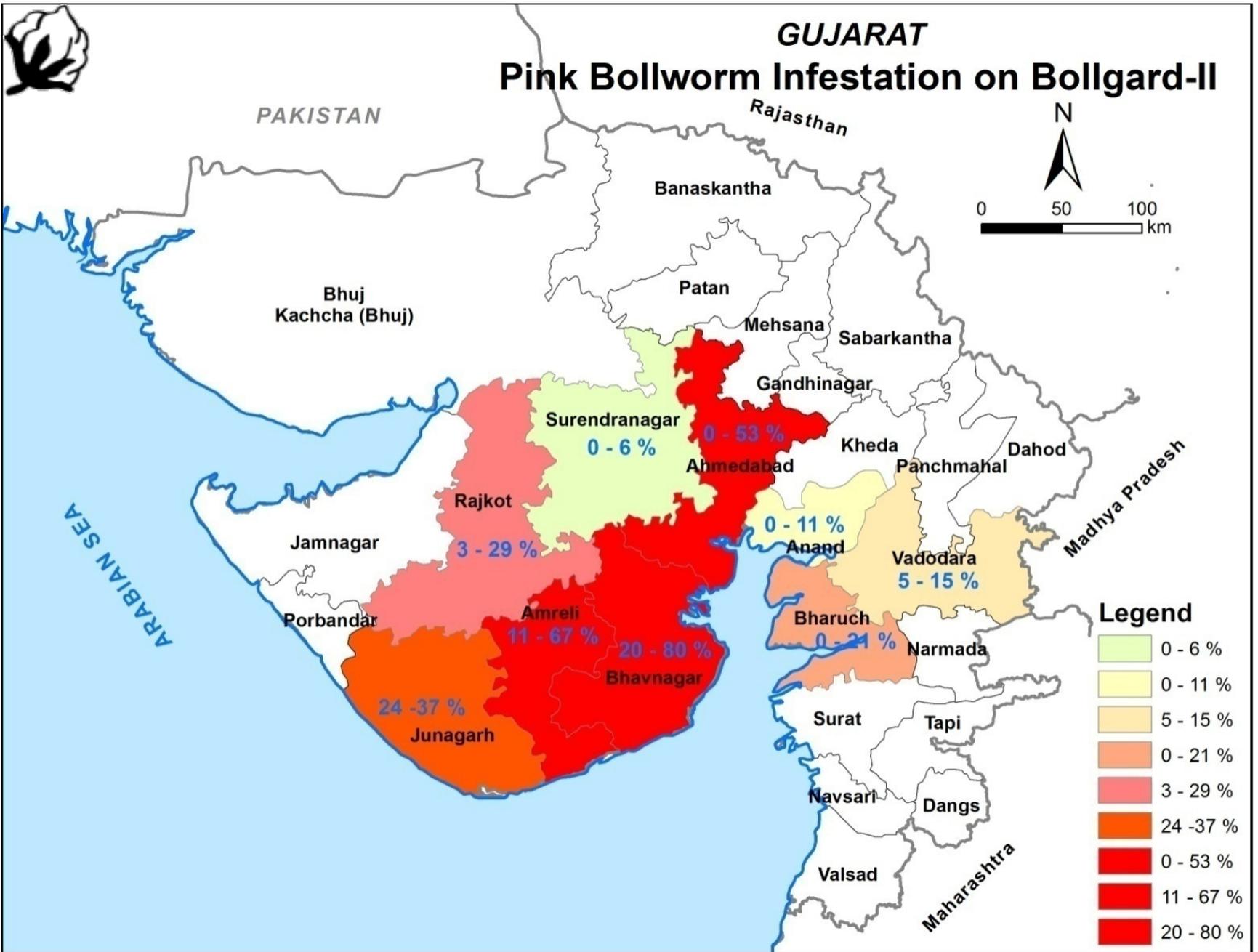


Sporadic appearance of Pink bollworm (1980-2000)

Extended crop in preceding years

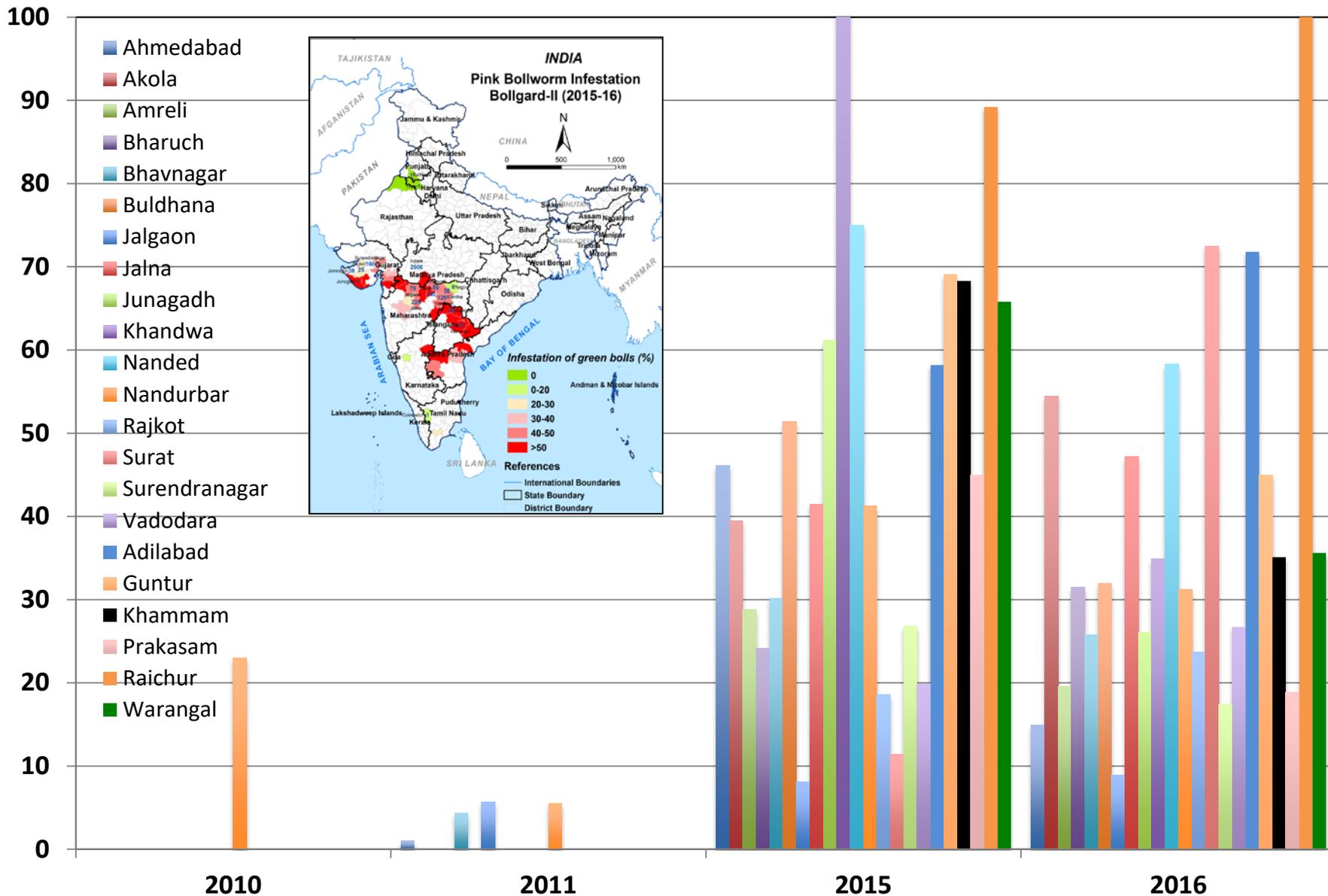


1035 moths in a single trap,
Janthmer, Bhavnagar 2014





PBW Larval recovery (%) from Bollgard-II bolls



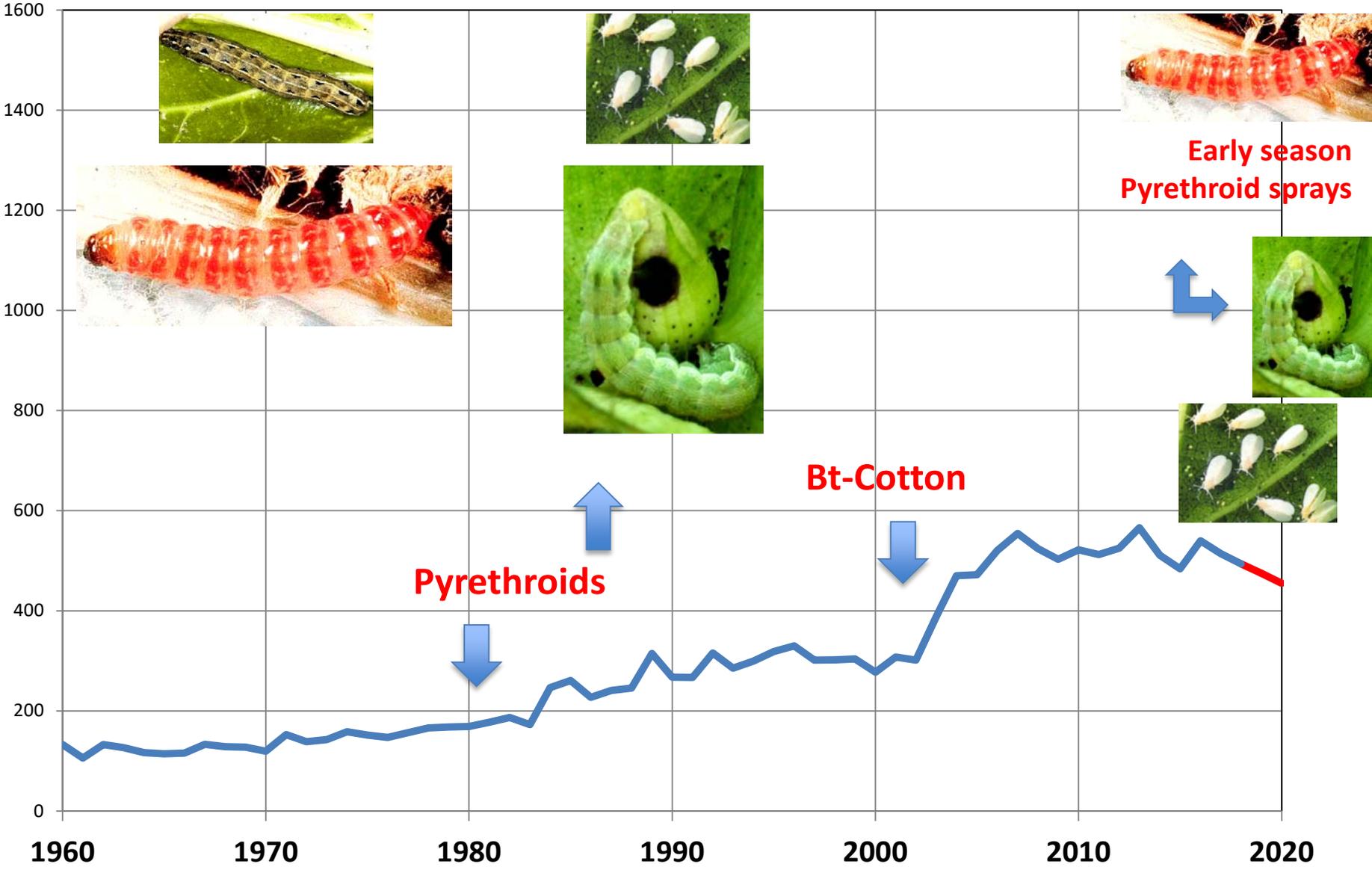


Shifts in Bollworm Dynamics

Long season cotton

Short-medium season cultivars

Long season Bt-hybrids



Early season
Pyrethroid sprays



Pyrethroids

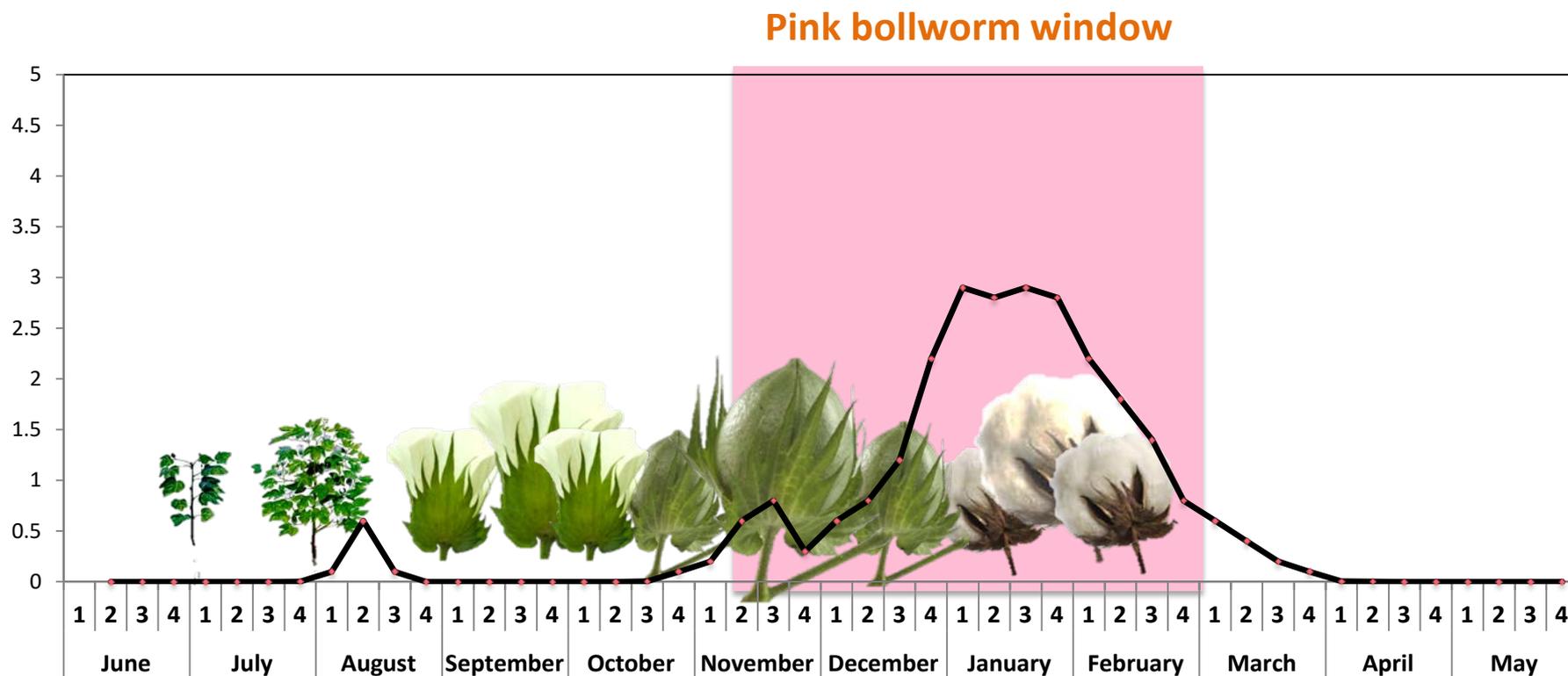
Bt-Cotton

1960 - 1980



LONG DURATION CULTIVARS: 180-240 days duration

Major Pest: Pink bollworm

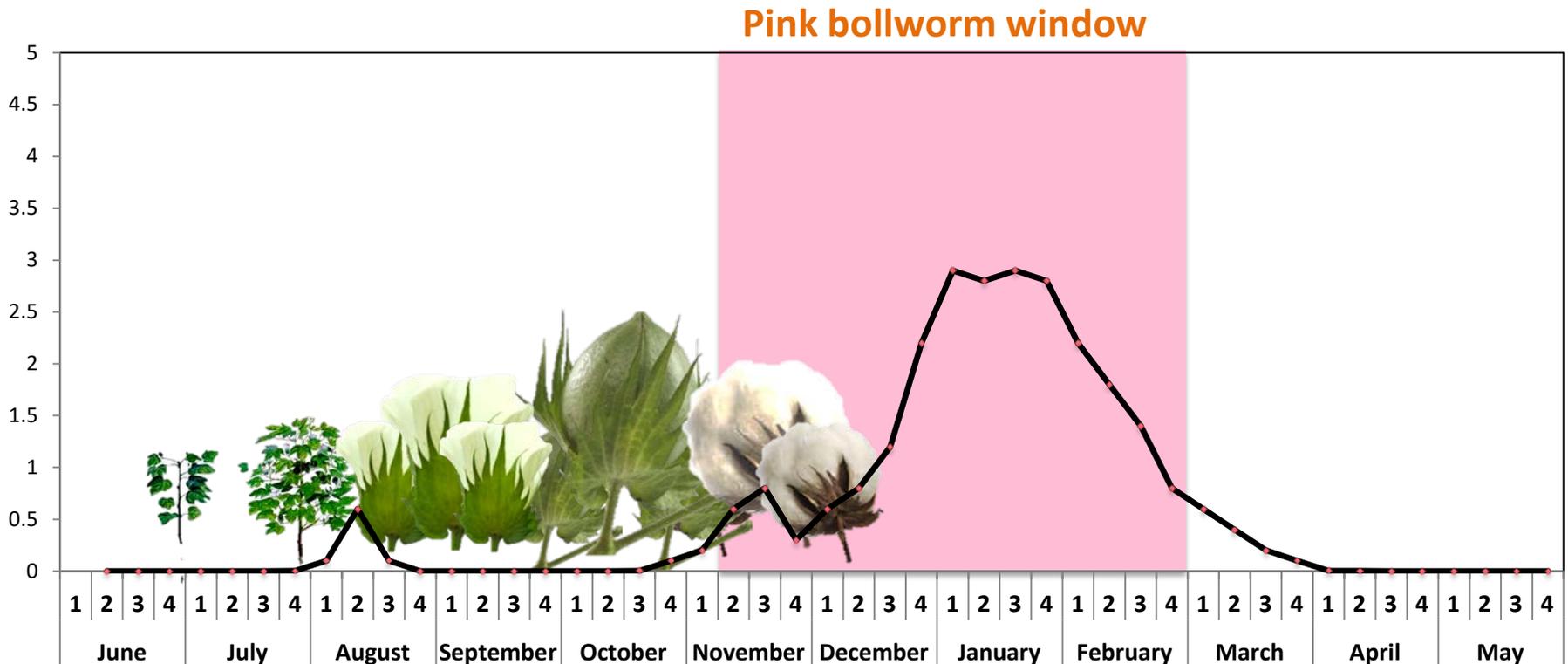


1980 - 2007



What drove the Pink bollworm away after 1981?

1. **New short season cultivars: 150-180 days**
2. **Pyrethroids** from 1981-1998
3. ***Bt*-cotton** from 2002-2007
4. **Timely crop termination:** poor quality late picked cotton



2007 - 2017

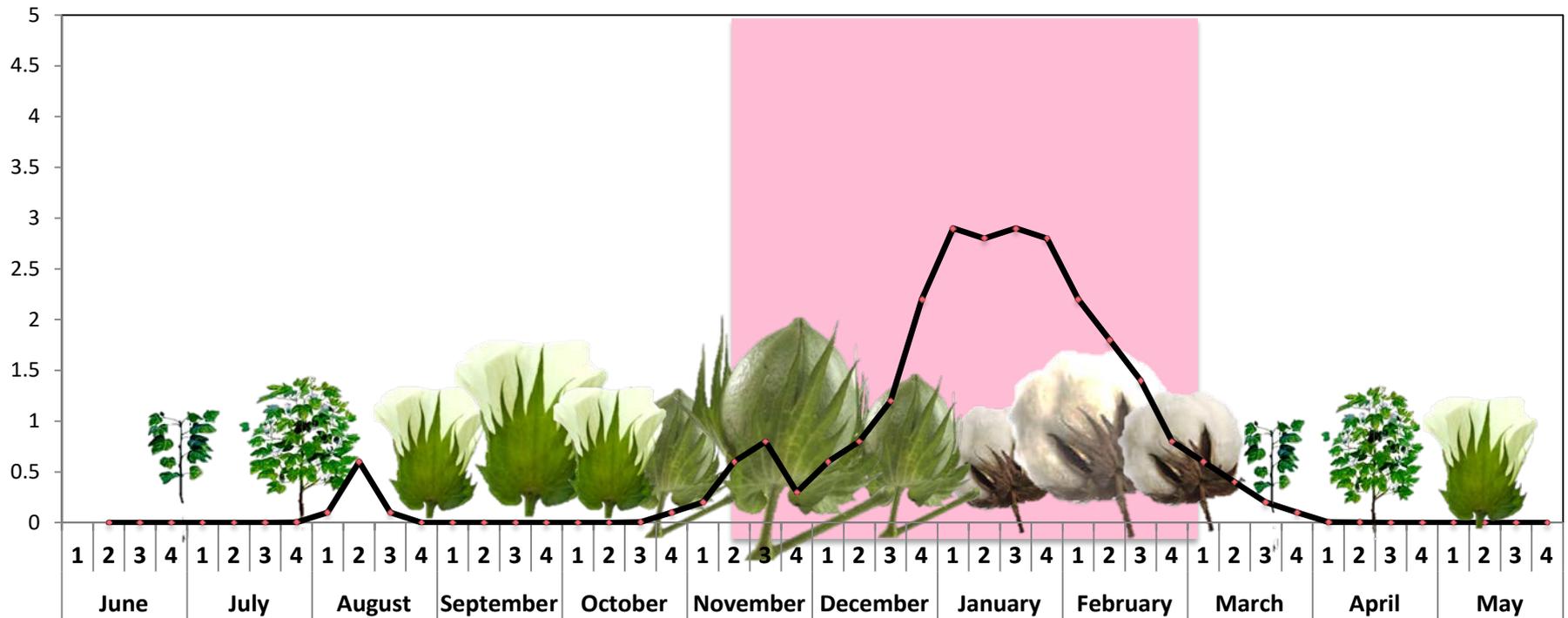


What brought the Pink bollworm back?

Good Food and Happy hours all year round

1. Hemizygous *Bt*-genes: Bolls have non-Bt seeds
2. >2000 *Bt*-hybrid cultivars: Provide flowers + bolls in overlapping windows
3. Long duration *Bt* hybrids + staggered sowing + extended crop
4. Reduced pyrethroid usage due to *Helicoverpa* resistance

Pink bollworm window





Resistance

Why did it adapt so fast?
Why did this happen only in India?





Field-evolved resistance to *Bt* toxin Cry1Ac in the pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae), from India

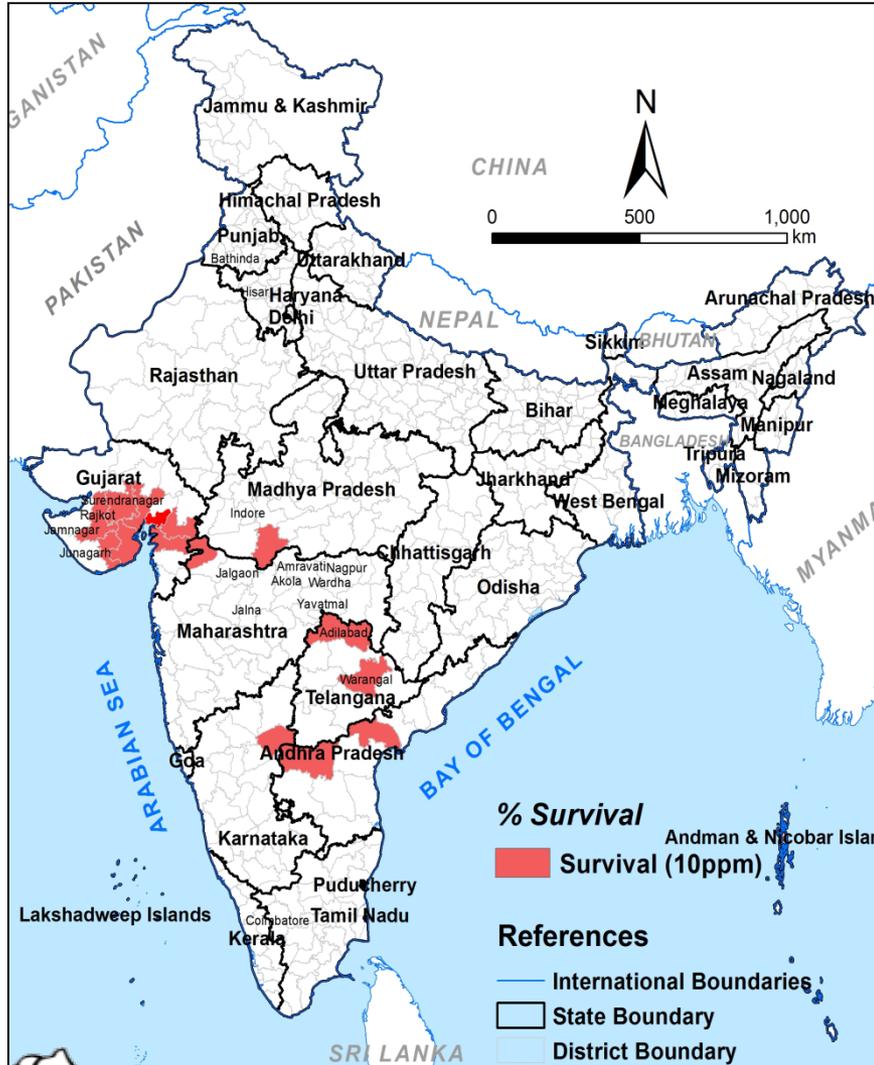
Sanyasi Dhurua and Govind T Gujar*

Susceptibility to Cry1Ac of *Pectinophora gossypiella* larvae from India

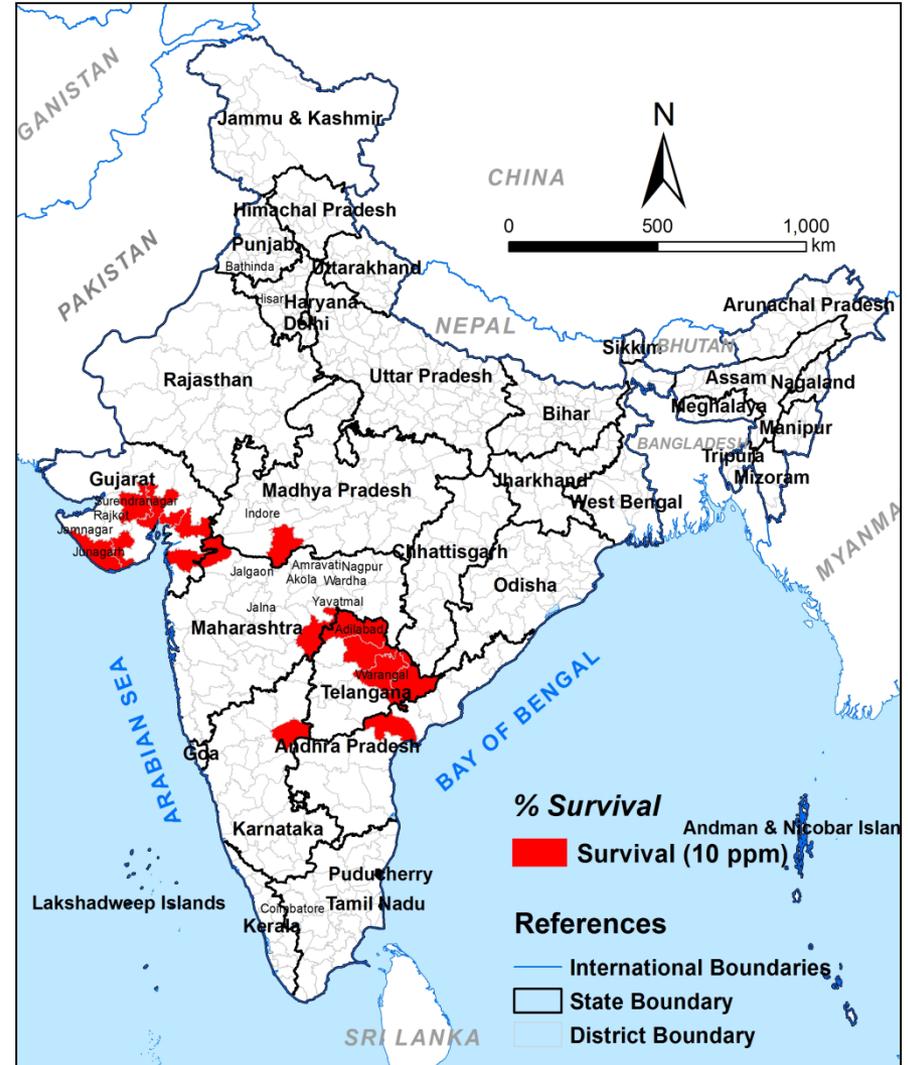
Population	Date of collection	Date of bioassay	LC ₅₀ (95% fiducial limits) (µg AI mL ⁻¹)	RR ^a	Slope ± SE	Mortality ^b (%) at 1 µg AI mL ⁻¹
Adilabad	22.12.2007	26.05.08	0.037 (0.013–0.089)	1	1.4 ± 0.4	100
Adilabad	12.01.2009	22.2.09	0.057 (0.037–0.088)	1.5	3.0 ± 0.7	100
Akola	15.12.2008	19.1.09	0.059 (0.039–0.090)	1.6	2.0 ± 0.3	96
Amreli	17.11.2008	16.12.08	1.75 (0.959–24.80)	47	1.9 ± 0.7	31
Amreli	17.11.2008	27.1.09	1.54 (1.110–2.200)	42	1.7 ± 0.3	24
Delhi	30.12.2007	30.6.08	0.052 (0.032–0.083)	1.4	1.6 ± 0.3	96
Delhi	30.12.2007	1.7.08	0.042 (0.021–0.074)	1.1	1.2 ± 0.2	96
Guntur	09.01.2009	17.2.09	0.056 (0.037–0.863)	1.5	1.8 ± 0.3	96

PINK BOLLWORM RESISTANCE TO BOLLGARD-II

Resistance to Cry1Ac

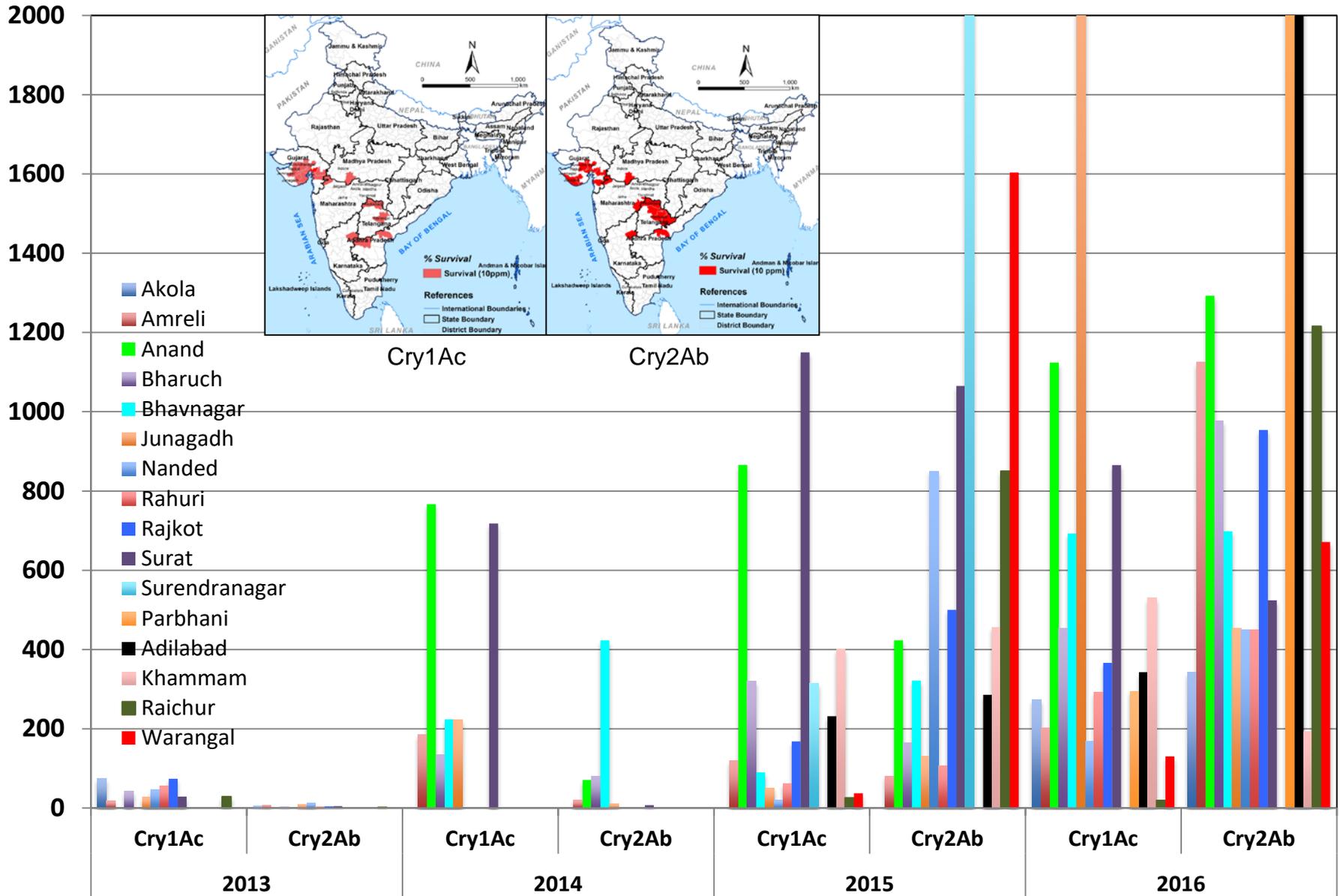


Resistance to Cry2Ab





PBW Resistance Ratios across central and south India



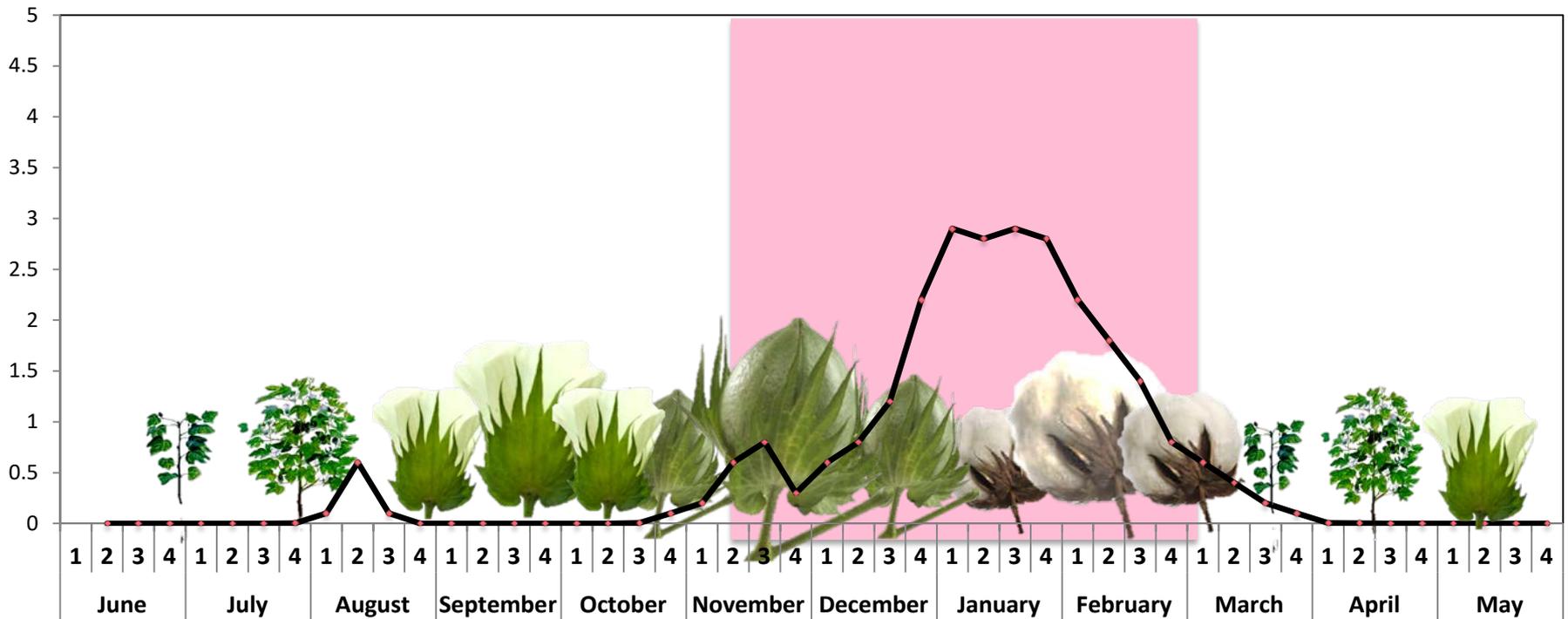
2006 - 2017



What accelerated resistance?

1. Extra insect generations in long duration extended crop
2. Hemizygous Bt-genes: Bolls have non-Bt seeds: Larval movement
3. Area saturation & poor quality refuge seeds: (Kranthi et al., 2017)

Pink bollworm window

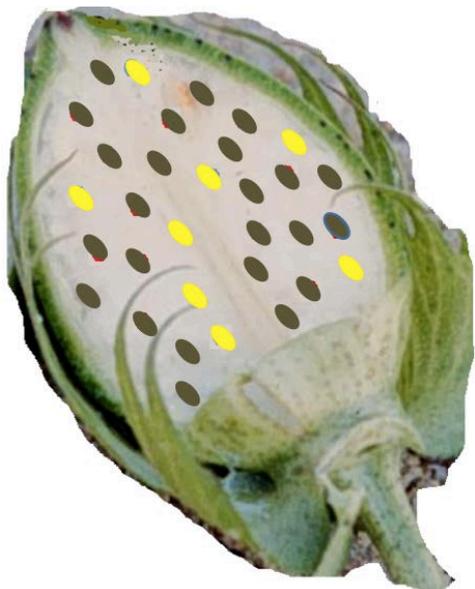


Bt is available in India only as hybrids



Bolls of Bt-cotton

25% developing seeds in BG & 6.25% in BG-II do not have Bt



BG: 75% seeds have Cry1Ac in bolls on F-1 hybrid plants.
25% are non-Bt



BG-II: 93.75% seeds have Bt
56.25% seeds have Cry1Ac+Cry2Ab;
18.75% seeds have Cry1Ac;
18.75% seeds have Cry2Ab and
6.25% are non-Bt



Concerns

No new genes in sight (Vip3A is weak on PBW)

Farmers have started early season pyrethroid + OP sprays
Helicoverpa armigera and whitefly are sure to return

H. armigera is rapidly adapting to Bollgard-II

The problem can only get worse from here if unattended to....





Strategies

1. Short-season cultivars + Early maturing + Early sowing + Synchronous sowing
2. Timely termination + Closed season
3. Homozygous *Bt* genes
4. Avoid agrochemicals that delay crop maturity
5. Pheromone traps + IPM



Thank You