Pink bollworm menace on *Bt*-cotton in India
critical insights and way forward

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COTTON IN INDIA

- 12 M ha
- 10 M farmers
- 95% Bollgard-II
- 520 Kg/ha

Number of States in India - 29
Union Territories - 7
16 Nov 2017
Pink bollworm may eat up half of Maharashtra’s cotton crop

22 Nov 2017
Pink bollworm tears into the very fibre of Maharashtra’s cotton growers

23 Nov 2017
India cotton exports to drop as pink bollworms eat crop

24 Jan 2018
Maharashtra cuts cotton forecast on worm infestation

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

14 Feb 2018
35 pink bollworm pest affected farmers arrested after police foil their bid to immolate themselves in Aurangabad

14 Feb 2018
Farmers demand compensation against boll worm

15 Feb 2018
In Maharashtra, vicious cycle of cotton farmers’ woes continues

15 Feb 2018
After pink bollworm attack, Maharashtra to promote short duration varieties of cotton
PI NK 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
GUJARAT

Pink Bollworm Infestation on Bollgard-II

Legend

- 0 - 6 %
- 0 - 11 %
- 5 - 15 %
- 0 - 21 %
- 3 - 29 %
- 24 - 37 %
- 0 - 53 %
- 11 - 67 %
- 20 - 80 %
- 5 - 15 %
- 0 - 21 %
- 3 - 29 %
- 24 - 37 %
- 0 - 53 %
- 11 - 67 %
- 20 - 80 %
Shifts in Bollworm Dynamics

Long season cotton | Short-medium season cultivars | Long season Bt-hybrids

- Early season Pyrethroid sprays
- Long season cotton
- Short-medium season cultivars
- Long season Bt-hybrids

Pyrethroids

Bt-Cotton

Graph showing the timeline from 1960 to 2020 with various icons representing different time periods and pest control methods.
1960 - 1980

LONG DURATION CULTIVARS: 180-240 days duration
Major Pest: Pink bollworm
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
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*
PI NK BOLLWORM RES ISTANCE TO BOLLGARD-II

Resistance to Cry1Ac

Resistance to Cry2Ab

ICAR-CICR data unpublished
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)
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