Cotton leaf curl virus disease in India- Integrated management strategies and the way ahead

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Cotton leaf curl virus disease (CLCuD)

- First observed in 1989 on G barbadense in IARI,New Delhi
- Appeared in patches around Sriganganagar and Punjab adjoining to international border with Pakistan in 1993 and spread to entire north zone(Around 15 lakh ha) in a span of 4-5 years
- The problem is increasing due to development of frequent recombinants

Occurrence of cotton leaf curl virus disease in northern zone of India

Integrated management strategies

- Date of sowing trials/recommendations
- Screening of released BG II hybrids against CLCuD/recommendations
- Weed identification/eradication program

Date of sowing trials (2014-15)

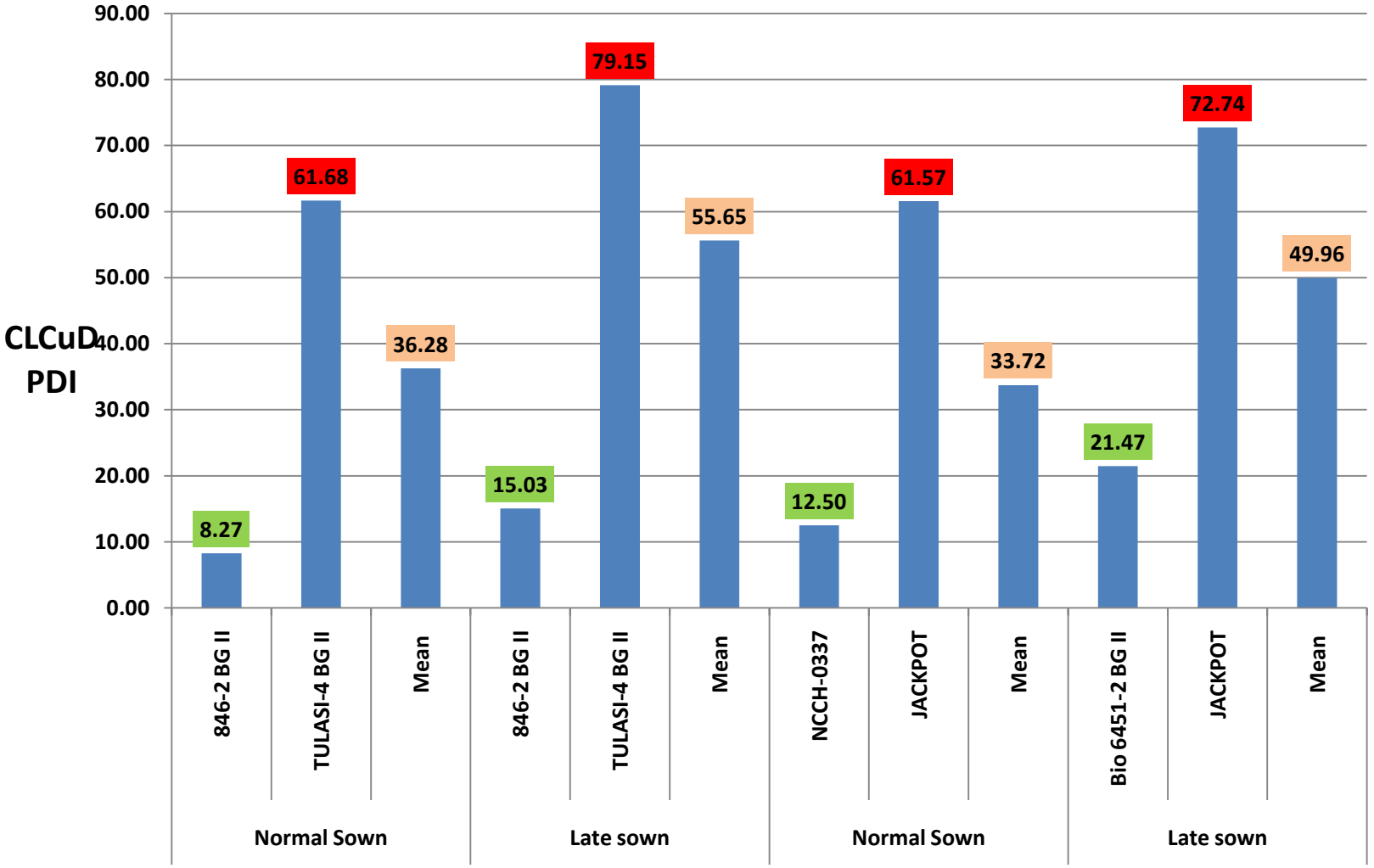
Four experiments were conducted at each of the five locations

(Hisar,Sirsa,Sriganganagar,Abohar &Faridkot)

Pre-release hybrids –Normal date of sowing
Pre-release hybrids –Late sown
Released hybrids –Normal date of sowing
Released hybrids –Late sown

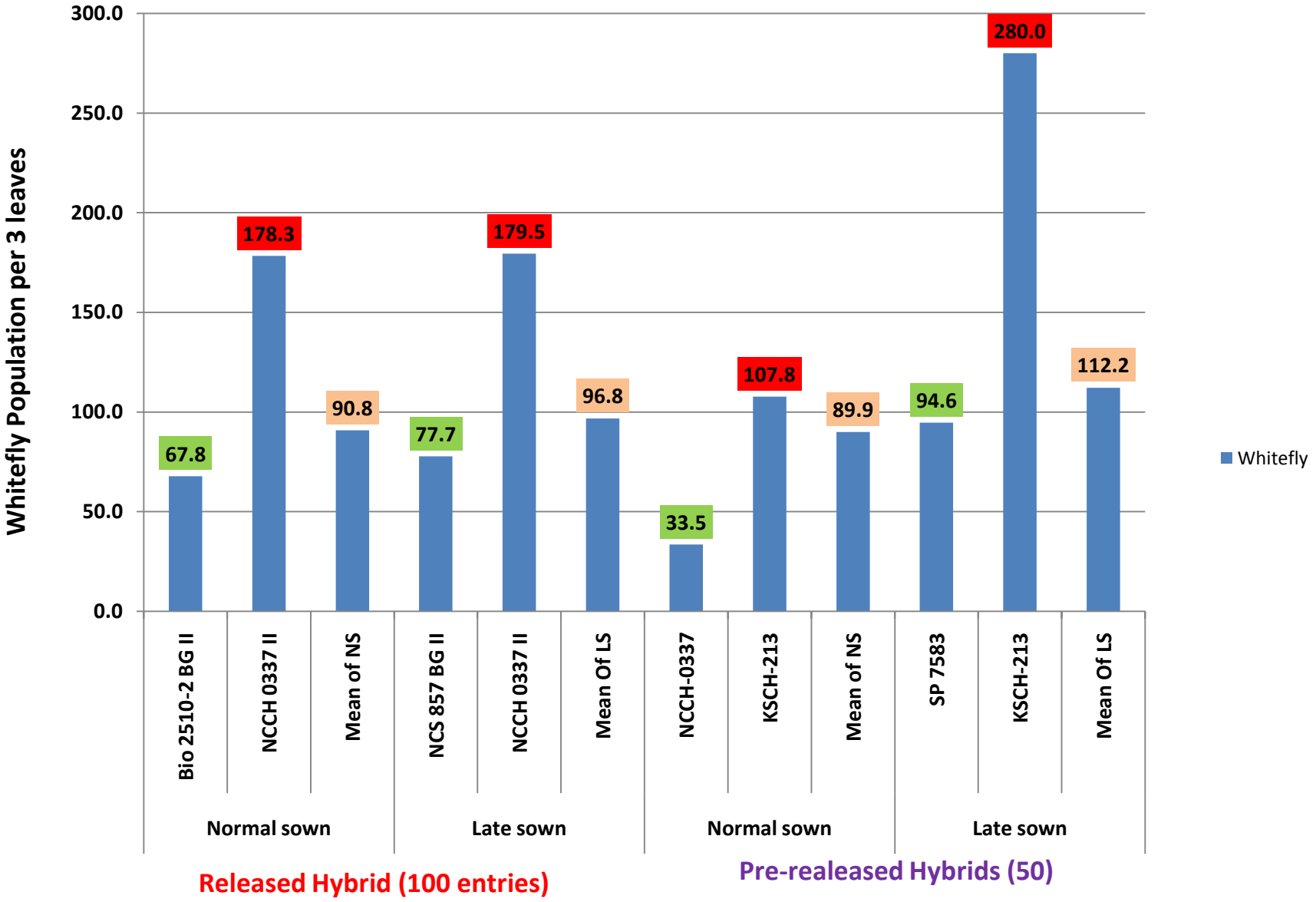
Released hybrids	**100**
Pre-release hybrids	50
Number of rows per entry	2
Row length	5.4 metres (10 dibbles per row)
Number of plants	20 per replication
Number of replications	2
Spacing	67.5 x 60 cm
Experimental Design	Released hybrids:10x10 lattice; Pre release hybrids: RBD
Susceptible check	Standard susceptible check planted after every four lines of the test entry hybrids

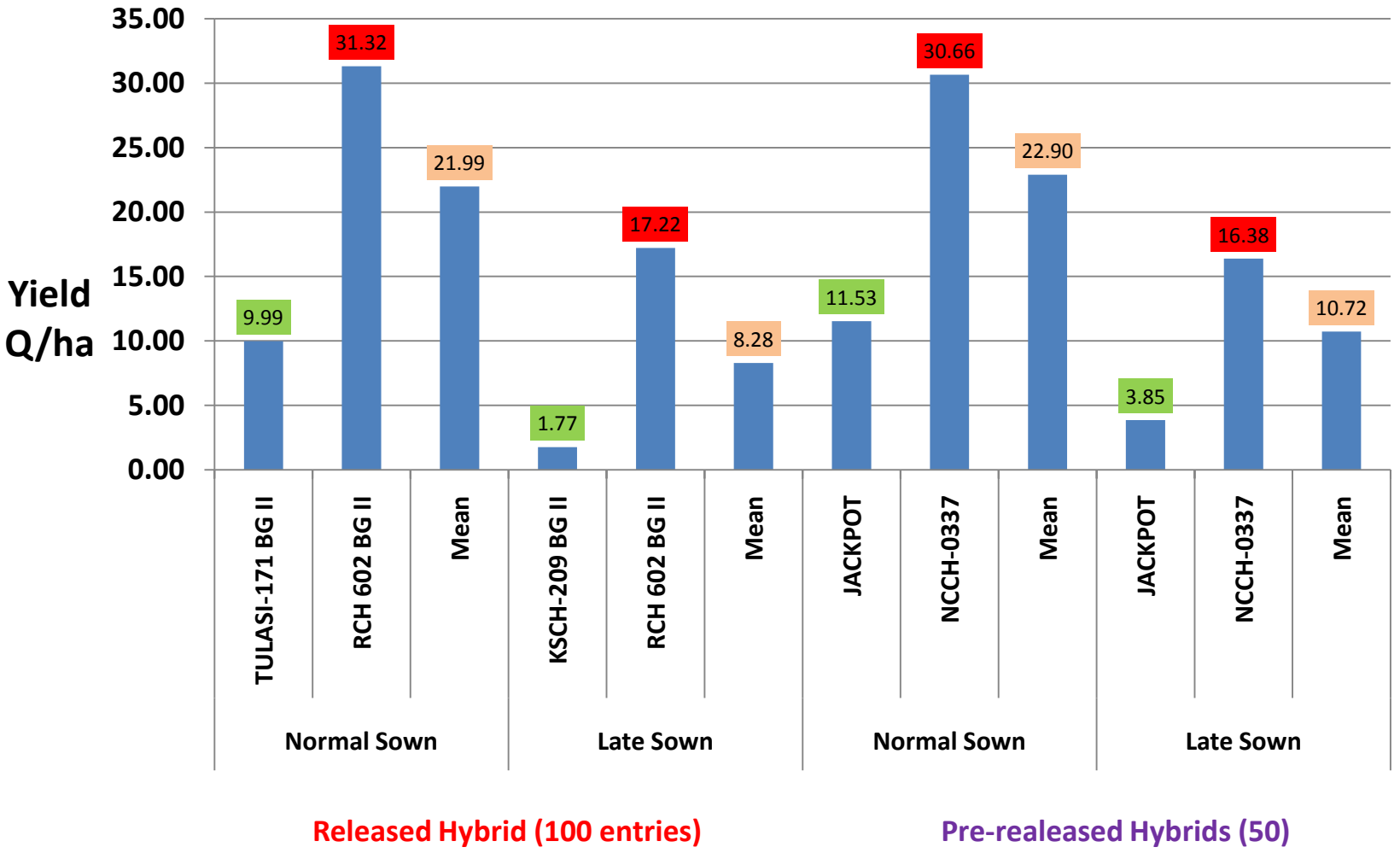
- Sowing dates for normal sown crop: 14-24 May, 2014
- Sowing dates for late sown crop: 4-7 June,2014



Released Hybrid (100 entries)

Pre-realeased Hybrids (50)

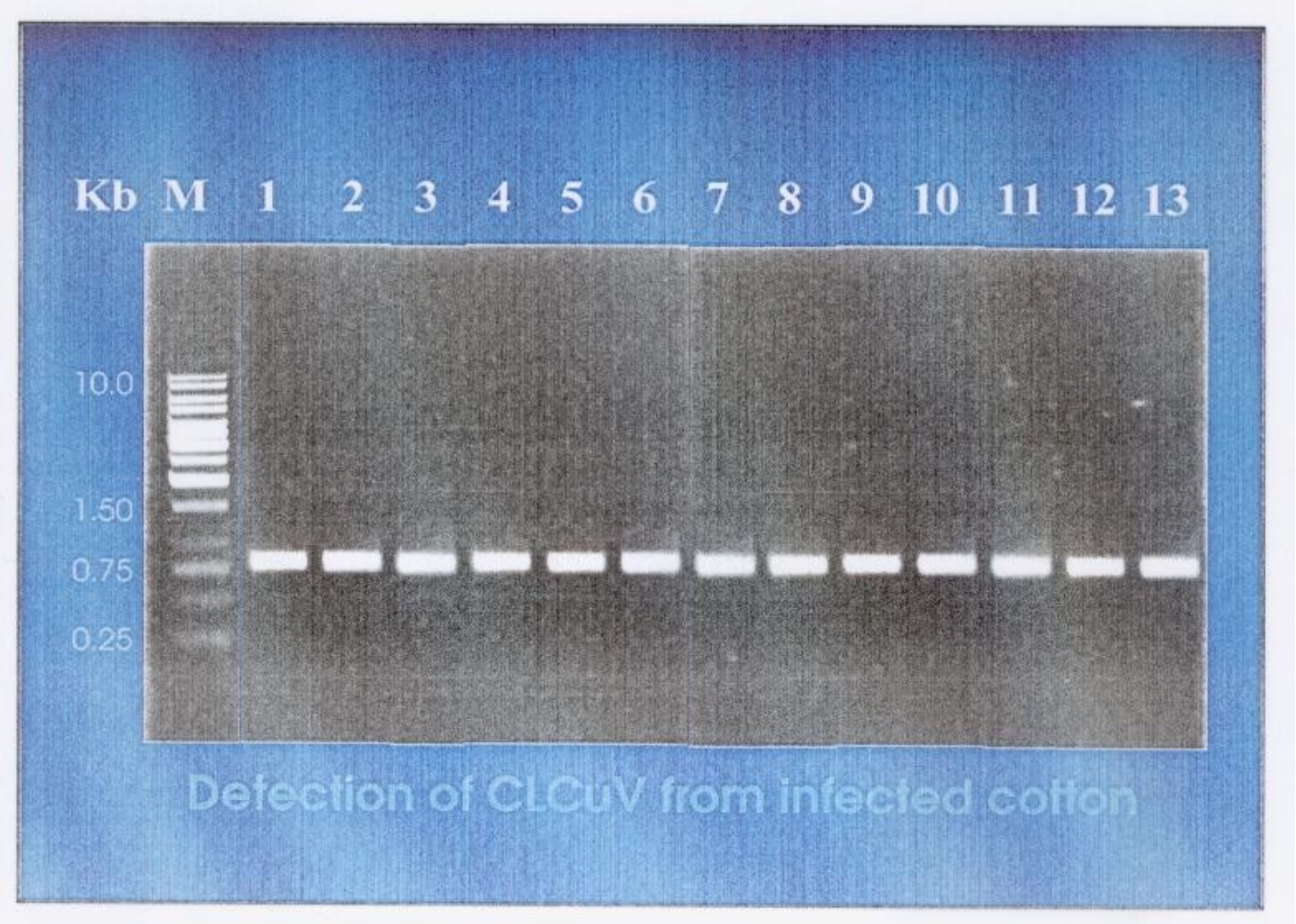

Whitefly Population per 3 leaves
300.0
250.0
200.0
150.0
100.0
50.0
0.0
67.8
178.3
90.8
77.7
179.5
96.8
33.5
107.8
89.9
94.6
280.0
112.2
Bio 2510-2 BG II
NCCH 0337 II
Mean of NS
NCS 857 BG II
NCCH 0337 II
Mean Of LS
NCCH-0337
KSCH-213
Mean of NS
SP 7583
KSCH-213
Mean Of LS
Normal sown
Late sown
Normal sown
Late sown
Released Hybrid (100 entries)
Pre-realeased Hybrids (50)
Whitefly


Yield Q/ha
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
9.99
31.32
21.99
1.77
17.22
8.28
11.53
30.66
22.90
3.85
16.38
10.72
TULASI-171 BG II
RCH 602 BG II
Mean
KSCH-209 BG II
RCH 602 BG II
Mean
JACKPOT
NCCH-0337
Mean
JACKPOT
NCCH-0337
Mean
Normal Sown
Late Sown
Normal Sown
Late Sown
Released Hybrid (100 entries)
Pre-realeased Hybrids (50)

Multi location trials for shortlisting of CLCuD tolerant hybrids

- The released BG II hybrids for north zone are screened (2014-15 onwards) under replicated trials at five locations(Rajasthan-Sriganganagar, Punjab-Bhatinda & Faridkot, Haryana-Sirsa & Hisar) with susceptible check as infector rows after every four rows of test entries.

- The shortlisted tolerant hybrids only are advocated for marketing of seeds to the farmers.

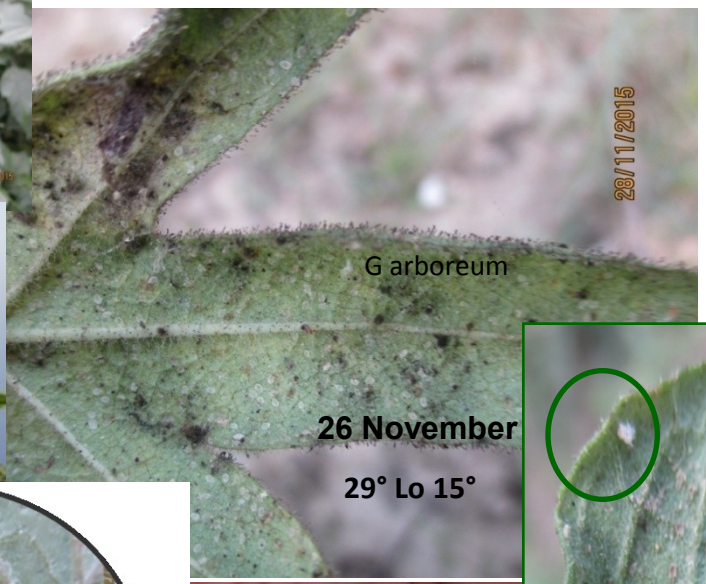


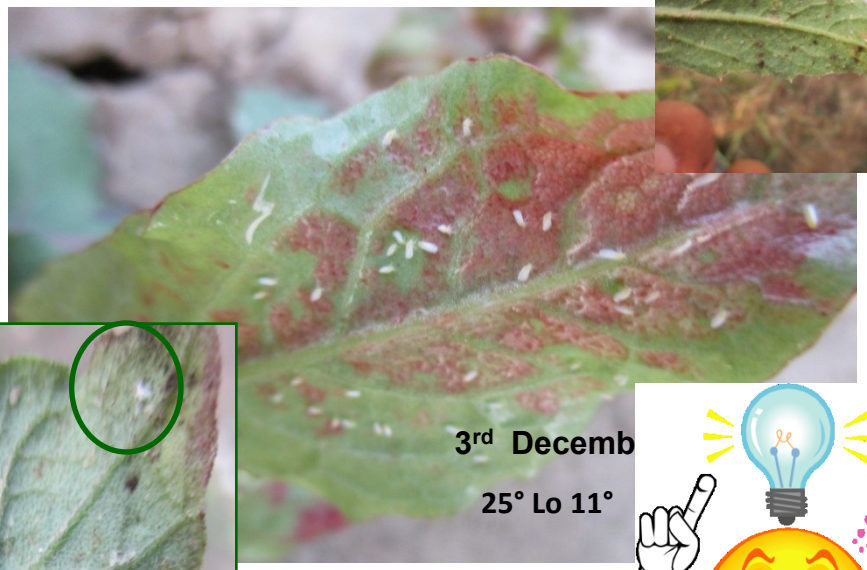
Chakrabarty, P.K, Sable, S., Monga, D. and Mayee, C. D. (2005). Polymerase chain reaction-based detection of Xanthomonas axonopodis pv malvacearum and cotton leaf curl virus. Indian J. Agric. Sci. 75: 524-27.

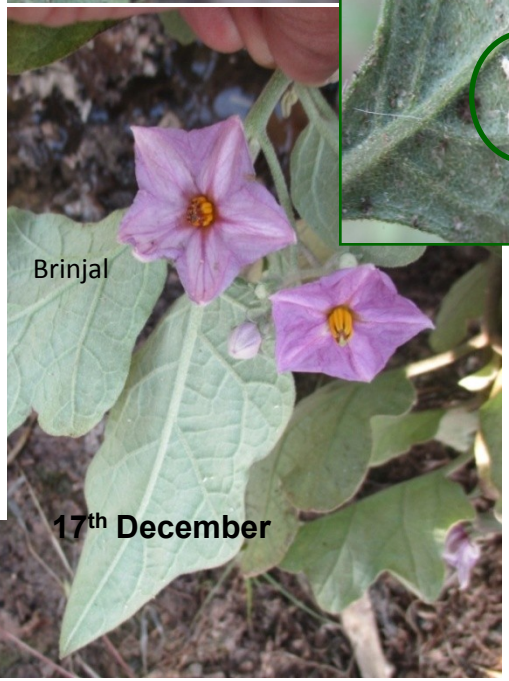
Detection of cotton leaf curl virus (CLCuV) in weeds showed that *Convulvus arvensis* (Hirankhuri), *Spinacea sp.* (Jungli Palak), *Solanum nigrum* (Blackberry nightshade), *Lantana camara (Raimuniya), Chenopodium album* (Bathua) were among naturally collected weeds which were detected positive by PCR amplification. *Achyrenthus aspera* (Puthkanda), *Digeria avensis* (Tandla), *Croton sprucifera* (Jungli mirch) and *Xanthium strumarium* (Gutpatna) were among artificially inoculated weeds which were found CLCuV positive by developing CLCuD type symptoms and by PCR amplification. Transmission of CLCuV from cotton to weeds and vice- versa was also successful.

Alok Kumar, D. Monga and Kishore Chand Kumhar (2017) Screening of cotton germplasm against leaf curl virus disease (CLCuD) and role of weeds for its development. J. Cotton res. Dev. 31 (1)87-96

Off season whitefly population on weeds and other hosts









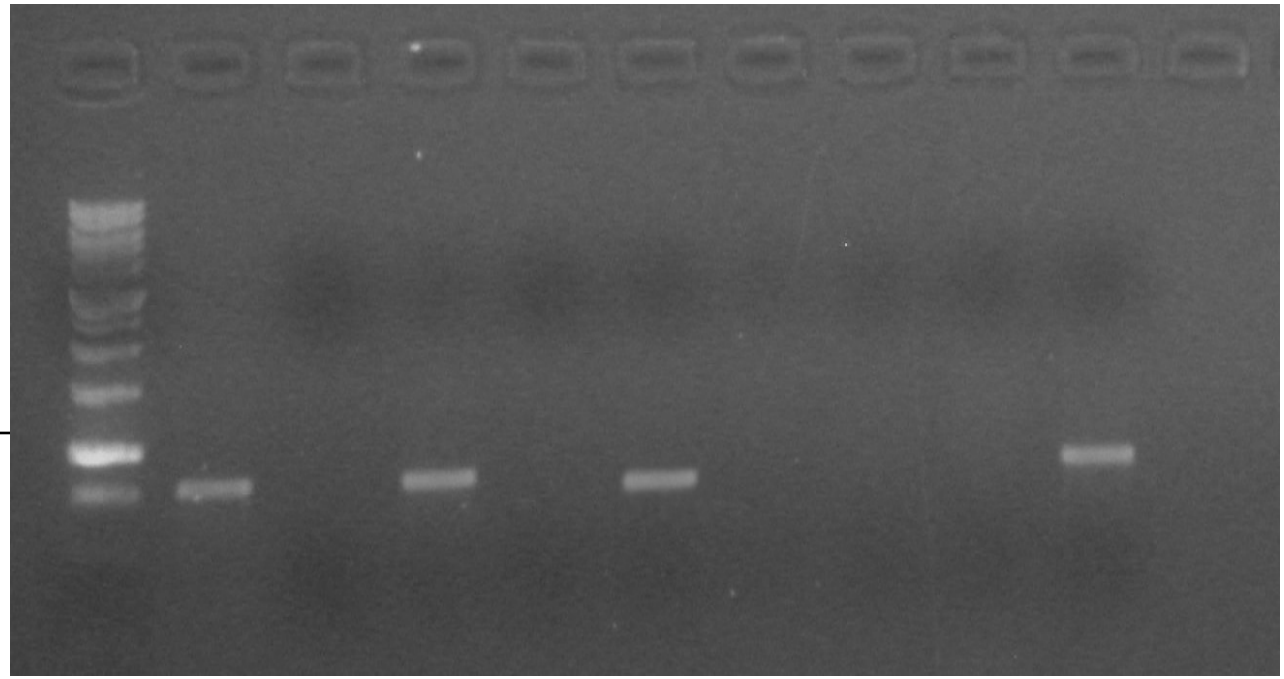



Figure: Amplification of CLCuV genomic components from the total DNA of weed plants with CP primers. Lane 1: Infected cotton; Lane 2: Healthy cotton; Lane 3: *Croton sparciflorus*; Lane 5: *Parthenium hysterophorus;* Lane 9: *Solanum americanum*; Lane 4, 6, 7 & 8: weeds showing no amplification.

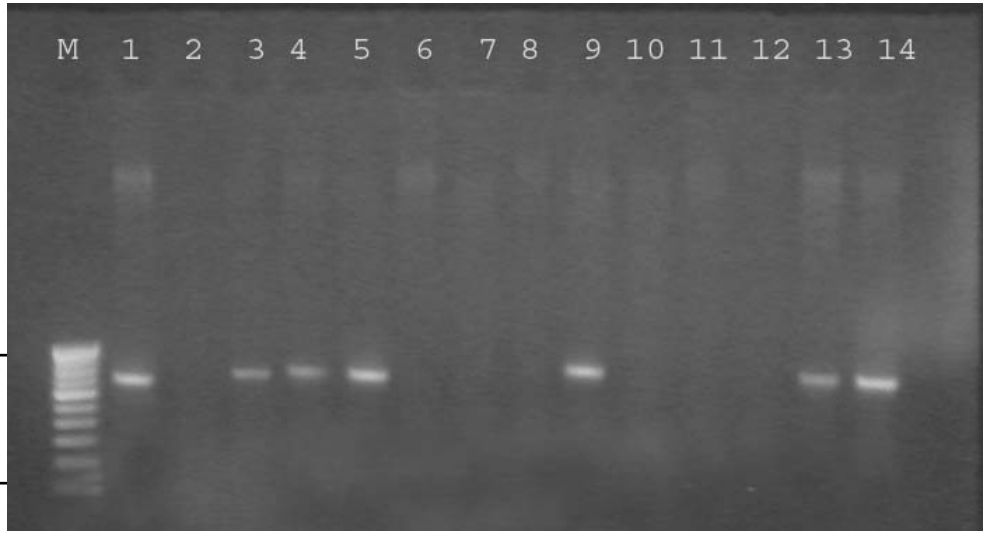


Figure : PCR amplification of weeds DNA collected from CICR RS Sirsa. Lane M-100 bp molecular marker Lane1. *Spinacea spp* **Lane2.** *Chenopodium murate* **Lane3.** *Chenopodium album* **Lane4.** *Solanum nigrum* **Lane5.** *Lantana camara***Lane6** *Aerua sativa* **Lane7.** *Ageratum* **Lane8.** *Parthenium spp* **Lane9.** *Convolvulus arvensis* **Lane10** *Solanum tubersum* **Lane11.** *Hibiscus rosa sinensis.* **Lane12.** *Chenopodium album* **Lane13.** *Check* **Lane14.***check*

Ageratum sps (Goat weed)

Chorchorus sps (Jangli jute)

Helianthus spp(Jungali suraj mukhi)

Tribulus terrestris (Bhakari)

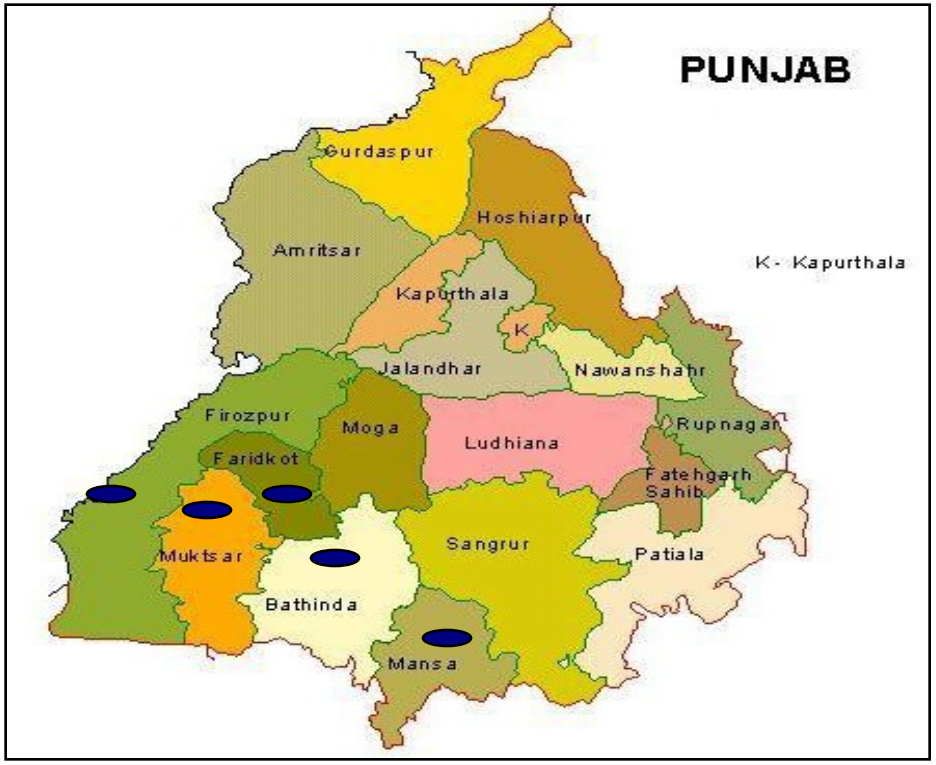
CLCuV inoculum shifting from weeds to cotton

Weed eradication campaigns

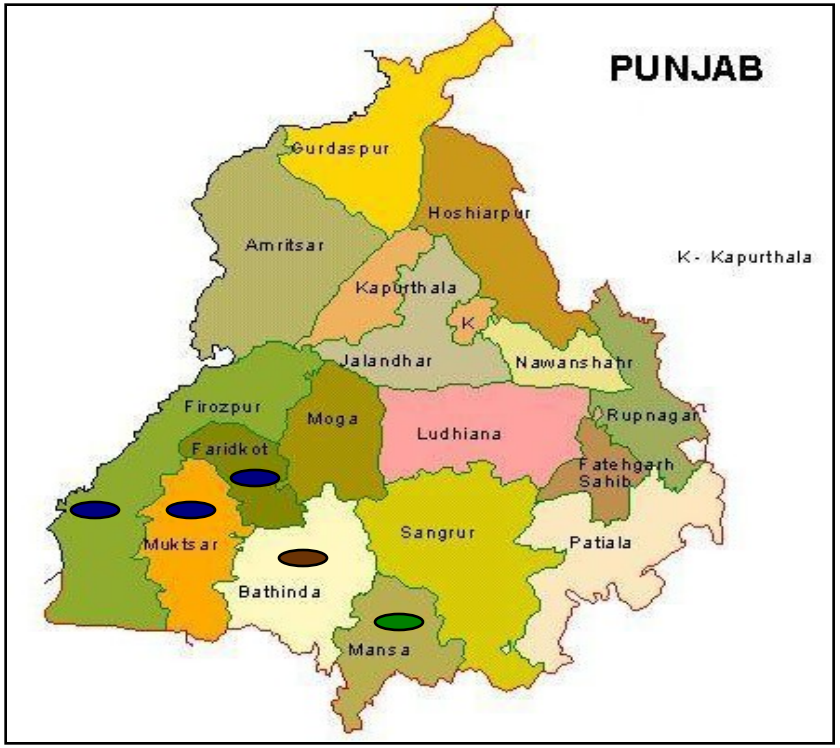
- Based on our trials regarding weeds serving as source of CLCuV inoculum, the state department officials conducted weed eradication programs starting from February onwards in a big way with active participation of farmers.

District wise incidence of CLCuD in Punjab

- > 50 % (V. Severe)
- 30.1-50 % (Severe)
- 20.1-30 % (Moderate)
- 10.1 - 20 % (Low)
- 0.1– 10 %(Very Low)
- 0.0 (Nil)



2015-16



2016-17

District wise incidence of CLCuD in Haryana

- > 50 % (V. Severe)
- 30.1-50 % (Severe)
- 20.1-30 % (Moderate)
- 10.1 - 20 % (Low)
- 0.1– 10 %(Very Low)
- 0.0 (Nil)

2015-16

2016-17

District wise incidence of CLCuD in Rajasthan

- > 50 % (V. Severe)
- 30.1-50 % (Severe)
- 20.1-30 % (Moderate)
- 10.1 - 20 % (Low)
- 0.1– 10 %(Very Low)
- 0.0 (Nil)

2015-16

2016-17

The Way Ahead

CLCuD resistant lines identification/ Pyramiding resistance/Introgression of resistance

- In India, from among 5000 *G. hirsutum* lines during 2013-14 and 2128 lines during 2014-15 screened against CLCuD, none of the line was found to be resistant/ immune.
- However, lines identified as tolerant to disease are being used in pyramiding resistance against this disease.
- Recently two *G hirsutum* lines GVS8 & GVS 9 received from USA have shown immune reaction towards CLCuD and are being used for transfer of resistant sources.
- Introgression of CLCuD resistance from *G arboreum* is being attempted.

Gene pyramiding for CLCuD

Tolerant Sources: Bhiyani 251, MR 786, CSH 27, CSH 46 and CSH 538

Technical Programme

1st Year : F1s-2015
2nd Year : F1s x F1s-2016
3rd Year : (F1s x F1s) x (F1s x F1s)-2017
4th Year : {(F1s x F1s) x (F1s x F1s)} x {(F1s x F1s) x (F1s x F1s)}
5th Year : [{(F1s x F1s) x (F1s x F1s)} x {(F1s x F1s) x (F1s x F1s)}] x [{(F1s x F1s) x (F1s x F1s)} x {(F1s x F1s) x (F1s x F1s)}]
so on …..
Selfing …. Selection of CLCuD resistant/tolerant plant

Lines showing resistant reaction against CLCuD

Crossing program to introgress resistance to elite cultivars

F1s showing resistant reaction against CLCuD

Introgression of CLCuD resistance from *G. arboreum*

Interspecific crosses :

- *CSH 3129 (G. hirsutum)* x CISA 310 (*G. arboreum)-(2015)* and subsequent crossing-(2016)using CSH 3129 *(G. hirsutum) as* recurrent parent.

  F1 (*CSH 3129* x CISA 310) x CSH 3129-(2017)

  so on…. Identification of plants having CLCuD resistance.

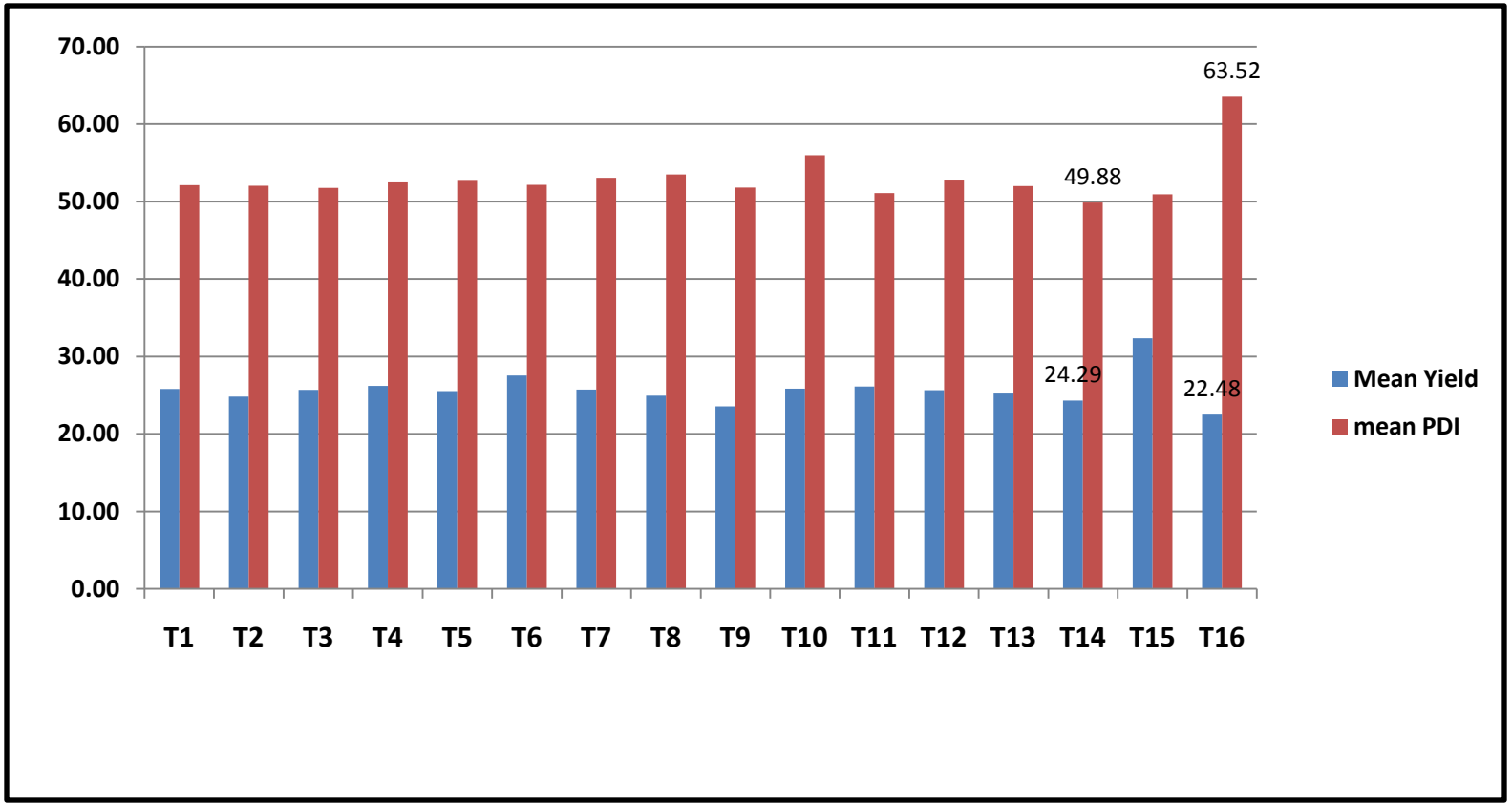
Introgression using colchicine treated *G. arboreum* :

- *CSH 3129 (G. hirsutum)* x CISA 310 (*G. arboreum) colchicine –(2016)treated and* subsequent crossing using CSH 3129 *(G. hirsutum) as* recurrent parent.

  F1 (CSH 3129 x CISA 310) x CSH 3129-(2017)

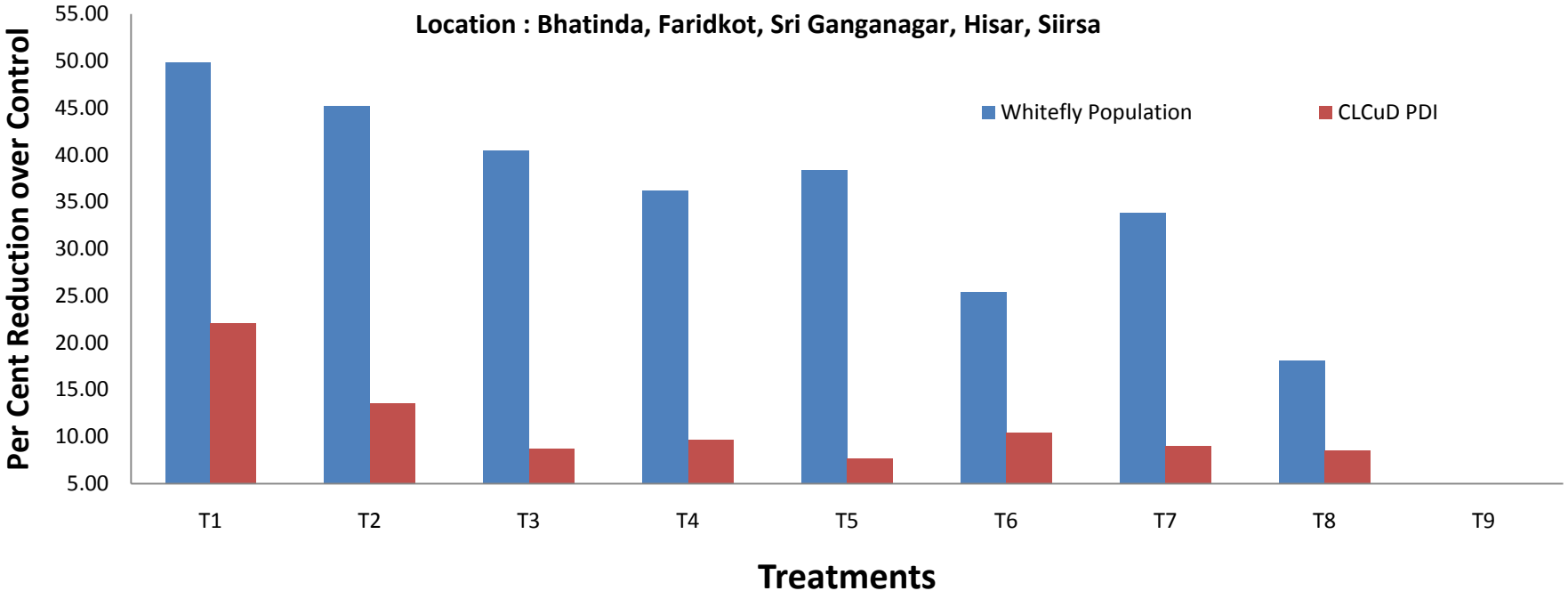
  so on…. Identification of plants having CLCuD resistance.

Path 3 e: Innovative interventions for the management of CLCuD in North Zone (Mean of two years 2015-16 and 2016-17)



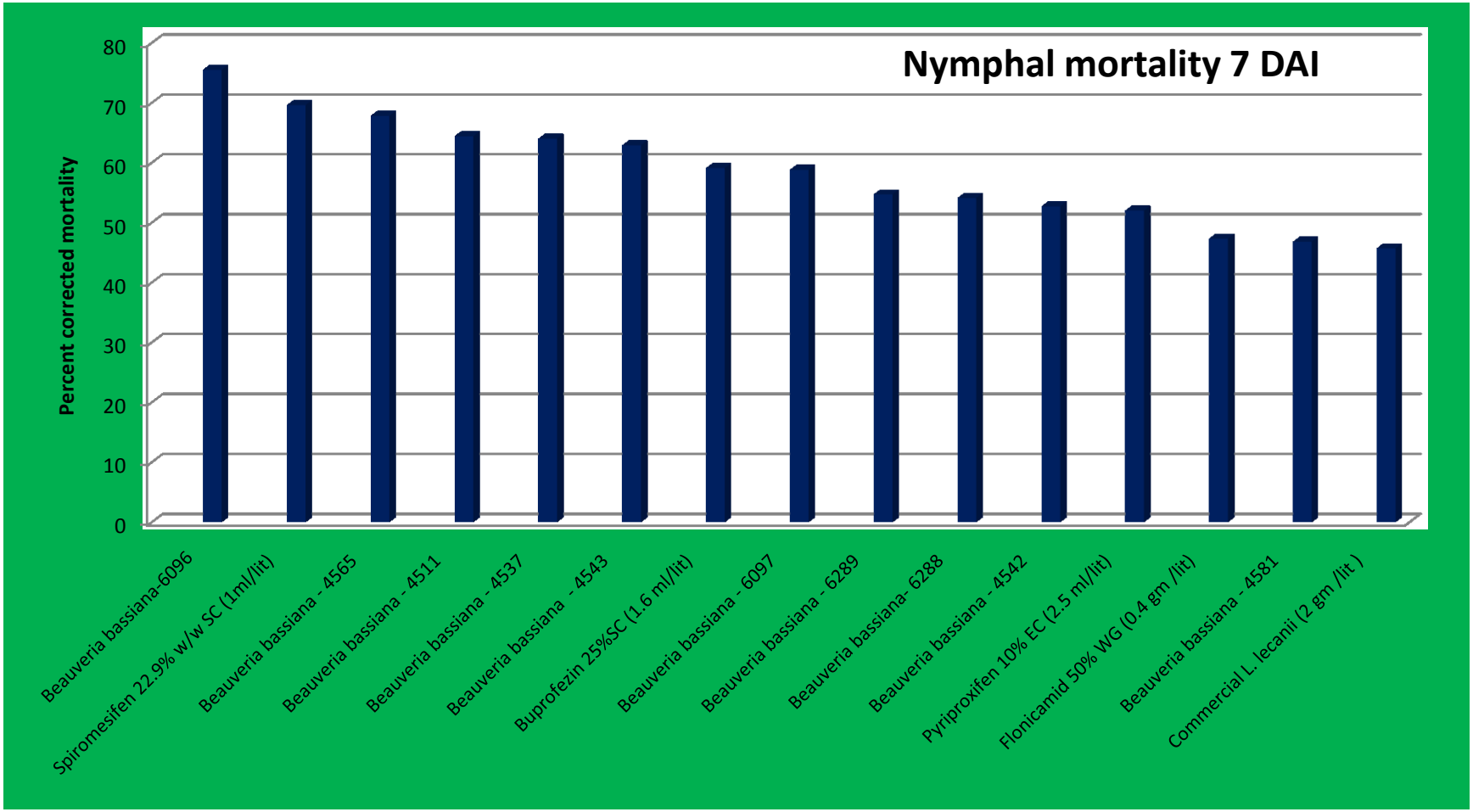
Treatments	
T-1: Butter Milk @ 5%	T-9: Lachesis 30 @ 0.1%
T-2: Cow Urine @ 6.6%	T-10: Digitalis 30 @ 0.1%
T-3: Neem Oil @ 1%	T-11: Apis Mallifera 30 @ 0.1%
T-4: Mustard Oil @ 3%	T-12: Bryonia 30 @ 0.1%
T-5: Calcium Nitrate @ 0.5%	T-13: Natrum Mure 30 @ 0.1%
T-6: Cow Urine + Calcium Nitrate	T-14: Polo @ 0.1% @ 0.1%
T-7: Cow Urine + Butter Milk	T-15: Salicyclic Acid@200ppm (single spray)
T-8: Butter Milk+ Calcium Nitrate	T-16: Control (Unsprayed)

Whitefly Population management module affecting CLCuD PDI (2014-2016)



Treatments	
T1	Spray of nimbicidine, V.lecanii, M.anisopliae, Difenthiurom, Hort.Min.Oil, Triazophos&Spiromesifen
T2	Spray of nimbicidine, 20 DAS
T3	Spray of V.lecanii, 45 DAS
T4	Spray of M.anisopliae, 60 DAS
T5	Spray of Difenthiurom, 75 DAS
T6	Spray of Horticultural Mineral Oil (Hort.Min.Oil), 90 DAS
T7	Spray of Triazophos, 105 DAS
T8	Spray of Spiromesifen, 120 DAS
T9	Control

Bioassay of selected EPFs and recommended chemical pesticides against whitefly nymphs under polyhouse condition



Thanks