TMC MMI 2.4: Physiological manipulation of Bt plant morphoframe for enhanced productivity under varied agroclimatic conditions

INTRODUCTION

About 70 per cent cotton cultivation in India is under rainfed conditions. Cotton suffers from various biotic and abiotic stresses right from the germination to maturity. The growth during the seedling establishment phase has a role to play in yield realization. Agood plant frame would provide sufficient space for holding and catering the needs of the reproductive parts during the later part of growth. Under Coimbatore condition, the crop experiences initial waterlogging and followed by sucking pests. Both these stresses cause considerable damage to the plant leading to stunted growth. As the cotton plant is photo insensitive they starts producing the reproductive parts irrespective of the environmental and physical conditions by 40-45 DAS. Hence sufficient morpho-frame will not be available for the plant to hold the reproductive parts. This leads the plants to either premature death or reduced boll load. Cotton crop failures can be often related to excessive vegetative growth. Lush 2 -2.5 mts cotton canopies with fully overlapping middle canopy are havens for insects, and verticillum wilt and boll rot fungi.. A luxuriant and dense canopy makes effective insect control essentially impossible and causes lodging, which makes harvesting difficult.. More over, squares or small bolls may be shed due to shading effect.. The reduced plant growth and modified shape, which result in better light penetration, earlier boll opening and higher harvest, index. Various growth regulators have been applied in cotton in attempts to set more bolls, limit vegetative growth or terminate fruiting. When boll load is limited by carbohydrate supply, exogenous modification of hormonal balance to increase boll set may be futile. More bolls may be set, but will be of smaller size and plant growth is terminated prematurely. Hormonal regulation of plant height is possible, and may be a useful practice where bushy growth of plant is observed and the insect pest infestation is severe. Basically, application of retardant is to remove squares and small bolls, late in the season to deprive pre-diapausing pink bollworm larvae of a food supply. The hormonal termination of growth can be effectively used where cotton is grown in rice fallow tracts and crop rotation systems.

The project entitled "Physiological manipulation of Bt plant morphoframe for enhanced productivity under varied agroclimatic conditions" with the funding under Technology Mission on Cotton- MiniMission I (TMC MMI 2.4) was initiated during the year 2007-08 with six centres and spread over varied agro-climatic conditions.

OBJECTIVES

1.To study the temporal and spatial distribution of fruiting forms in Bt vs non-Bt (medium and long duration Bt hybrids)

2.To understand the consequences of altered sink activity on physiology and growth of the plant..

3.To formulate product(s) to manipulate morphoframes to minimise yield gap.

SALIENT FINDINGS

Field experiments were conducted at 6 cooperating centers spread across different agro climatic regions of cotton growing zones with the main objective of altering the source sink competition to enhance seed cotton yield through foliar application of ethylene. The experimental locations were CICR (Nagpur), IISS (Bhopal) and GAU (Surat) at Central zone and CICR (Coimbatore), UAS (Dharwad) and ANGRAU (Guntur) at Southern zone. Of these locations cotton is grown under irrigated conditions at Surat & Coimbatore and rest are under rainfed condition.

Experiment I : Manipulation of morphoframe using action specific chemicals- Ethylene in the form of ethrel in cotton

The experiments were laid as per the technical programme at all the centres representing various agro-climatic conditions. The crop was raised during 2009-10 cropping season with five entries viz Bunny Bt, RCH2 Bt, NECH 2RBt, JKCH 99Bt and NCS 138Bt (Mallika Bt) as main treatments and four different manipulation viz., treatments control (T1), 5.7 mM ethylene at 35-40 DAS(square initiation)(T2), 8.56 mM ethylene at 35-40 DAS (square initiation) (T3) and nipping of squares at 35-40 DAS(square initiation)(T4). The treatments were imposed soon after square initiation. Sudden drop of all the young squares was noticed within 48 hours after foliar spray of Ethylene in all the entries under test..

Acharya N G RangaAgricultural University, Guntur:

Significant differences were noticed in all the yield and yield attributing characters due to entries, manipulation treatments and the interaction of entries with the manipulation treatments. In RCH2 Bt, highest seed cotton yield was obtained in T2 (2382 Kg/ha) followed by T3 (2122Kg/ha) and T4 (2243Kg/ha) compared to control (1721 Kg/ha). In NECH 2R Bt, treatment T3 produced highest seed cotton yield (2246 Kg/ha) followed by T4 (1997 Kg/ha) and T2 (1900 Kg/ha) while lowest in Control (1446kg/ha). In NCS 145 Bt, significant increase in yield was recoded due to T2 (2502 Kg/ha) compared to control..

Seed index, lint index and ginning percentage also showed significant variation due to entries, manipulation treatments and also due to the interaction of entries with the manipulation treatments. All the manipulation treatments increased the seed index and lint index significantly.

University of Agricultural Sciences, **Dharwad**

There was a significant improvement in yield attributing characters like number of sympodia, leaf area, number of fruiting parts. The seed cotton yield also showed a positive trend with T2 producing the highest followed by T3, T4, in comparison to control.. The pooled data showed that application of 8.56 mM (283 Kg/ha) or 5.7 mM ethrel (2951 Kg/ha) record significant high yield than control (2641 Kg/ha). The treatments mechanical removal of squares although recorded more yield (2717 Kg/ha) than control (2641 Kg/ha), it was not significant. .

Central Institute **for Cotton Research, Coimbatore:**

Foliar application of ethrel brought about a significant improvement in physiological parameters viz., plant height, leaf area and number of fruiting parts with foliar application of ethylene in the form of ethrel and square removal.. These effects synergistically worked and brought about changes in plant ideotype. There was a positive change in the partitioning of photosynthates to the roots initial stage during the early stage and developing bolls in the later stages.

In Bunny Bt genotype, there was a significantly higher seed cotton yield with foliar application of ethrel @ 5.7 mM (22.6q/ha) followed by control (20.0 q/ha) followed by T4 (mechanical removal of squares (17.4 q/ha). In Bunny NBt genotype the treatment T2 (Ethrel @ 5.7 mM) yielded highest seed cotton yield (17.2 q/ha) followed by T4 (16.1 q/ha) and least in T1 (10 q/ha). Similar results were observed in mallika Bt, Mallika NBt and JKCH 99 Bt. Alteration in morpho-frame was one of the factors responsible for enhancement of the seed cotton yield.

Central Institute **for Cotton Research, Nagpur:**

Five genotypes were tested against foliar application of ethrel.. During the year there was severe incidence of sucking pests and all the genotypes were badly effected. The foliar application of ethrel brought about reduction in yield by around 2.0 q/ha. There was no compensation for the initial loss of fruiting parts. These results were not reflecting the data obtained during the previous two years were in there was additional yield due to treatments.

NavasariAgricultural University, Surat:

Four Bt hybrids and one local hybrid (non Bt) was tested against foliar application of ethrel.. There was a significant improvement in plant height at harvest with T3 (136.7 cm) followed byT2 (128.3cm), while T1 and T4 were on par.

Similar trends were observed in no. of monopodia, sympodia and boll numbers. The total seed cotton yield also showed that T3 was highest (1533 kg/ha) followed byT41428 kg/ha), T2 (1324 kg/ha) and least in T1 (1299 kg/ha).

Indian Institute for Soil Sciences, Bhopal:

The plant samples obtained from CICR, Coimbatore was analysed for uptake and partitioning in Bunny Bt and its counter part Bunny Nbt.. It was observed that there was an improvement in uptake of N by leaves with foliar application of Ethrel while the partitioning into other parts was not effected. The uptake of Phosphorous was not altered with application of ethrel, while Potassium uptake was significantly improved. Foliar application of ethrel enhanced the root length, volume and dry weight of root significantly

Experiment II : Manipulation of morphoframe through nipping at Grand growth stage and mimic the effect using action specific chemicals- Maleic hydrazide in cotton

Acharya N G RangaAgricultural University, Guntur:

Significant variation was noticed among the treatments for plant height (cm), number of monopodia per plant, number of sympodia per plant, number of nodes per plant, number of squares per plant, number of flowers per plant and boll weight at harvest.. Significantly highest plant height was recorded in XL 708 Bt (137.5 cm) and it was on par with NCS 145 non Bt (127.3 cm).

In NCS-145 Bt. the treatment T4 - Maleic hydrazide @500ppm at 85 DAS recorded significantly lower plant height 108.3 cm and it was on par with T3 - Detopping at 95 DAS followed by nipping of the sympodial meristem at 105 DAS (111.3cm). In Excel 708 Bt and and NCS 145 non Bt, lower plant height was recorded in T3- Detopping at 95 DAS followed by nipping of the sympodial meristem at 105 DAS only.

Yield and yield attributing characters:

The seed cotton yield per hectare was significantly high in NCS 145 Bt (2517 kg/ha) and it was on par with Excel 708 Bt (2462 Kg/ha). Significantly higher seed cotton yield was recorded in T3 treatment followed by T4. Seed cotton yield was significantly high in T3, T4 and T2. In all the manipulation treatments, significant yield improvement was noticed compared to control..

University of Agricultural Sciences, **Dharwad**

At harvest, the treatment(T2) detopping at 85 DAS and nipping 95 DAS recorded maximum number of bolls per plant (2656 kg/ha) while MH @ 500 ppm (T4) recorded the least (2317kg/ha) yield. The pooled data showed significant difference between genotype and treatments. The boll weight also followed the same trend of yield. Detopping at 85 DAS followed nipping at 95 DAS recorded significantly more boll weight than control or MH @ 500 ppm. Detopping at 85 DAS followed by nipping at 95 DAS recorded significantly more yield than control as well as application of MH @ 500 ppm. This treatment was on par with detopping at 95 DAS and nipping 105 DAS.

Central Institute for Cotton Research, Coimbatore

Three cotton genotypes viz., RCH 708C Bt, DCH 32 and Suvin. The treatments were initiated as per the technical programme. Among the treatments T3 (Detopping at 95 DAS followed by nipping of monopodia sympodia at 105 DAS yielded the highest seed cotton yield (1850 kg/ha) followed by T4 -foliar application of maleic hydrazide (1720 kg/ha), T2 (1640 kg/ha), while the least in control (1253 kg/ha). Application of Maleic hydrazide @ 500 ppm changed the plant morphology with reduced internodal elongation. The LAI improved with better LAD.

Central Institute **for Cotton Research, Nagpur**

Three cotton hybrids were tested during the year. The results indicated that NCS 145 NBt produced the highest kapas yield followed by NCS 145 BG II and NCS 145 Bt, while XL 708 Bt produced the least.. Among the treatments T3 (Detopping at 95 DAS followed by nipping of monopodia sympodia at 105 DAS yielded the highest seed cotton yield (1050 kg/ha) and was on-par with T4 - foliar application of maleic hydrazide (1033 kg/ha),while T2 (979 kg/ha) and control produced the least (933 kg/ha).

Navasari Agricultural University, Surat

The results indicated the varietal difference in plant height, number of node and height to node ratio and the non Bt showed greater values of all the three parameters. The plant height reduced by significant margin by both the physical detopping and nipping treatments and also by MH. The biomass and harvest index showed significant differences in the genotype tested. The higher biomass and H. I. was recorded in Bunny Bt compare to its N Bt counterparts. The check variety G. *Cot. Hyb.* 102 recorded minimum harvest index. Detopping at 95 DAS followed by nipping of sympodial meristem at 105 DAS, as also foliar application of MH increased both biomass and H.1..compare to the control..

Boll weight and yield/plant significantly higher yield was recorded due to detopping at 95 DAS followed by nipping of sympodial meristem and also by foliar application of MH (500 ppm) at 85 DAS. Thus detopping of long duration tall cotton varieties at 95 DAS followed by nipping of sympodial meristem at 105 DAS or foliar application of MH at 85 DAS (500 ppm) had significant effect on biomass, number of bolls, boll weight and seed cotton yield.

SPECIFIC TECHNOLOGIES/ RECOMMENDATIONS

From the three years experiments on foliar application of ethrel, it is confirmed that foliar application of ethrel @ 8.56 mM ethylene at square initation stage brought about changes in the plant morpho-frame leading to synchnonous squaring, flowering and boll bursting. There was an enhanced seed cotton yield of 25% across the genotypes and also the agroclimatic zones with no negative effect on fibre quality.

EFFORTS MADE TO POPULARIZE THE TECHNOLOGY / RECOMMENDATION

During the year 2009-10, three on-farm trial was conducted in village using RCH 708 Bt cotton, to demonstrate the technology. The results showed that there was enhanced sympodial growth and around 20-30 extra bolls produced per plant, with foliar application of ethrel @ 8.56 mM during square initation stage. There was also uniform boll bursting with no harmful effect on fibre quality.