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## High Density Planting (HDP) in Cotton : A option for Rainfed Region of Vidarbha



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**ALL INDIA CO-ORDINATED RESEARCH PROJECT ON COTTON**  
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## **High Density Planting in Cotton : A option for Rainfed Region of Vidarbha**

A system of high density planting (HDP) leading to more rapid canopy closure and decreased soil water evaporation. In many countries narrow row planting have been adopted after showing improvement in cotton productivity. The adoption of High density planting (Accommodation of more plants per unit area) along with better genotype with good fertilizer, early weed and boll worm management is one of the option under rainfed to break the current trend of stagnating yield of cotton around 550 lint kg ha<sup>-1</sup> in India and 325 lint kg ha<sup>-1</sup> in Vidarbha region of Maharashtra.

In Vidarbha cotton crop is cultivated under rainfed conditions mostly by marginal and small farmers. Socio economic status of the farmers, small land holdings, mono cropping over years, aberrant weather conditions, imbalanced fertilization, non adoption of optimum plant population, indiscriminate use of insecticides and mounting pest and disease complex are the major constraints in cotton cultivation in general. The shallow and medium soils under rainfed conditions which occupied major cotton area after introduction of Bt are unable to sustain the crop for longer duration and the full potentiality of these Bt hybrids is not being harnessed. Further, the farmers forced to invest the sizable amount of money on purchase of Bt cotton seed every year. Even though, significant improvement is not seen in seed cotton yield, the cost of cultivation of Bt cotton increased tremendously and the major share is taken away by picking of kapas, fertilizers and control of sucking pests under rainfed ecosystem.

The concept of high density cotton planting, popularly known as UNR (Ultra narrow row cotton) is the system followed in several countries like Brazil, China, Australia, Spain, USA, etc. In

Ultra Narrow Row Cotton (UNR), the higher plant population of 2-2.5 lakh cotton plants per hectare is being maintained as against 12-24 thousand plants per hectare in conventional cotton in India. The UNR cotton plants produce fewer bolls than conventionally planted cotton but retain a higher percentage of total bolls, thereby higher number of bolls per unit area. The other advantages include better light interception, efficient leaf area development and early canopy closure which will shade out the weeds and reduce its competitiveness. The early maturity cotton group under UNR is the ideal system for shallow to medium soils under rainfed conditions which do not support excessive vegetative growth. These marginal soils are not suitable for the conventional late maturity hybrids which experience terminal stress.



In the Vidarbha region of Maharashtra 50 per cent of cotton is being cultivated in marginal soils under rainfed conditions. Under these circumstances, High Density Planting System with suitable varieties associated with management aspects is a viable alternate approach for improving cotton production. The manipulation of plant density and crop geometry is time tested agronomic technique for achieving high crop yield. High Density



Planting System is highly technical system and practicing the system needs careful planning, rigorous and timely monitoring of agronomic and plant protection measures, précised implements for weed control, use of growth regulators etc.

The HDPS system comprises of compact short stature, short duration varieties planted in row ranging from 45 cm to 90 cm with 10cm spacing between plants in a row, accommodating 1.1 to 2.2 lakh plants per hectare. The system is ideally suited for machine harvest. Since, there is synchronous boll maturation picking is done only once. Such varieties in high density produce few bolls (8-10 per plant) over a 60 day reproductive phase with a narrow window of 30-40 days vulnerability for bollworm attack. In many countries, the sowing window is adjusted in a manner that the crop escapes bollworms. Dr. Panjabrao Deshmukh Krishi Vidyapeeth cotton variety AKH-081 is dwarf, tolerant to sucking pest and early maturing (140-160 days) is suitable for high density planting under rainfed condition of Vidarbha region. Similarly SURAJ from Central Institute for Cotton Research, Nagpur and NH 615 from Vasantnao Naik Marathwada Krishi Vidyapeeth, Parbhani for high density planting. Integrated nutrient management with 125% RDF + Zn and foliar spray of nutrients at flowering and boll development is needed as the population increased per ha but boll load per plant is less. Sowing of HDPS

cotton on BBF or furrow opening in between cotton rows for *in situ* moisture conservation is essential under rainfed. In cotton weed compete for nutrient, moisture and sunlight. The weed free maintenance of 50 days after emergence of cotton is necessary for better yield in HDPS cotton.

Experiments were carried out with presently available semi compact genotypes for HDPS with different plant geometry and integrated nutrient with moisture conservation practices and integrated weed management for sustainable production of cotton under rainfed condition during 2013-2016 at All India Co-ordinated Research Project on cotton, Dr. PDKV, Akola under Technology Mission on Cotton MM I 1.4. The soil was medium deep clayey and having organic carbon 4.20 g kg<sup>-1</sup>, pH 7.9, EC 0.30 dSm<sup>-1</sup>, available N, P and K 180, 14.4 and 401 kg ha<sup>-1</sup>, respectively. The rainfall of the three season were 908, 593 and 645 mm and rainy days 49, 29 and 28, respectively.

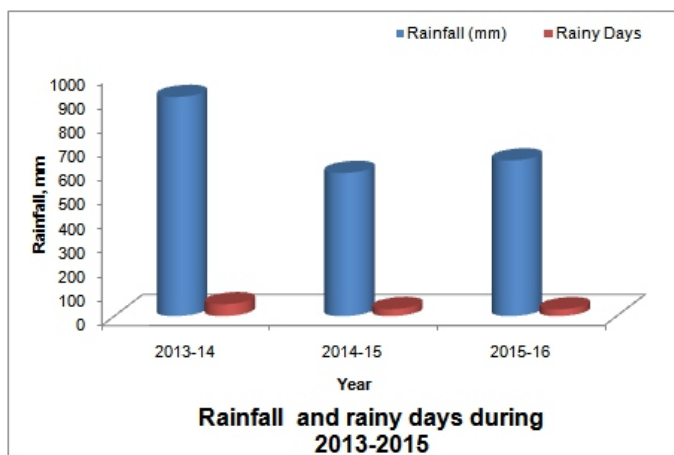
### **Objectives**

1. To study the performance of better genotypes for HDPS.
2. To study nutrient requirement for cotton under HDPS.
3. To study the moisture conservation techniques under HDPS
4. To study the effect of herbicides on growth and yield of HDPS cotton.
5. To study the bollworm management with different insecticides.

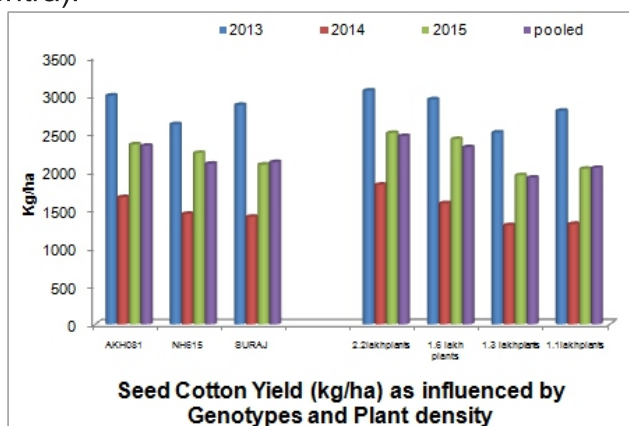
## Results

The following findings are observed from the experimentation on HDPS Cotton.

### A) Three promising genotypes were tested under HDPS with four planting spacing for evaluation of suitable genotype with plant density



The rainfall of the three season were 908, 593 and 645 mm and rainy days 49, 29 and 28 respectively. In 2014 monsoon was delayed onset and early withdrawal affected growth and Seed Cotton Yield (SCY) of HDPS cotton. In varied climatic condition also HDPS cotton performed better in rainfed condition at Akola (Maharashtra).



## Seed cotton Yield

The seed cotton yield was significantly highest in variety AKH 081 followed by NH615 and Suraj during individual as well as in pooled data. The Seed Cotton Yield was less due to delayed onset and early withdrawal of monsoon in 2014 .

The highest Seed Cotton Yield was recorded significantly highest (2843 Kg ha<sup>-1</sup>) by AKH 081 with 2.22 lakh/ha (45 x 10 cm), which is at par with 60 x 10 cm (2651 Kg ha<sup>-1</sup>). Suraj variety performed better at 75 x 10cm (2220 kg ha<sup>-1</sup>). Boll numbers were recorded maximum under AKH 081 and boll weight under Suraj. Boll numbers were higher at wider spacing.

The genotypes AKH 081, Suraj NH 615 are suitable for high density planting at 60 x 10 cm with 1.66 lakh population per ha under medium depth soils of Vidarbha in changing climate.



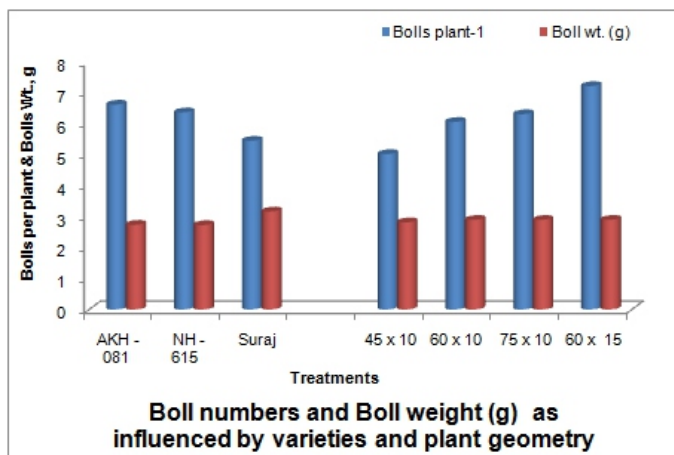
**AKH 081 at 60 x 10 cm**



**Suraj at 75 x 10 cm**



**Plant to plant distance 10 cm**





## **B) Three Moisture Conservation Techniques were tested with four nutrient management levels at 60 x 10 cm (1.66 plant population/ha) for AKH081**

### **Moisture Conservation Techniques (MCT)**

The seed cotton yield per hectare was significantly influenced due to moisture conservation techniques. Significantly highest SCY (2934 Kg ha<sup>-1</sup>) was recorded by tractor drawn Broad Bed Furrows (3 rows at 60 x 10 cm) followed by opening of furrows at 40-60 Days After Sowing over flat sowing. Significantly highest Gross monetary return, Net monetary returns were obtained with Broad Bed Furrow under HDPS. Benefit cost ratio was maximum with Broad Bed Furrow sowing.

### **Nutrient management**

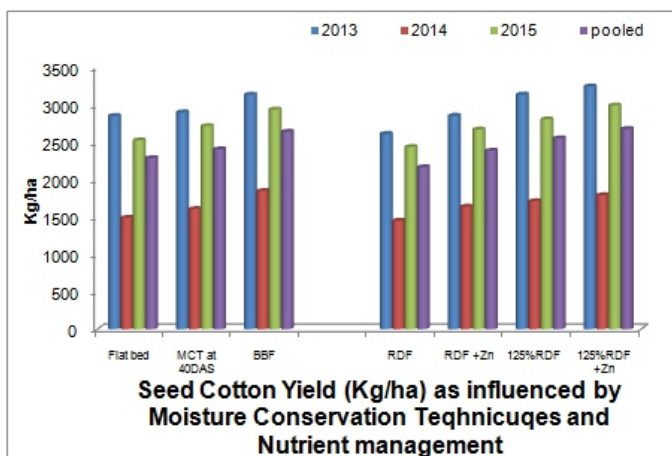
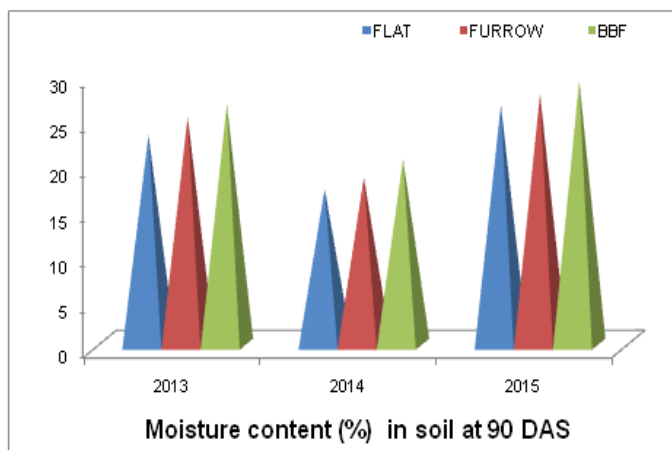
Nutrient management with different levels significantly influenced the yield attributes and Seed cotton under HDPS. Boll weight and Seed Cotton Yield per metre square was enhanced with nutrient levels. Significantly highest Seed Cotton Yield (3035 Kg ha<sup>-1</sup>) was recorded with 125% Recommended Dose of Fertilizer (75 : 37.5 : 37.5 NPK + 2.5 Zn Kg ha<sup>-1</sup>) over Recommended Dose of Fertilizer (2428 Kg ha<sup>-1</sup>). The Gross monetary returns were significantly influenced by different nutrient levels. The highest Gross monetary returns and Net monetary returns with 125% RDF + Zn which is at par with 125% RDF + foliar spray of 1% urea and 1% magnesium sulphate at boll development stage, which is the need of higher plant density. Benefit cost ratio was highest recorded with higher doses of nutrient under HDPS.

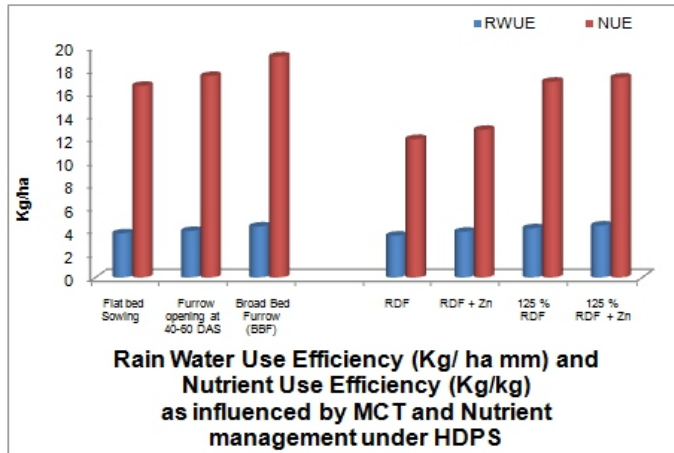
### **Rain water and nutrient use efficiency**

The maximum rain water use efficiency (4.41 kg ha mm) and nutrient use efficiency (16.6 kg/kg) with moisture

conservation practice with BBF and nutrient management with 125% RDF + 2.5 kg Zn ha<sup>-1</sup> and foliar spray of 1% urea and 1% magnesium sulphate at boll development stage. Moisture content at 90 days after sowing during three years indicated higher moisture content in BBF, which was supplied moisture for better growth of bolls and SCY under HDPS.

Sowing of high density planting at 1.66 lakh per hectare (60 X 10 cm) on BBF with 125% RDF(75 : 37.5 : 37.5 NPK + 2.5 Zn Kg ha<sup>-1</sup>) and foliar spray of 1% urea and 1% magnesium sulphate at boll development stage was found to get higher seed cotton yield, economic returns and conservation of moisture.





**Dry seeding with Broad Bed Furrow system**



**Moisture conservation under Broad Bed Furrow system after rains and germination of Cotton was not affected**



**Moisture conservation in BBF**



**AKH 081 at Boll development stage**



**Better harvest from AKH 081 grown on BBF**

### **C) Integrated weed management under HDPS was tested with pre and post emergence herbicides with combinations of cultural practices**

Dominant weed flora was *Commelina benghalensis*, *Cynodon dactylon*, *Cyperus rotundus* among the monocot species and in dicots *Euphorbia geniculata*, *Euphorbia geniculata*, *Parthenium hysterophorus*, *Celosia argentea* and *Digera arvensis* during experimentation.

#### **Weed control efficiency (%)**

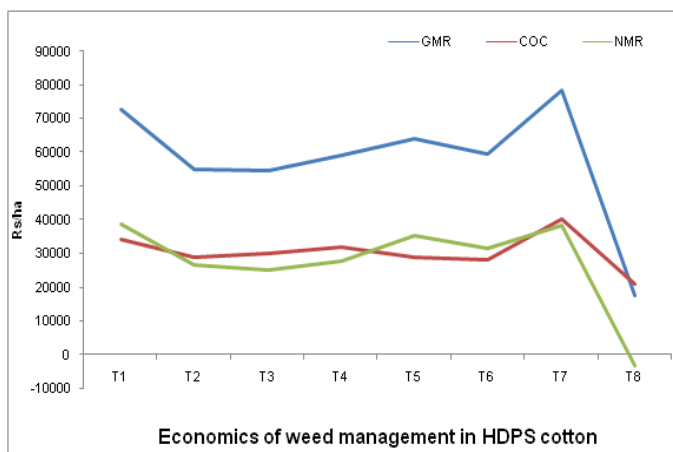
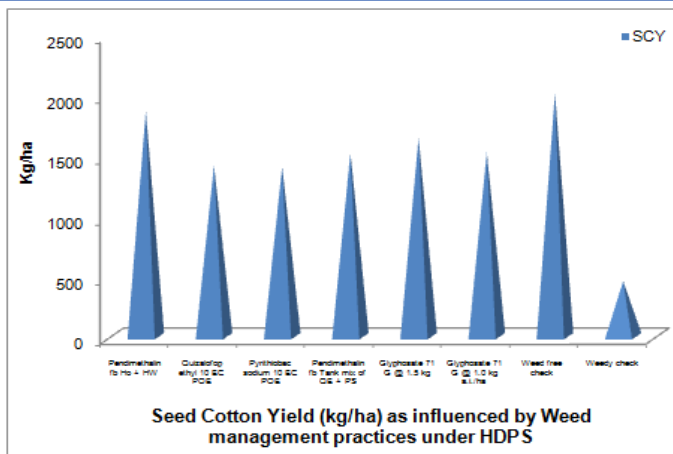
The highest WCE was observed with weed free check (83 %) and 87% in early and late sown condition of HDPS followed by weed control efficiency was maximum with PE Pendimethalin (81%) and 77% at 60 DAS at picking in early and late sown condition of HDPS AKH081. Glyphosate was found third rank but some phyto-toxic effect was noticed in HDP cotton leaves.

#### **Seed Cotton Yield and Economics**

The seed cotton yield was significantly highest with weed free plot followed by spraying of PE Pendimethalin *fb* Hoeing at 30 DAS + weeding at 45 DAS.

The significantly highest gross returns with weed free check, whereas B:C with Pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha *fb* hoeing at 30 DAS and one Hand Weeding at 45 DAS. A negative NMR with weedy check was observed in pooled data.

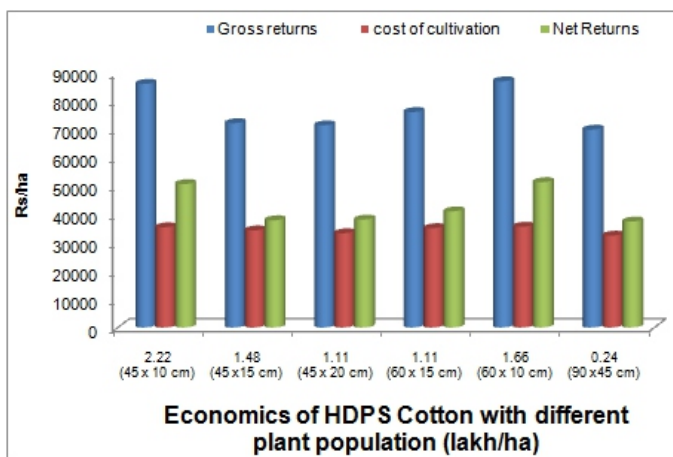
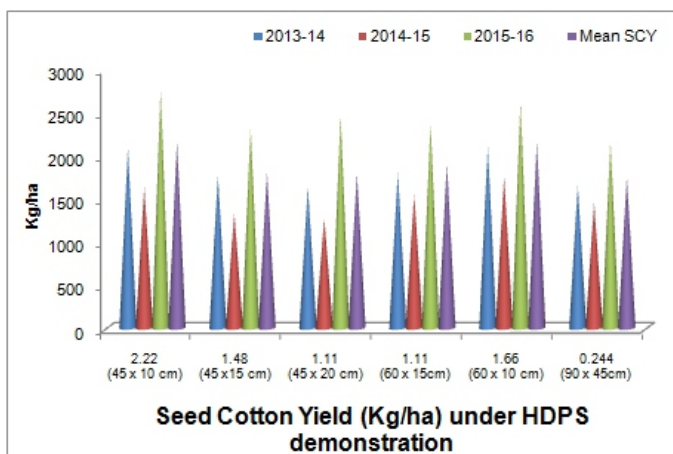
Pre emergence application of Pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha (3.3 litre in 700 litre water) *fb* hoeing at 30 DAS and one hand weeding is recommended to reduce early period weed competition under high density planting of cotton for getting higher economic returns.



**Weed control by pre-emergence application of Pendimethaline @1.25 kg a.i./ha + one hoeing + one handweeding**

## D) Demonstrations on HDPS

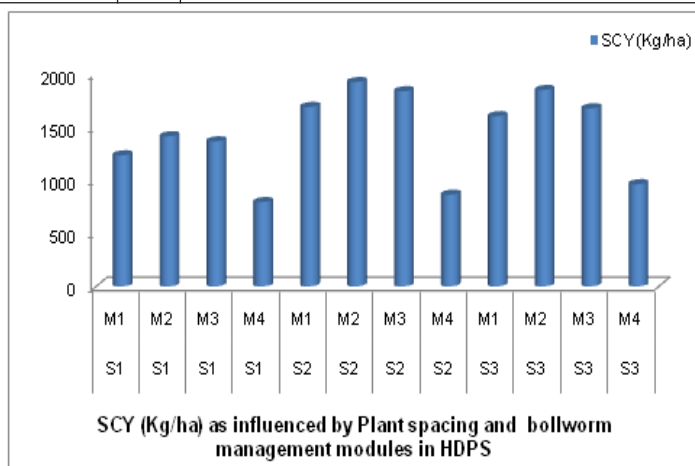
The variety AKH 081 was demonstrated on one acre of HDPS on medium black cotton soil in the month of June with plant density of 2.22 lakh/ha (45 x 10 cm) and 60 x 10 cm (1.66 lakh /ha) and 60 x 15 (1.11 lakh/ha) and other spacings 45 x 10, 45 x 15 and 45 x 20 cm were demonstrated with normal spacing of Bt Cotton on 95 x 45 cm (24 thousand plants/ha). The highest gross returns and net returns were obtained from HDPS with plant density of 2.22 lakh/ha (45 x 10 cm) and it was at par with 60 x 10 cm (1.66 lakh /ha).



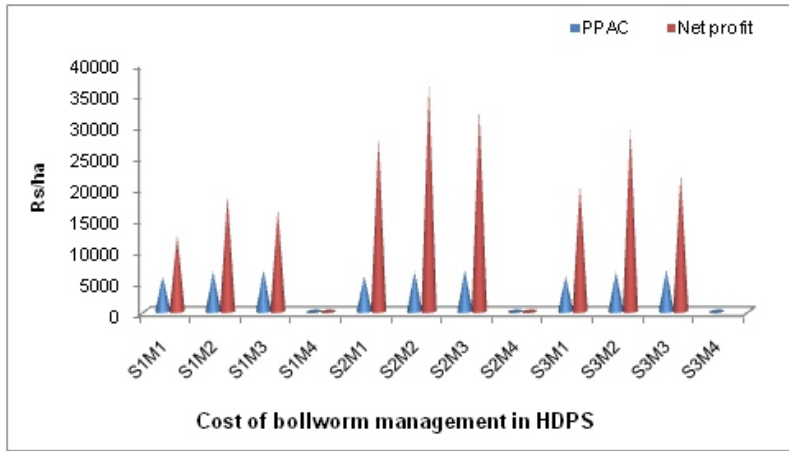
**E) Bollworm management with different insecticides were tested with spacing's under HDPS at Akola, Amravati and Yeotmal location (2015-16)**

Minimum larval population, damaged green fruiting bodies (GFB), open boll and loculi damaged was recorded in 60 x 10 cm spacing and it was at par with 60 x 15 cm spacing. Highest Seed Cotton Yield and Incremental Cost Benefit Ratio was recorded in 60 x 10 cm spacing with spraying of M2 module i.e. Flubendamide 480 SC @ 40ml/acre > Chlorantraniliprole 18.5 SC @ 60 ml/acre > Fenvalerate 20 EC @ 200 ml/acre.

	<b>Plant spacing</b>		<b>Bollworm management modules</b>
S1	45 x 10 cm	M1	Quinalphos 25 EC@ 400 ml/ acre > Spinosad 45%SC @ 60 ml/acre > Fenvalerate 20 EC @ 200 ml/acre
S2	60 x 10 cm	M2	Flubendamide 480 SC @ 40 ml/acre > Chlorantraniliprole 18.5 SC @ 60 ml/acre > Fenvalerate 20 EC @ 200 ml/acre
S3	60 x 15 cm	M3	Flubendamide 480 SC 50 ml /acre > Spinosad (45% SC) 60 ml /acre > Fenvelrate 20EC @ 160 ml/acre
		M4	M4 - Control







**Front Line Demonstration in village Borva, Tq. Akot, Dist. Akola**

### Specific recommendation emerged from the project:

- 1) AKH-081, Suraj or NH-615 genotypes are suitable for high density planting in cotton under medium deep soil of rainfed Vidarbha and sown on Broad Bed Furrows at 60 x 10 cm with 125% RDF (75 : 37.7 : 37.5 : 15 NPKS kg/ha) and foliar application of 1% Urea + 1% Magnesium Sulphate at boll development stage is recommended for higher seed cotton yield, economic returns and rainfall use efficiency.
- 2) Pre emergence application of Pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha (3.3 litre/ ha) *fb* hoeing at 30 DAS and hand weeding at 45 DAS is recommended for effective management of weeds under high density planting of cotton for getting higher economic returns.

### Bollworm management is must with IPM under non Bt HDPS in cotton



By adopting HDPS with suitable varieties under rainfed condition, farmers are expected to get an additional advantage of 15-20% over conventional system. Further this method of planting with Bt variety is an utilization for mechanization which needs further research and refinement.

## **ACKNOWLEDGEMENT**

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**Technology mission on cotton MM I- 1.4**

**Evaluation of genotypes and standardization of agrotechniques for HDPS and surgical cotton production**

