TMC MM I 2.1: Development of production technologies for Bt cotton and improvement of water and nutrient use efficiency with precision farming techniques

INTRODUCTION

Although Bt cotton hybrid is cultivated in about 83 percent of the cotton growing area, the agronomic recommendations developed for conventional hybrids are being advocated to Bt hybrids also. However, considering the higher yield potential, altered morphoframe, shorter duration and more synchronous boll setting, more so in the form of the first flush, it would be appropriate to develop site-specific nutrient and water management technologies to harness the higher yield potential if any of Bt cotton. This project aims to develop site-specific nutrient and water management technologies for higher water and nutrient use efficiency.

Field experiments on different nutrient and water management practices for Bt hybrid cotton were conducted at different locations viz., Central zone: Nagpur, Parbhani, Akola, Khandwa and Surat; South zone: Nandyal, Dharwad and Coimbatore ; North zone: Sirsa, Abohar and Sriganganagar for three years viz.2007 -08 to 2009-1 O.

OBJECTIVES

- To study the effect of *in-situ* moisture conservation measures in conjunction with INM in rainfed situation on productivity and fibre quality
- To find out optimum irrigation schedule and nutrient requirement with drip and fertigation for higher productvity and its synergetic effect on water and nutrient use efficiency
- To synchronize Nand K supply with crop demand to enhance nutrient use efficiency of Bt Cotton.

SALIENT FINDINGS

Sub Project 1: Effect of integrated rain water and nutrient management for improvement in productivity and fibre quality of Bt cotton.

Central Zone:

CICR, Nagpur:

Significantly higher cotton equivalent yield (1790 kg/ha) was obtained with green gram intercropped with cotton as compared to cotton + green manuring *in-situ* system (1225 kg/ha) and alternate furrows system (1022 kg/ha) which is due to additional yield of intercrop as well as higher yield of seed cotton (Fig.2.1.1). Among different nutrient sources, application of 75 % N through inorganic + 25 % N through organic (FYM) recorded higher cotton equivalent yield, as compared to other INM treatments(Fig.2.1.2). It was due to higher bolls per plant. With reference to fiber quality, neither moisture conservation techniques nor different INM treatments influenced the fiber quality however, marginal improvement in fibre strength of Bt (NCS 145) was observed with the application of micronutrients along with soil test based RDF(112N:56$P_2$0S:45$K_2$0).

PKV,Akola:

Cotton equivalent yield (1545 kg/ha) was recorded significantly higher with intercropping system cotton + black gram over alternate furrows system and green manuring in situ system in Bt. Among different nutrient sources RDF + micronutrients was found to be best treatment. Similar trend was observed in case of income also.

MAU, Parbhani:

Data on cotton equivalent yield indicates that cotton + soybean intercropping system recorded significantly highest seed cotton equivalent yield (2190 kg/ha) over wheat straw mulch in cotton (1233 kg/ha) and opening of furrow in alternate row (1452 kg/ha). Application of limiting micronutrients (Zn and Fe @10 kg/ha with RDF) and application of 75% N through inorganic + 25% N through vermicompost were at par and recorded

significantly higher cotton equivalent yield as compared to rest of the N fertilizer sources. Treatments with intercropping system and RDF + micronutrients had registered higher economic returns and B: C ratio.

ARS, Khandwa:

Intercropping of soybean with cotton resulted in highest cotton equivalent yield (1030 kg/ha) over rest of the moisture conservation techniques. Cotton yield was significantly increased by supplementing the nutrient supply through either vermicompost (25 or 50% N) or FYM (50%N) as compared to RDF (inorganic). Treatment RDF and RDF + micronutrients showing almost equal amount of nutrient recovery. Nutrient use efficiency was highest under treatment RDF . Water use efficiency was significantly influenced with the use of organic manures over RDF (only inorganic).

South Zone:

UAS, Dharwad

Growing of intercrop green gram in Bt cotton produced significantly higher cotton equivalent yield (3511 kg/ha) as compared to other conservation practices (Fig. 2.1.3). Different N sources produced similar cotton equivalent yields (Fig. 2.1.4). Highest cotton equivalent yield (3134 kg/ha) was registered in RDF + micronutrients treatment than the rest of the N sources. Intercropping system had produced significantly highest income and higher nutrient use efficiency.

ANGRAU, Nandyal

No significant difference in seed cotton yield and nitrogen use efficiency was observed among different moisture conservation techniques. But higher cotton equivalent yield (CEY) was obtained with intercropping soybean in Bt cotton. Higher CEY was recorded with 75% RDF N through FYM + 25% N through vermicompost as compared to RDF and RDF + micronutrients. There was was slightly higher soil moisture on surface 80 DAS with application of 75 % N through inorganic and 25% N through FYM.

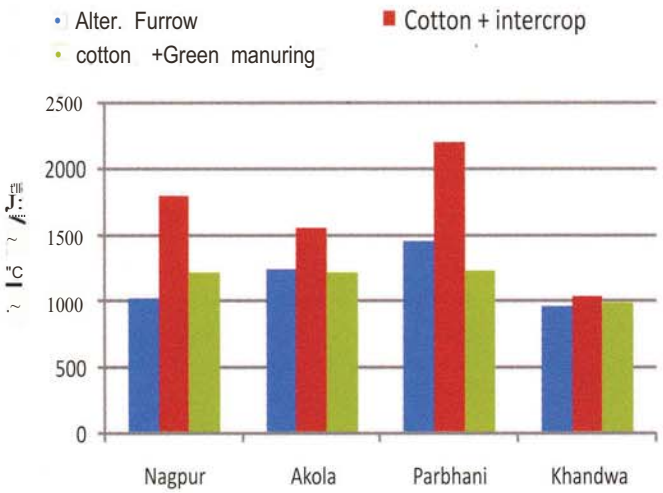

Fig.1 Effect of moisture conservation techniques on cotton equivalent yield (kg/ha)

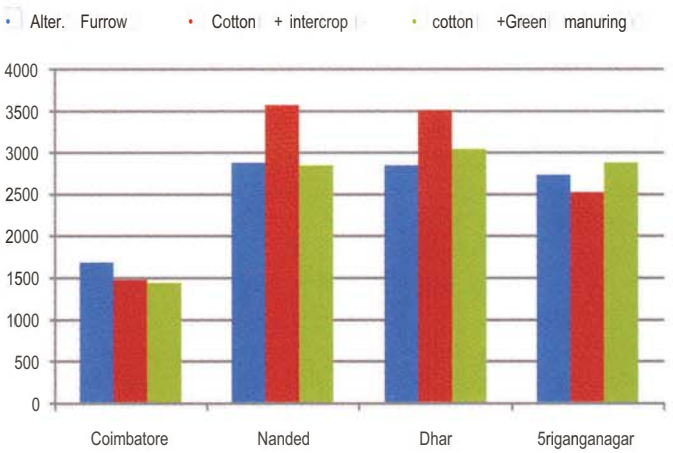

Fig.3 Effect of moisture conservation on cotton equivalent yield (kg/ha)

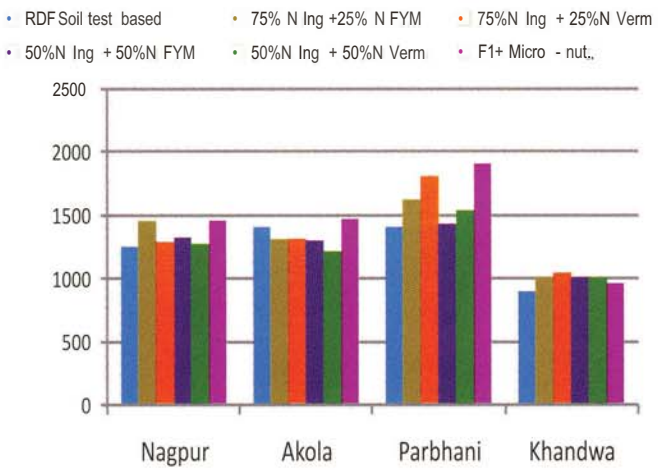

Fig. 2 Effect of integrated nutrient management on cotton equivalent yield (kg/ha)

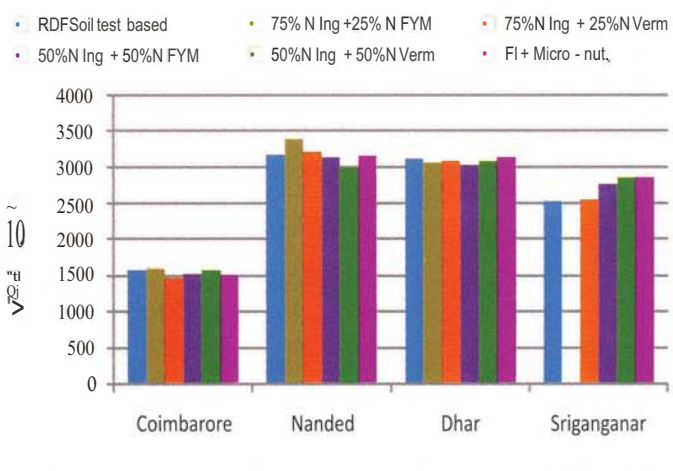

Fig.4 Effect of integrated nutrient management on cotton equivalent yield (kg/ha)

North Zone

RAU, Sriganganagar:

Analysis of seed cotton yield indicated that the treatment green manuring in cotton with dhaincha recorded highest seed cotton yield (2884 kg/ha) followed by opening of alternate furrows (2736 kg/ha). Treatment RDF (150:40:20) + Zn recorded highest seed cotton yield (3226 kg/ha) followed by RDF (inorganic), 50% N through inorganic and remaining 50% N through vermicompost. . Similar trend was observed for WUE and WP (water productivity) .

Sub Project II: Effect of precision application of irrigation and fertilizer through drip on productivity and fibre quality of Bt cotton

Central Zone

CICR, Nagpur:

Data on seed cotton yield at different irrigation and fertigationlevels (Fig. 2.1.5) indicated that irrigation at 0.8 ETc registered seed cotton yield (2164 kg/ha) similar to that of 1.0 ETc (2166 kg/ha). Higher WUE was recorded at 0.8 ETc which saved 20 % of irrigation water. Higher nutrients use efficiency was recorded at 0.6 ETc followed by 0.8 and 1.0 ETc levels of irrigation This was due to higher NPK uptake at 0.8 ETc and 1.0 ETc levels. Application of 100% NK fertilizer through drip registered higher seed cotton yield as compared to other fertigation levels (Fig. 2.1.6). Higher returns was recorded at 0.8 ETc followed by 1.0 ETc as compared to 0.6 ETc level of irrigation. There was no difference in returns at any fertilizer levels. Data on fibre quality showed no difference at any irrigation and fertigation levels.

PKV,Akola

Irrigation applied at 1.0 ETc recorded significantly highest seed cotton yield (1787 kg/ha) than other irrigation treatments. The yield difference between 0.6 ETc and 0.8 ETc was non significant but these treatments produced significantly more yield over furrow irrigation. Similar type of results were observed in net returns and B: C ratio. Application of 125% RDF through drip in six splits recorded significantly higher seed cotton yield (1510 kg/ha) than other fertilizer treatments. Interaction effects between irrigation and fertilizer levels were non significant in respect of yield attributes, seed cotton yield and monetary returns.

MAU, Parbhani

Irrigation scheduled at 1.0 and 0.8 ETc were at par and recorded significantly higher seed cotton yield (3250 - 3290 kg/ha) as compared to irrigation scheduled at 0.6 ETc (2489 kg/ha). Application of 100% and 125% RDF through drip in 6 splits were at par and significantly superior over 100% RDF soil application regarding the yield. Highest fertilizer nitrogen use efficiency was recorded at 0.8 ETc closely followed by irrigations at 1.0 Etc.

NAU,Surat

Irrigation at 0.8 ETc recorded highest yield attributes. Irrigation at 0.6 Etc recorded 90% of yield of 0.8 ETc saving 40% irrigation water. Water use efficiency and water productivity was higher at irrigation at 0.8 Etc followed by furrow irrigation (0.6 ETc).

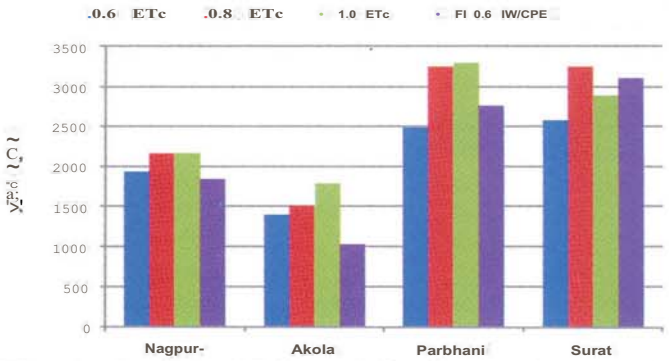

Fig. 2.1.5 Effect of different irrigation levels on seed cotton yield in kg/ha

South Zone

UAS, Dharwad:

Irrigation at different ETc levels had produced on par yield levels (Fig. 2.1.7). Application of 125% RDF significantly increased seed cotton yield (3004 kg/ha) as compared to the 75% RDF as fertigation and 100% RDF applied as soil application (2524, 2753 kg/ha) (Fig. 2.1.8). Increased yield due to increased fertilization was associated with significant increase in number of bolls per plant.. Interactions (irrigation X fertilizers) effects were non significant in case of seed cotton yields.

Scheduling of drip irrigation did not affect net returns and B: C ratio. However, drip irrigation at 1.0 ETc produced highest net returns and B:C ratio (2.24). Though the difference in monetary returns between drip and surface irrigation methods were less but saving of irrigation water was important in drip irrigation. Among different levels of fertigation, 125% RDF produced significantly higher net returns and B: C ratio (2.21) as compared to other fertigation levels.

Increasing levels of irrigation increased the nutrient uptake in Bt. Highest WUE (39.9 kg/ha cm) and WP (11.17 Rs/m3) were recorded with drip irrigation at 1.0 ETc. Enhancement in WUE and WP at higher level of irrigation were due to increased yield.

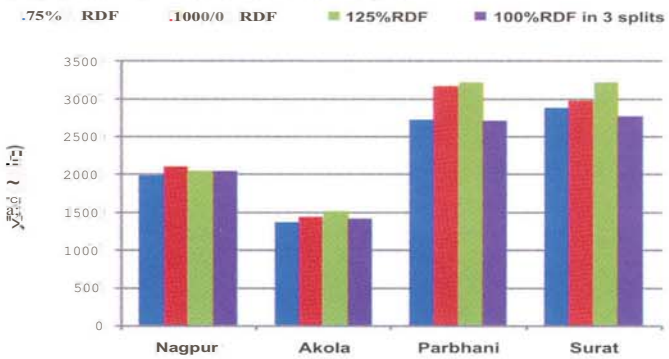

Fig. 2.1.6 Effect fertigation levels on seed cotton yield in kg/ha

CICR, Coimbatore:

Among irrigation scheduling, drip irrigation at 0.8 ETc registered the significantly highest seed cotton yield of 2021 kg/ha which was on par with irrigation scheduling @

1.0 and 0.6 ETc through drip (Fig. 2.1.7). Surface irrigation by adopting furrow method @ 0.6 *IWI* CPE registered the significantly least seed cotton yield (1534 kg/ha). Drip irrigation method (at 0.6,0.8 and 1.0 ETc) out yielded surface method of irrigation.

Different level of fertilizers (75, 100 and 125 % RDF) applied as drip fertigation in six splits (at 15, 30, 45, 60, 75 and 90 DAS) did not have significant influenced over soil application of 100% RDF in three splits (at 0, 45 & 90 DAS) (Fig. 2.1.8). Higher nutrient uptake was recorded with 100 % RDF through drip.

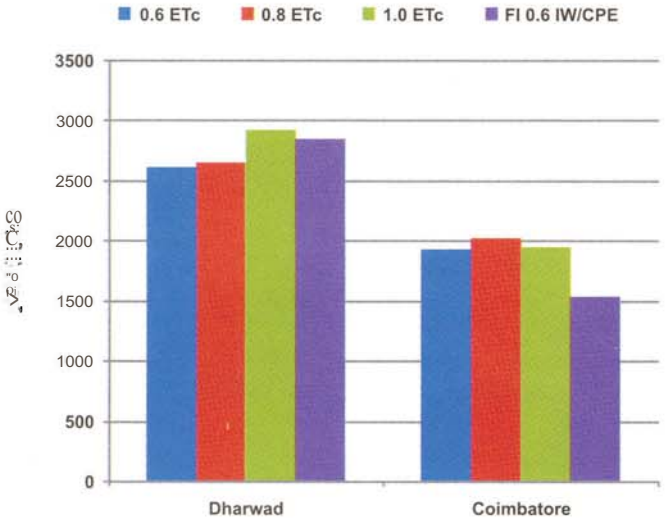

Fig. 2.1.7 Effect of irrigation levels on seed cotton equivalent yield in kg/ha

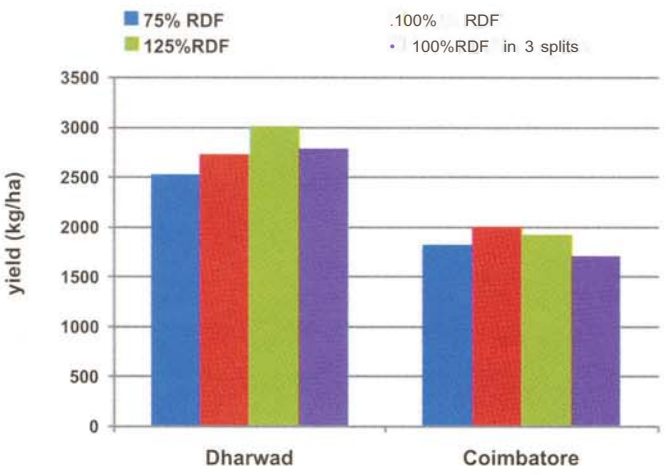

Fig. 2.1.8 Effect of fertigation levels on seed cotton equivalent yield in kg/ha

North Zone

PAU, Abohar:

The data on seed cotton yield at different irrigation levels 0.6, 0.8 and 1.0 ETc and fertigations was non significant (Fig.2.1.9). However, seed cotton yield which was significantly highest over the furrow irrigation treatment (again due to severe incidence of CLCV). Fertilizers application through drip did not resulted in any significant differences in seed cotton yield (Fig. 2.1.10). Nitrogen and potassium use efficiency showed non significant with respect to different irrigations. However, for different fertilizer levels, NUE, PUE and KUE showed significant differences with lowest value at 100 % fertilizer applied at surface. This showed enhanced fertilizer use efficiency when fertilizer applied as fertigation as compared to surface application. Irrigation at 0.6 ETc gave highest net returns and 8: C ratio, as well as fertilizer level at 75 % RDF applied through drip irrigation is better than higher fertilizer levels.

WUE and water productivity (36.8 kg/ha - cm and 8.08 Rs/m3) were significantly higher in 0.6 ETc and decreased with increase in irrigation water applied with lowest value under furrow irrigation (8.7kg/ha-cm). WUE and water productivity did not show any significant differences when different fertilizer levels were compared.

H.A.U., Sirsa:

The highest seed cotton yield was obtained at 1.0 ETc level of irrigation which was significantly superior over other irrigation levels (Fig2.1.9). Among different fertigations, highest seed cotton yield was obtained with 125 % RDF level offertilizer as compared to 75 and 100% RDF through irrigations (Fig 12). The WUE was recorded higher at 1.0 ETc irrigation.

Pooled data ofthree years:

Results of mean of three years i.e. 2007-08, 2008-09 and 2009-10 on seed cotton yield, WUE and NUE at different irrigation schedules and fertilizer levels for 8t cotton is reported here as zone-wise.

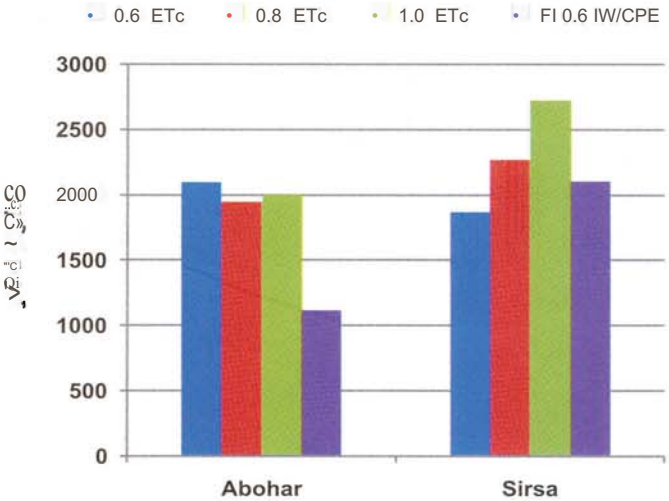

Fig. 2.1.9 Effect of irrigation levels on seed cotton equivalent yield in kg/ha

Central Zone:

Data of mean yield of seed cotton was non significant at different irrigations and fertigation in 8t NCS- 145 at Nagpur (Table 2.1.1) however, the irrigation schedule at 0.6 ETc with 100% RDF realized 90 % yield of the yield at 1.0 ETc which showed the 40% water saving. There was no significant effect of different irrigation treatment at Akola. at Parbhani irrigation at 0.8 Etc was optimum. Mean data of all centres showed higher water use efficiency at 0.8 ETc as compared to 1.0 ETc.

Fig. 2.1.10: Effect of fertigation on seed cotton equivalent yield (kg/ha)

South Zone:

Data on seed cotton yield (mean of 3 years) as influenced by different irrigations and fertigations indicate that seed cotton yield was significantly increased with 100% RDF through drip at 0.8 ETc over 0.6 ETc at both Coimbatore and Dharwad centre (Table 2.1.2). Nutrient use efficiency (NUE and KUE) was found to be increased with increase of irrigation and fertigation levels. Higher WUE was observed at 0.8 ETc as compared to 1.0 ETc at both the centres. However, higher WUE (68.70 kg/ha-cm) was calculated at 0.6 ETc may be due to yields at 0.8 or 1.0 ETcwas notfound much difference with 0.6 ETc.

North Zone:

Mean seed cotton yield of 3 years recorded atAbohar and Sirsa indicates that significant increase in yield was recorded at 0.8 ETc as compared to 0.6 ETc. Yield at different fertilizer levels did not influenced by higher doses of fertilizer given through drip as compared to 100% RDF in Bt cotton in north region, it was noticed due to CLCV disease occurred on Btcotton. Similar trend was observed on WUE determined at 0.6, 0.8 and 1.0 ETc levels.

SPECIFIC TECHNOLOGIES/ RECOMMENDATIONS

Central Zone:

1.Intercropping with pulses/soybean in Bt cotton (NCS 145).

2.Soil test based RDF + micronutrient and 75% N through inorganic + 25 % through organic manure.

3.Irrigation at 0.8 ETc with 100 % RDF (120:60:60) was found economically beneficial in achieving higher seed cotton yield as well as saving of 20 % water.

4.Three split application of N K nutrient with P as basal is recommended for rainfed Bt hybrid.

South Zone:

1. Growing of intercrop with green gram/soybean with Bt cotton (NCS 145). At Dharwad centre where insitu mulching of sun hemp is recorded.

2.Drip irrigation at 0.8 ETc with 100 % RDF registered the significantly highest seed cotton yield as well as higher WUE in Bt.

North Zone :

1. Mulching with straw in Bt (RCH 134 Bt) at Sriganganagar was found to be better in achieving maximum seed cotton yield and WUE.

2.Irrigation at 0.6 ETc could provide at least 90 % of the yield obtained at 1.0 ETc at all centre except Sirsa thus saving in 40 % of water.

Table 2.1.2 : Effect of different Irrigation and fertilizer levels on seed cotton yield kg/ha (Mean of 3 years)

Treatments	Central zone				South Zone		North Zone	
	Nagpur	Akola	Parbhani	Surat	Coimb	Dharwad	Abohar	Sirsa
Irrigation levels								
11(0.6 ETc)	1990	1762	2240	2741	2606	2536	2196	2230
12(0.8 ETc)	2094	1833	3139	3372	3017	2697	2415	2625
13(1.0 ETc)	2136	1976	3185	2961	3008	2791	2450	2889
14(FI) 0.6 ETc	1890	1594	2504	3186	3067	2648	2051	2478
CD	244	NS	178	206	360	110	369	
Fertilizer levels								
F1: 75% RDF	2005	1623	2516	3043	2842	2414	2228	2360
F2: 100% RDF	2026	1764	2967	3069	3058	2641	2280	2598
F3:125%RDF	2025	1973	3005	3228	3013	2836	2274	2752
F4:100%RDF in 3 splits	2054	1803	2580	2920	2784	2668	2162	2512
CD	132	185.4	76	197	154	70	NS	-

Table 2.1.2 : Effect of different Irrigation and fertilizer levels on WUE (kg/ha-cm)

Treatments	Central zone				South Zone		North Zone	
	Nagpur	Akola	Parbhani	Surat	Coimbat	Dharwad	Abohar	Sirsa
Irrigation levels								
11(0.6 ETc)	29.73	29.50	53.60	49.37	68.70	47.20	28.00	53.50
12(0.8 ETc)	30.73	29.60	61.30	51.10	63.70	48.30	29.80	56.80
13(1.0 ETc)	30.95	30.90	51.10	37.29	53.30	46.40	25.90	57.70
14(FI) 0.6 ETc	30.93	22.60	32.00	49.89	48.60	41.80	14.00	40.20
Fertilizer levels								
F1: 75% RDF	29.91	25.30	42.70	--	56.10	40.50	27.20	47.10
F2: 100% RDF	29.78	27.50	51.00	--	61.50	44.40	27.40	51.80
F3:125%RDF	30.84	30.80	51.50	--	60.30	47.60	27.30	55.00
F4:100%RDF in 3 splits	31.16	28.10	44.80	--	56.30	44.70	25.90	50.10

Moisture conservation techniques at CICR Farm, Nagpur

Drip irrigation system at CICR, R. S., Coimbatore