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Influence of different Moisture Conservation Practices on Yield, Quality and Root Growth of *Bt.* Cotton under Dryland condition of Central India

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ABSTRACT: Controlling groundwater extraction in Maharashtra necessitates the use of water-saving techniques. In this region, *Bt* cotton provides a diversification option. The bottlenecks for *Bt* cotton production are high soil evaporation and soil temperature in the early portion of the growing season. In this research, we demonstrate that mulching and drip irrigation are the optimal water-saving strategies. Keeping the above in mind, a field experiment was conducted during *Kharif* season of 2016-17 to assess the influence of different moisture conservation practices in *Bt.* Cotton. This experiment was laid out in Randomized Complete Block design (RCBD) with seven treatments which were replicated thrice. The treatments were, i.e., T_1: poly mulch on ridges and furrow with drip, T_2: bio mulch on broad bed and furrow with drip, T_3: poly mulch on broad bed and furrow with drip, T_4: dust mulch on flatbed with drip, T_5: no mulch on flatbed with drip, T_6: conventional irrigation on ridges and furrow and T_7: no irrigation on ridges and furrow. Significantly higher seed cotton yield (3704 kg ha^{-1}) and stalk yield (4116 kg ha^{-1}) has been recorded with T_2 while the longer staple length (31.07 mm) and higher fibre strength (26 g tex^{-1}) was recorded with T_3. However, higher oil content (22.62%) was recorded with T_1, however, does not reach the limit of statistical significance So, the perusal of experimental data indicates that the application of bio- mulching or poly-mulching along with drip irrigation can improve growth, yield and quality of *Bt.* Cotton.

Keywords: Cotton, Mulching, Drip, Growth, Yield, Quality.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.), popularly known as "white gold" or "king of fibres," is one of India's most valuable commercial crops. India ranks first in the world having an area of 11.9 million ha with the cotton production of 35.3 million bales and productivity of 462 kg lint ha^{-1} in 2020-21. Maharashtra is one of the leading cotton growing state in India having 42.9 lakh ha area under cotton cultivation which is one third of countries area of cotton cultivation with the production of 95.8 lakh bales. The productivity of cotton in Maharashtra is 380 kg lint ha^{-1} in 2020-21 (Anonymous, 2021). Despite the fact that cotton is recommended for black soils, more than 65 per cent of cotton in India is grown in red soils. Proper land arrangement according to soil type aids in efficient soil moisture conservation under rainfed conditions, as well as enhanced stand, establishment, uniform growth, fertiliser usage efficiency and yield.

In dryland agriculture, not only is there insufficient rainfall, but its distribution is also out of sync with crop evapotranspiration needs. Conservation of moisture is a crucial issue in dry land agriculture. As a result, there is a need for in-situ rainwater conservation. Effective rain water management, such as in-situ moisture conservation techniques such as furrow opening, intercropping, and mulching, is critical for achieving long-term yields (Gokhale *et al*., 2012). Mulch slowed the movement of water vapour from the soil surface to the microclimate, reducing soil water loss by direct evaporation (Xie *et al*., 2006) and increasing soil water availability to the crops. In cotton, the use of plastic mulch has proven water savings of 40-50 per cent (Nalayani *et al*., 2009).

Crop production is hampered by a lack of water. Agricultural producers are concerned about both the economy and the ecology when it comes to water use. Because land is a finite resource, increasing productivity per unit of land and water is the best approach to achieve this aim. There is no way to boost irrigation potential by utilising more water now that water is becoming a scarce resource. As a result, the only method to boost fibre production is to improve water efficiency. Irrigation's goal in the modern era is not just to provide additional water for crop production, but also to boost crop yield per drop of water. Faulty Improper irrigation procedures result in not just the waste of a valuable and precise resource, but also a reduction in agricultural yield, quality and economic return (Isal *et al.*, 2019). There are two possibilities for meeting the water shortage requirement: either enhance gross irrigation potential or increase water use efficiency. Cotton is primarily farmed as a rainfed crop in Vidarbha, and rainfed cotton production has a direct impact on the region's agrarian economy. The low productivity is mostly attributable to the fact that the majority of cotton is rainfed, which is characterised by irregular rainfall distribution. Micro-irrigation systems have been discovered to be one of the most advanced irrigation methods. Drip irrigation has been shown to save 30 to 50 per cent of irrigation water while increasing crop output by 15 to 20%. Furthermore, it reduces the cost of inter-cultivation, which enhances fertiliser efficiency, accelerates crop maturity, and improves the quality of the final product. The amount of fertilizer lost through leaching could be as low as 10 per cent in drip fertigation as compared to 50 per cent in the conventional method of fertilizer application (Sankaranarayanan *et al*., 2010; Shruti and Aladakatti, 2017).

To address the ever-increasing need for irrigation water, a well-known strategy is to employ mulch in conjunction with micro irrigation, which has been demonstrated to be efficient and cost-effective. The new emerging technologies must be thoroughly understood, and appropriate management must be developed in order to adequately address them. In light of the foregoing considerations, the current study was undertaken to determine the impact of mulch and drip irrigation on *Bt* cotton output in the western Vidarbha region, specifically at the Akola location.

MATERIALS AND METHODS

The field experiment was carried out at Cotton Research Unit field, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *Kharif* season of 2016-17. The experimental site is situated in the subtropical region at 22°42′ North latitude and 77°02′ East longitude, and an altitude of 307.42 m above mean sea level. The experimental site witnesses a scorching summer season especially in the month of May with a mean maximum temperature of 34.4°C while in winter it falls up to 8.4°C during the month of December. During the whole cropping period, total 832.8 mm of rainfall was received in a span of 45 rainy days. The mean daily evaporation reached as high as 6.1 mm in the month of June and as low as 3.4 mm in the month of December. The maximum relative humidity was present during Monsoon (74-87%) while the lowest was observed during the month of December (42-52%). The topography of the field was reasonably uniform and level. The soil was medium black cotton belonging to *Vertisols*.

The experiment was laid out in Randomized Block Design (RBD) with seven treatments which were replicated thrice. Each net plot sized 3.6 × 3.0 m. The treatments were; $T_{1:}$ poly mulch on ridges and furrow with drip, T_2: bio mulch on a broad bed and furrow with drip, T_3: poly mulch on broad bed and furrow with drip, T_4: dust mulch on flatbed with drip, T_5: no mulch on flatbed with drip, T_6: conventional irrigation on ridges and furrow and T_7: no irrigation on ridges and furrow. The *Bt.* cotton variety RCH 659 BG-II has been used for experimentation with a spacing of 120 cm × 50 cm, which was sown using the dibbling method. The recommended dose of fertilizer (120 : 60 : 60 kg NPK) was provided to the plants following standard package and practices.

Irrigation was administered immediately after seeding by soaking the entire bed, with following irrigations scheduled every two days. The working pressure for the drip fertigation system was kept at 1.0 kg cm^2. Drip irrigation was applied once every two days according to the schedule, based on cumulative pan evaporation. The following formula was used to determine the amount of irrigation water to be applied to $plant^{-1}$ $plot^{-1}$

$$V(lpd) = (ET_0 \times Kc \times A \times Wp) - (RE \times A),$$

where V: Volume of water applied (litre day^{-1} $plant^{-1}$), ET_0: Reference evapotranspiration (mm day^{-1}), Kc: crop factor, A: Area under crop (m^2), Wp: wetted area fraction and RE: effective rainfall in mm. The net depth of water to be applied in drip irrigation of alternate day was determined by the following formula:

$$D = (ET_0 \times Kc) - RE;$$

where, D: net depth of water to be required (mm), ET_0: Reference evapotranspiration (mm day^{-1}) and RE: Effective rainfall (mm). Time of operation of drip system to deliver the required volume of water $plot^{-1}$ was computed using the formula,

$$\text{Time of operation} = \frac{\text{Volume of water required}}{\text{Emitter discharge rate} \times \text{No. of emitter}}$$

The values of crop coefficients for different growth stages of cotton were estimated as per the FAO Irrigation Water Management, Training Manual No. 3 (1986).

The plots where Broad bed and furrow (BBF) and Ridge and Furrow (RF) were used; 30micron silver top polythene sheet was used as poly- mulch. Bio mulching was done by slaying and layering of Sun hemp plants before flowering while the weed mulching was done with the weeds collected after weeding from the plot. Three light hoeing was given to treatment plots as dust mulching just to check the evaporation loss.

The bolls of cotton were harvested in two pickings *i.e.*, 140 DAS and 176 DAS. The observations have been taken from five tagged plants from each plot. Root volume was measured by dipping roots in 1000 ml measuring cylinder and displacement of water was measured. Ginning out turn (%) of various treatments was calculated by ginning 500 g of seed cotton picked from first picking (as the yield of seed cotton was more in the first picking). The seed and lint weight were recorded in 'g' after ginning. The ginning out turn was calculated by employing the formula suggested by Santhanam (1976).

$$\text{Ginning (\%)} = \frac{\text{Weight of lint (g)}}{\text{Weight of seed cotton (g)}} \times 100$$

RESULTS AND DISCUSSION

A. Yield

Seed cotton yield significantly influenced by different moisture conservation practices (Table 1). Moisture conservation practice of bio-mulch on BBF with a drip (T_2) recorded highest seed cotton yield (3704 kg ha^{-1})

followed by poly mulch on BBF with a drip (T_3) (3451 kg ha^{-1}) and which were 48.7% and 42% more than the lowest seed cotton yield (2253 kg ha^{-1}) recorded in T_7 where no irrigation was used. The same way stalk yield was also found to be 27% and 20.5% higher with T_2 and T_3 than T_7. The moisture conservation practices resulted in a significant increase in stalk yield over no mulch, conventional irrigation method and no irrigation might be due to better utilization of N and K nutrients by the plant and maximum allocation of dry matter to vegetative parts (Halemani, 2010; Ahmad *et al*., 2015; Isal *et al.*, 2019).

Table 1: Seed cotton yield (kg ha^{-1}), stalk yield (kg ha^{-1}) and biological yield (kg ha^{-1}) as influenced by different moisture conservation practices.

Treatments	Seed cotton yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Biological yield (kg ha^{-1})
T_1: PM+RF+DI	3117	3715	6832
T_2: BM+BBF+DI	3704	4116	7820
T_3: PM+BBF+DI	3451	3850	7301
T_4: DM+FB+DI	2824	3458	6282
T_5: NM+FB+DI	2593	3359	5951
T_6: CI+RF	2423	3408	5831
T_7: NI+RF	2253	3133	5386
SE (m)	160	200	271
CD P= 0.05	492	612	833

B. Quality parameters

The effect of moisture conservation practice on fibre quality was found to be statistically non-significant at 5% level of significance (Table 2). However, highest staple length was recorded with poly mulch on BBF with a drip (T_3) resulted in 6% longer staple length than no irrigation (T_7) which has been closely followed by bio-mulch (T_2) which was 5% longer. Among the fibre characters in cotton, fibre fineness (micronaire value) usually ranges from 2.6 to 5.6. The fineness of the fibre is measured by micronaire value, lower the value finer the fibre and vice-versa. The finer fibre was recorded in the poly mulch on BBF with a drip (T_3), dust mulch on FB with a drip (T_4) and no irrigation on RF (T_7) compared to other treatments. The higher fibre strength (26.00 g tex^{-1}) was also recorded in the poly mulch on BBF with a drip (T_3), and lowest (24.70 g tex^{-1}) was recorded in both the poly mulch on RF with a drip (T_1) and conventional irrigation on RF (T_6). Ginning per cent was also better with T_3. Similar findings had also been reported by Kumari *et al*. (2018); Irfan *et al*. (2019), which supports the findings of the present investigation.

Moisture conservation practice of bio-mulch on BBF with a drip (T_2) recorded higher seed index (11.2 g) followed by poly mulch on BBF with a drip (T_3) with the value of 10.7 g. While the lowest seed index (10.2 g) was recorded with no irrigation on RF (T_7). In case of oil content moisture conservation practice of poly mulch on RF with a drip (T_1) was recorded higher value (22.62 %), followed by poly mulch on BBF with a drip (T_3) with the value of 22.08 %. Lowest oil content (21.55%) was recorded with conventional irrigation on RF (T_6).

Table 2: Quality parameters as influenced by different moisture conservation practices.

Treatments	Staple Length (mm)	Fineness (Micronaire) (μm/inch)	Strength (g/tex)	Ginning (%)	Seed Index (g)	Oil content (%)
T_1:PM+RF+DI	30.27	4.20	24.70	42.54	10.4	22.62
T_2:BM+BBF+DI	30.47	4.00	25.20	37.03	11.2	21.84
T_3 :PM+BBF+DI	31.07	3.90	26.00	42.61	10.7	22.08
T_4 :DM+FB+DI	30.73	3.90	25.80	39.39	10.3	21.77
T_5 :NM+FB+DI	29.43	4.00	25.90	38.69	10.3	21.86
T_6 :CI+RF	29.83	4.20	24.70	41.17	10.5	21.55
T_7 :NI+RF	28.97	3.90	25.80	40.00	10.2	21.61

C. Root studies

Availability of moisture and root characters of the plant are closely interrelated. The perusal of data (Fig. 1) on total root volume (cc) and root dry weight (g) has been found significantly affected due to different moisture conservation practices. Moisture conservation practice of poly mulch on BBF with a drip (T_3) recorded the highest root volume which is 71% more than no mulch on FB with a drip (T_5) which has lowest root volume. In case of root dry weight, bio-mulch on BBF with a drip (T_2) recorded the highest root weight, which is 36% more than no irrigation on RF (T_7).

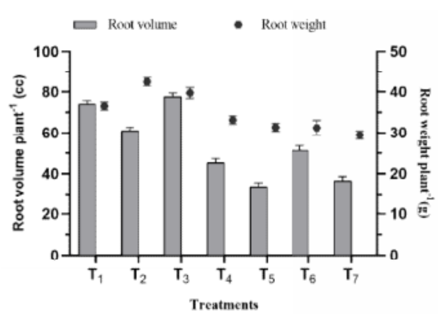

Fig. 1. Root volume (cc) and root weight (g) at harvest as influenced by different moisture conservation practices.

The different trend between root volume and root dry weight is maybe since, less availability of water resulted in the thinner but more extensive spreading of roots in search of moisture, while the availability of constant moisture resulted in a heavier but less extended rooting network. Similar findings had also been reported by Wang *et al*. (2020); Wang *et al*. (2021), which supports the findings of the present investigation.

CONCLUSION

Based on above results, it can be concluded that maximum yield from Bt. cotton can be obtained by moisture conservation practice of bio-mulch on BBF with a drip (T_2). However, poly mulch on BBF with a drip (T_3) recorded higher values of fibre qualities. Root volume and root weight were significantly higher with bio-mulch on BBF with a drip (T_2).

FUTURE SCOPE

Future research should look at a variety of crop species and kinds with the goal of determining the viability of various mulches, both organic and inorganic under drip irrigation that can withstand environmental impact, are easy to apply and allelopathic effect on plants.

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Conflicts of Interest. The results furnished in this paper were from my own research and there were no any conflicts from other research scholars or scientists.

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