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Effect of Tillage and Weed Management Practices on Weed Density and Yield of *Bt* Cotton (*Gossypium hirsutum* L.) in Vertisol

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ABSTRACT: The field experiment was conducted at experimental farm, AICRP on Integrated Farming Systems, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.) during *kharif* 2019-20 and 2020-21 seasons to study "Response of Bt cotton (*Gossypium hirsutum* L.) to tillage and weed management practices in vertisol". Treatment consisted of sixteen treatment combinations comprising four tillage practices (T_1- Conventional tillage, T_2- Rotary tillage, T_3- Minimum tillage, T_4- Zero tillage) in main plot, and four weed management practices (W_1 - Weed check,W_2 - Weed free, W_3 – Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC)@ 50 g ha^1(PoE) + Hoeing. and W_4- Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE +Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching 2.5t/ha. The result of the study revealed that conventional tillage (T_1) recorded lesser weed population and weed dry weight and higher weed control efficiency with lower weed index and higher seed cotton yield (kg ha^{-1}) than other treatments and however it was at par with rotary tillage (T_2). Among the weed management practices weed free (W_2) recorded) recorded lesser weed population and weed dry weight and higher weed control efficiency with lower weed index and higher seed cotton yield (kg ha^{-1}) and however it was at par with Pendimethalin (30% EC) @ 0.75 kg ha^{-1}as PE +Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching 2.5t/ha (W_4).

Keywords: Herbicide,Weed density, weed control efficiency, weed index, seed cotton yield.

INTRODUCTION

Cotton (*Gossypium* spp.) is a key fibre crop in India, accounting for 85 percent of the textile industry's raw materials. Cotton is grown commercially in 111 nations around the world and is known as the "King of Fibers" or "White Gold." India occupies a unique position among the world's cotton-growing nations. Cotton (*Gossypium hirsutum* L.) is a valuable cash crop and one of the oldest among the world's commercial crops, it is also a backbone of the textile industry, owing to its lint. Cotton is valued for its oil as well as its fibre, and cotton seed cake is an important livestock feed. Cotton seeds contain 15 to 20% oil, which can be used in the soap industry after refining.

India continues to have the largest cotton-growing area and is the world's second-largest cotton producer, after China, with 34% of global area and 21% of global production. World cotton area is estimated at 34.7 million ha with production of 125.8 million bales with an average productivity of 789.0 kg ha^{-1} (Anonymous, 2019[a]). Cotton is grown on 129.57 lakh ha in India, with 371 lakh bales produced and a productivity of 487 kg lint ha^{-1} (Anonymous, 2020[b]) Maharashtra ranks first in both area and production in the country, covering 41.84 lakh ha and production 86.0 lakh bales with a productivity of 349 kg lint ha^{-1} (Anonymous, 2020[c]).

Tillage is the process of mechanically manipulating soil to provide favourable conditions for crop development and, in most cases, crop nurturing. In the field, it is the most difficult and time-consuming process. Ploughing is the initial step in the seedbed preparation process. It makes a significant contribution to achieving good tilth and even moisture conservation. Tillage is the process of opening up the soil in order to lower soil strength and cover crop wastes. Deep ploughing, subsoiling, minimum tillage, zero tillage or no tillage, mulch tillage, and puddling are all examples of tillage. Deep ploughing varies depending on the type of plough and the amount of power available. Animal ploughing is commonly associated with shallow ploughing. Although tractor power allows for deeper ploughing, average ploughing depths are up to 20 cm. On many soils, deeper ploughing has been advocated to extend the depth of the root bed, both to increase root elongation and proliferation and to increase the average soil moisture. Deep ploughing is based on the nature of crop, climate, type of soil and the operation's economics.

Intensive tillage methods contribute to deteriorating air, water, and soil quality; however, reducing soil disturbance by using conservation tillage may help to improve this condition. In comparison to traditional tillage, research on zero and minimum tillage has shown that the accumulation of crop residues at the soil surface provides a larger possibility to increase soil organic carbon, microbial activity, nutrients, and extractable phosphorus (Vu *et al*., 2009).

Conservation agriculture systems that are well-implemented improve soil quality and production sustainability, while additional research on some aspects of the system is needed (Verhulsta *et al*., 2010).

The yield level of this crop varies from year to year depending on the problem of insect pests and diseases, which are closely associated to the region's climatic conditions. Since, the crop has long growth cycle, it has to pass through frequent rains and thus weed also pose a serious problem. Weed losses in cotton can range from 50 to 85 percent, depending on the type and intensity of the weeds. In cotton, the essential period for weed competition was found to be 15 to 60 days (Sharma, Rajiv. 2008).

Weed control is essential for successful cotton production. Because cotton grows more slowly early in the season and is less competitive with weeds, effective weed management has been more difficult in cotton than in other row crops such as maize and soybean. Early in the growth season, there is usually the most competition. The effects of weed competition at the square formation and flower development stages were found to be more harmful than the effects of weed competition at later stages (Farrell *et al.,* 2001)

The period of weed interference, crop damage and the critical period of crop weed competition were 30 to 60 days which occupied 50 per cent of the whole cotton growing period. Seed cotton yield loss increased with the increase in the duration of competition and maximum loss was observed due to full season competition. (Poonguzhalan, 2014).

To see how different tillage practises, such as conventional tillage, rotary tillage, minimum tillage, and zero tillage, affect the performance of *Bt* cotton, as well as various weed management practises. Considering all of the above, as well as the decrease in production costs, such as the efficient use of expensive inputs. In this context, present study was carried out to study "Response of Bt cotton (*Gossypium hirsutum* L.) to tillage and weed management practices in vertisol"**.** was taken up with the following objectives.

1. To study the effect of tillage and weed management practices on weed density of cotton.
2. To study the effect of tillage and weed management practices on yield and yield contributing characters of cotton.

MATERIAL AND METHODS

During the *Kharif* seasons of 2019-20 and 2020-21 a field experiment was conducted at experimental farm, AICRP on Integrated Farming Systems, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S., India). The site of experiment was clayey in texture with slightly alkaline pH of 8. The available nitrogen was in the range of low (222.40 kg ha^{-1}), P_2O_5 medium (17.54 kg ha^{-1}) and K_2O was high (545.52 kg ha^{-1}).

Treatment consists of sixteen treatment combinations comprising four tillage practices (T_1- Conventional tillage, T_2- Rotary tillage, T_3- Minimum tillage, T_4- Zero tillage) in main plot, and four weed management practices (W_1 - Weed check,W_2 - Weed free, W_3 – Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC)@ 50 g ha^{1}(PoE) + Hoeing. and W_4- Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE +Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching.) during *Kharif* in a split plot design with three replication. Recommended dose of fertilizers 120:60:60 NPK kg ha^{-1} was applied during both the years of study. The *Bt* cotton was sown by dibbling method at 120 cm × 45 cm spacing on 03-07-2019 and 02-07-2020 after receipt of sufficient monsoon rains. During the experimentation of first and second year total quantity rainfall received 936.7 and 857.0 mm respectively. The mean daily maximum temperature ranged from 30.8°C to over 45°C, while the mean daily minimum temperature ranged from 11.9°C to 24.9°C, respectively. The soil was medium deep black and well drained. The topography of the experimental field was fairly uniform and levelled. The recommended dose of fertilizers 120:60:60NPK kg ha^{-1} was applied. The 40 per cent of nitrogen and full dose of phosphorus and potash were applied as basal application at the time of sowing.

RESULTS AND DISCUSSION

Weed flora. During the experiment, the main weed flora present in the experimental plot was obsered. The weed infestation at the experimental site was dominated by grassy weeds, sedges, and broad-leaved weeds, *Ageratum conyzoides, Alternanthera sessilis, Commelina benghalensis, Euphorbia geniculata, Mollugo disticha, Parthenium hysterophorus, Phylanthus maderaspatensis, Corchorus trilocularis*; among the grassy weeds, *Brachiaria eruciformis, Cynodon dactylon, Dinebra retroflexa* and among sedges, *Cyperus rotundus* were reported.

Weed count (m^2) and total dry weed weight (g)

Tillage practices. The effect of various tillage practices treatments applied to cotton crop on number of monocot and dicot weed count (m^{-2}) and total dry weed weight (g) showed significant differences at all growth stages of crop, during both the years of experimentation and data are presented in Table 1 and 2.

The number of monocot and dicot weed count (m^{-2}) and total dry weed weight (g) differed significantly due to different tillage practices in *Bt* cotton at various growth stages of crop during both the years of study during 2019-20 and 2020-21. The zero tillage (T_4) registered significantly highest number of monocot and dicot weed count (m^{-2}) and total dry weed weight (g) of cotton from 30 DAS to at harvest over other treatments but at par with minimum tillage (T_3). Conventional tillage (T_1) recorded lower number of monocot and dicot weed count (m^{-2}) and total dry weed weight (g) during 2019-20 and 2020-21 respectively. The population of weeds in general declined with the progress of the growth of crop. The maximum population of weed m^{-2} was recorded at 30 DAS for all the weed species and it declined at 60 DAS and then further declined to minimum at 90 DAS. Weed population was influenced by varying degrees due to tillage practices. The maximum weed population in zero tillage is obvious, since these treatments did not receive any tillage operations to control the weeds. On the other hand, conventional tillage plots, weeds were removed due to continuous interculture operation. Mandol (2006); Manjith and Angadi (2016) also showed similar kind of results.

Weed management. The effect of various weed management treatments applied to cotton crop on number of monocot and dicot weed count (m^{-2}) and total dry weed weight (g) showed significant differences at all growth stages of crop, during both the years of experimentation and data are presented in Table 1 and 2.

The weed free (W_2) treatment recorded significantly lower number of monocot and dicot weed count (m^{-2}) and total dry weed weight (g) over rest of the treatments. The data revealed that among the weed management treatments at 30 DAS monocot and dicot weed count (m^{-2}) and total dry weed weight (g) were significantly lower in Pendimethalin (30% EC) @ 0.75 kg a.i. ha^{-1} PE (W_3,W_4) sprayed as pre-emergence, because of the reduction in weed population at initial stage. The treatment weedy check (W_1) registered maximum monocot and dicot weed count (m^{-2}) and total dry weed weight (g) population during the both year of experimentation. Significantly lowest monocot and dicot weed count (m^{-2}) and total dry weed weight (g) population from 30 DAS up to harvest were recorded in weed free (W_2) treatments. The next best treatment was Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching (W_4) but at par with Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC) @ 50 g ha^{-1} (PoE) + Hoeing (W_3) and maximum number of weeds were observed in weedy check (W_1) during the both year. In weed management weed free (W_2) treatments recorded significantly lowest weed count at all the stages of crop growth, this was due to keeping weed free environment, while among the various weed management treatments. Minimum monocot and dicot weed count (m^2) and total dry weed weight (g) observed with treatment Pendimethalin (30% EC) @ 0.75 kg a.i. ha^{-1} PE (W_3,W_4) at 30 DAS, this might be due to the pre-emergence application of pendimethalin, results in better weed control at initial stage by inhibiting weed seed germination and seedling development. From 30 DAS up to harvest were recorded Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching (W_4) treatment recorded lowest monocot and dicot weed count(m^{-2}) and total dry weed weight (g) and which was at par with Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC) @ 50 g ha^{-1} (PoE) + Hoeing (W_3), Similar trend of results were noticed at 60,90,120,150 and at harvest stage during the both year of experimentation. This might be due to Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching (W_4),that have longer effect on controlling monocot and dicot weed count (m^{-2}) and total dry weed weight (g). Similar results were also reported by Hargilas *et al*., (2015); Rajendra *et al*., (2016); Shivashankar *et al*., (2017); Chaudhari *et al*., (2017); Oad *et al*. (2007).

Weed control efficiency (%) of monocot, dicot and total weed of *Bt* cotton

The data on mean weed control efficiency of monocot weed of *Bt* cotton as influenced periodically by different tillage and weed management practices are presented in Table 3 during 2019-20 and 2020-21, respectively.

Tillage practices

The mean weed control efficiency of monocot and dicot weed of *Bt* cotton was recorded maximum (69.25 % and 69.48 %) at the 30 DAS conventional tillage (T_1) and lowest weed control efficiency was recorded in zero tillage (T_4) during 2019-20 and 2020-21.

Weed management. In weed management, weed free (W_2) treatment recorded higher mean weed control efficiency of weed control efficiency of monocot and dicot weed of *Bt* cotton (94.80 %) in 2019-20 and (96.14 %) in 2020-21 during the 30 DAS. Among the weedicide treatment was found effective highest weed control efficiency in Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching (W_4) followed by Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC) @ 50 g ha^{-1} (PoE) + Hoeing (W_3) and the lowest weed control efficiency was found to be weedy check (W_1) during the both year of experimentation. Similar finding reported by Rajendra *et al*. (2016); Hargilas *et al*. (2015); Shivashankar *et al*. (2017).

Weed index

Tillage practices. Perusals of data in Table 4 revealed that the conventional tillage (T_1) was recorded lowest weed index of *Bt* cotton (12.67%), (13.85%) and (13.26%) which was followed by rotary tillage (T_2) and highest weed index (16.55%), (18.16%) and (17.35%) was recorded in zero tillage (T_4) during both the years and in pooled analysis respectively.

Weed management. It was observed from Table 4 that the Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching (W_4) recorded lowest weed index of *Bt* cotton (3.73%), (3.62%) and (3.67%) which was followed by Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC) @ 50 g ha^{-1} (PoE) + Hoeing (W_3) and highest weed index of *Bt* cotton (47.78%), (49.52%) and (48.65%) was recorded with weedy check (W_1) during both the years and in pooled analysis respectively. Similar finding reported by Rajendra *et al*. (2016); Shivashankar *et al*. (2017).

Yield (kg ha^{-1}). Data pertaining to seed cotton yield as influenced by different treatments of tillage and weed management practices are presented in Table 4. The mean seed cotton yield was 1816 kg ha^{-1} in 2019-20, 1903 kg ha^{-1} in 2020-21 and 1860 kg ha^{-1} in pooled analysis.

Tillage practices. Scrutiny of data presented in Table 4 stipulated that the mean seed cotton yield (kg ha^{-1}) of *Bt* cotton was influenced significantly due to different tillage practices during both the years and in pooled analysis. The conventional tillage (T_1) was found to be significantly superior over other tillage practices in recording significantly more seed cotton yield 2092 kg ha^{-1}, 2177 kg ha^{-1} and 2134 kg ha^{-1} and however it was found at par with the rotary tillage (T_2) during both the years and followed by in pooled analysis, respectively. The lowest seed cotton yield kg ha^{-1} was recorded with zero tillage T_4 during both the years and in pooled analysis. This might be due to more favoured overall growth due to favourable seed bed resulting from deceased bulk density, increased pore space, better aeration, increased infiltration rate, with scope for more space, light interception, benefit of more conserved moisture during dry spell period and its support at critical growth stages like flowering, numbers of bolls $plant^{-1}$ and development. This ultimately resulted in higher values of yield attributing characters and which in turn resulted in higher yields of *Bt* cotton. This results correlate with the work of Gul *et al.* (2003); Manjith and Angadi (2016).

Weed management. Glimpse of data presented in Table 4 showed that, the mean seed cotton yield, kg ha^{-1} was influenced significantly due to different weed management practices during both the years and in pooled data. The weed free (W_2) treatment was found to be significantly superior over other weed management practices produced higher seed cotton yield kg ha^{-1} of 2150 kg ha^{-1}, 2261 kg ha^{-1} and 2205 kg ha^{-1} and however it was found at par with Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching (W_4) during both the years and in pooled analysis, respectively.

The weedy check (W_1) recorded the lowest seed cotton yield (kg ha^{-1}) during 2019-20, 2020-21 and in pooled analysis. The weed free (W_2) treatment recorded significantly higher seed cotton yield $plant^{-1}$ indicating least competition offered by weeds for nutrients and moisture at crucial growth stages under this treatment ultimately improved all yield attributes besides increased rate of N, P and K absorption cumulatively helped the crop plants to produce more surface area for high photosynthetic rate as well as maximum translocation of photosynthesis from source to sink, subsequently resulted in improvement of all yield attributes. Because of synergist effect among the yield attributes they benefited each other. These findings are in accordance with those of Rajanand *et al.* (2013); Hargilas *et al*. (2015); Singh and Rathore (2015).

Interaction effects. The interaction effects between tillage and weed management did not reached to the level of significance during 2019-20, 2020-21 and pooled data.

CONCLUSION

It can be concluded that-

Among tillage practices conventional tillage (T_1) recorded lesser weed population, weed dry weight and higher weed control efficiency with lower weed index and higher seed cotton yield (kg ha^{-1}) than other treatments and however it was at par with rotary tillage (T_2).

Among weed management practices weed free (W_2) recorded lesser weed population, weed dry weight and higher weed control efficiency with lower weed index and higher seed cotton yield (kg ha^{-1}) and however it was at par with Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE +Pyrithiobac-sodium (10% EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching 2.5t/ha (W_4).

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Conflict of Interest. None.

Table 1: Monocot & dicot weeds/m^2 of *Bt* cotton hybrid as influenced by different treatments during 2019-20 & 2020-21.

Treatment detail	Monocot 2019-20			Monocot 2020-21			Dicot 2019-20			Dicot 2020-21		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
A) Main plot - Tillage practices												
T_1- Conventional tillage	9.33	13.50	25.92	10.42	13.42	27.08	11.08	13.08	23.75	12.17	14.50	24.50
T_2 - Rotary tillage	11.00	16.00	29.42	12.08	16.08	30.58	12.67	15.75	28.58	14.00	16.83	28.83
T_3 - Minimum tillage	13.50	18.92	34.75	14.58	18.58	35.83	16.17	18.33	34.17	17.33	21.25	34.67
T_4 - Zero tillage	14.42	20.25	36.00	15.75	20.42	38.00	17.08	20.67	36.58	18.17	21.83	35.42
SE (m) ±	0.33	0.52	0.53	0.46	0.70	0.97	0.38	0.73	1.10	0.45	0.38	1.00
CD at 5%	1.14	1.81	1.84	1.58	2.41	3.35	1.32	2.52	3.81	1.54	1.30	3.46
B) Sub plot - Weed management												
W_1 - Weedy check	33.58	46.00	69.75	34.08	47.17	74.42	37.33	43.75	65.33	43.25	47.08	64.67
W_2 - Weed free	2.08	3.08	7.50	2.58	2.25	8.25	2.42	3.33	9.50	2.58	3.17	9.83
W_3-Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC) @ 50 g ha^{-1} (PoE) + Hoeing.	5.58	8.67	22.33	7.50	8.33	20.75	9.42	13.25	28.25	8.75	15.25	28.75
W_4- Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE+ Pyrithiobac-sodium (10%EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching .	7.00	10.92	26.50	8.67	10.75	28.08	7.83	7.50	20.00	7.08	8.92	20.17
SE (m) ±	0.51	0.73	1.08	0.55	0.72	1.09	0.59	0.71	1.27	0.63	0.76	1.29
CD at 5%	1.49	2.13	3.15	1.62	2.10	3.17	1.72	2.07	3.71	1.84	2.21	3.78
Interaction (AxB)												
SE (m)±	1.02	1.46	2.16	1.11	1.44	2.17	1.18	1.42	2.55	1.26	1.51	2.59
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM	**12.06**	**17.17**	**31.52**	**3.23**	**17.13**	**32.88**	**14.25**	**16.96**	**30.77**	**15.42**	**18.60**	**30.85**

Table 2: Monocot & dicot dry weed weight (g) of *Bt* cotton hybrid as influenced by different treatments during 2019-20 & 2020-21.

Treatment detail	Monocot dry weed weight (g) 2019-20			Monocot dry weed weight (g) 2020-21			Dicot dry weed weight (g) 2019-20			Dicot dry weed weight (g) 2019-20		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At Harvest	30 DAS	60 DAS	At harvest
A) Main plot - Tillage practices												
T_1- Conventional tillage	9.36	12.97	22.47	12.89	17.41	27.78	10.94	16.17	28.47	14.78	20.81	29.37
T_2 - Rotary tillage	10.24	15.38	25.91	14.84	20.47	31.75	12.53	18.27	31.64	16.36	23.87	33.94
T_3 - Minimum tillage	12.04	19.58	31.54	18.31	23.50	37.83	15.04	21.85	37.29	20.25	28.86	40.85
T_4 - Zero tillage	12.43	20.52	33.41	19.22	25.41	39.23	15.91	23.01	38.02	21.03	30.43	42.51
SE (m) ±	0.20	0.34	0.66	0.35	0.74	0.52	0.31	0.48	0.71	0.31	0.68	0.81
CD at 5%	0.68	1.17	2.29	1.21	2.57	1.79	1.06	1.65	2.45	1.07	2.35	2.79
B) Sub plot - Weed management												
W_1 - Weedy check	32.97	47.57	62.07	50.18	58.39	76.48	38.61	54.04	74.64	52.05	70.06	83.85
W_2 - Weed free	1.51	3.16	7.93	1.64	3.38	11.27	2.28	3.66	12.06	2.36	3.62	13.25
W_3-Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC) @ 50 g ha^{-1} (PoE) + Hoeing.	4.62	7.98	20.28	6.94	10.82	21.88	7.27	12.44	26.23	9.47	18.63	29.00
W_4- Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE+ Pyrithiobac-sodium (10%EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching .	4.98	9.73	23.05	6.51	14.21	26.96	6.27	9.15	22.51	8.54	11.67	20.56
SE (m) ±	0.47	0.55	0.85	0.54	0.86	0.98	0.51	0.62	1.04	0.73	1.09	0.93
CD at 5%	1.38	1.61	2.48	1.56	2.51	2.85	1.50	1.82	3.04	2.12	3.19	2.72
Interaction (AxB)												
SE (m)±	0.95	1.11	1.70	1.07	1.72	1.95	1.03	1.24	2.08	1.45	2.19	1.87
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM	**11.02**	**17.11**	**28.33**	**16.32**	**21.70**	**34.15**	**13.60**	**19.82**	**33.86**	**18.10**	**25.99**	**36.67**

Table 3: Monocot & dicot weed control efficiency (%) of *Bt* cotton hybrid as influenced by different treatments during 2019-20 & 2020-21.

Treatment detail	Monocot weed control efficiency (%)			Monocot weed control efficiency (%)			Dicot weed control efficiency (%)			Dicot weed control efficiency (%)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At Harvest	30 DAS	60 DAS	At harvest
A) Main plot - Tillage practices												
T_1- Conventional tillage	70.22	68.79	57.44	71.30	65.89	57.87	68.35	67.14	57.33	67.71	65.59	60.54
T_2 - Rotary tillage	68.39	66.85	56.12	69.31	63.90	57.08	66.19	65.92	56.74	66.57	63.76	57.09
T_3 - Minimum tillage	64.35	60.85	52.42	65.53	61.62	53.87	62.53	60.57	52.59	64.29	61.78	54.53
T_4 - Zero tillage	63.50	60.55	51.99	64.62	60.40	52.92	62.50	60.12	52.17	63.41	60.88	53.65
B) Sub plot - Weed management												
W_1 - Weedy check	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
W_2 - Weed free	95.45	93.47	87.50	96.82	94.33	85.37	94.24	93.40	84.03	95.46	94.91	84.50
W_3-Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC) @ 50 g ha^{-1} (PoE) + Hoeing.	86.04	83.63	67.39	86.51	81.59	71.52	81.33	77.14	64.91	82.35	73.66	65.60
W_4- Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE+ Pyrithiobac-sodium (10%EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching .	84.97	79.94	63.07	87.43	75.90	64.84	84.00	83.22	69.89	84.16	83.45	75.71
GM	**76.13**	**73.44**	**62.27**	**77.36**	**71.95**	**63.35**	**74.16**	**72.50**	**62.52**	**74.85**	**72.00**	**65.52**

Table 4: Weed index (%) and mean seed cotton yield (kg ha^{-1}) of *Bt* cotton hybrid as influenced by different treatments during 2019-20, 2020-21 and pooled.

Treatment detail	Weed index (%)			Seed yield (kg ha^{-1})		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
A) Main plot - Tillage practices						
T_1- Conventional tillage	12.67	13.85	13.26	2092	2177	2134
T_2 - Rotary tillage	14.32	14.72	14.52	1982	2073	2027
T_3 - Minimum tillage	16.19	15.89	16.04	1649	1739	1694
T_4 - Zero tillage	16.55	18.16	17.35	1541	1624	1583
SE (m) ±	--	--	--	45.76	52.72	29.99
CD at 5%	--	--	--	158.34	182.45	103.79
B) Sub plot - Weed management						
W_1 - Weedy check	47.78	49.52	48.65	1126	1145	1135
W_2 - Weed free	0.00	0.00	0.00	2150	2261	2205
W_3-Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE + Quizalofop ethyl (5% EC) @ 50 g ha^{-1} (PoE) + Hoeing.	8.22	9.10	8.66	1922	2028	1975
W_4- Pendimethalin (30% EC) @ 0.75 kg ha^{-1} as PE+ Pyrithiobac-sodium (10%EC) @ 62.5 g ha^{-1} (PoE) + Straw mulching .	3.73	3.62	3.67	2067	2179	2123
SE (m) ±	--	--	--	41.91	33.37	31.16
CD at 5%	--	--	--	122.32	97.41	90.94
Interaction (AxB)						
SE (m)±	--	--	--	83.81	66.74	62.31
CD at 5%	--	--	--	NS	NS	NS
GM	**14.93**	**15.96**	**15.27**	**1816**	**1903**	**1860**

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