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Growth rates of *Bt* cotton (*Gossypium hirsutum* L.) hybrid NHH-44 as influenced by tillage and integrated nutrient management practices under rainfed conditions

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Abstract
A field experiment was conducted to evaluate the effect of tillage and integrated nutrient management practices on *Bt* cotton (*Gossypium hirsutum* L.) at AICRP on Dryland Agriculture farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* 2020-21. Fifteen treatment combinations consisting of three tillage practices (conventional tillage, reduced tillage and zero tillage) and five integrated nutrient management practices (100% RDF (120:60:60 kg NPK ha^{-1}), 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}, 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}, 50% RDF + FYM 12 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} and Control) were evaluated in split plot design with three replications. The mean maximum AGR for plant height and dry matter were recorded under conventional tillage. Among different growth intervals 61-90 DAS recorded maximum AGR for plant height (1.397 cm day^{-1} plant^{-1}), while mean maximum AGR for dry matter (3.393 g day^{-1} plant^{-1}) were recorded between 91-120 DAS under conventional tillage. Among integrated nutrient management practices, 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} recorded mean maximum AGR for plant height (1.455 cm day^{-1} plant^{-1}) 61-90 DAS interval, while mean maximum AGR for dry matter (3.359 g day^{-1} plant^{-1}) were recorded between 91-120 DAS. The mean CGR, RGR, NAR and LAI were also maximum under conventional tillage and 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}.

Keywords: Fifteen treatment, cotton occupies

1. Introduction
Cotton, popularly known as “King of fibre” and “White gold” is the most important fibre and commercial crop of global significance, which is cultivated in tropical and subtropical regions of more than seventy countries all over the world. Cotton is entwined with culture and heritage of India for centuries. Cotton occupies a vital role in the agricultural economy of India. It provides employment to about 70 million people and contributes nearly 75 per cent of total raw material to the textile industry in India (Ushanandini *et al.*, 2017) [13]. India holds the unique distinction of being the only country in the world that grows all the four cultivated species of cotton and their hybrids in the vast diverse agro-climatic situations prevailing across the length and breadth of the country.
India ranks first in the World in terms of area under cotton cultivation. The total world area under cotton cultivation is 33.16 million hectares with the production of 25.89 million tons. India covers an area of 12.06 million hectares (36% of world area) with the production of 5.36 million tons (21% of world production) (Anonymous, 2021[a]) [1]. In fact, the average yield of cotton is very low and it is around 445 kg ha^{-1} as against the average yield of 781 kg ha^{-1} in the world (Anonymous, 2021[b]) [2]. In India, only 35.8 per cent of area under cotton crop is irrigated.
Indian agriculture has entered in a new phase of research and development from the green revolution era of enhancing crop productivity to resolving the new challenges emerged out from green revolution. In order to resolve these problems and meet out emerging needs, the demand for efficient use and conservation of resources is the need of the hour (Himoud *et al.*, 2022) [8]. Agricultural systems relying upon approaches like sustainable agriculture or conservation agriculture are not only supporting high productivity, but are also preserving biodiversity along with environmental safeguards. Sustainable agriculture relies on practices that help to maintain ecological equilibrium and encourage natural regenerative processes, like

nitrogen fixation, nutrient cycling, soil regeneration and protection of natural enemies of pest and diseases as well as the targeted use of inputs (Bhattacharyya *et al*., 2013) [3]. Its increasing concerns have been seen as a positive response to limits both, traditional low input agriculture and intensive modern high input in agriculture production systems.

Intensive tillage practices are contributing to declining air, water and soil quality. Reducing soil disturbance by implementing conservation tillage may improve this situation. Research on zero and minimum tillage has illustrated the greater opportunity to increase soil organic carbon, microbial activity, nutrients and extractable phosphorus due to accumulation of crop residues at the soil surface compared with conventional tillage (Vu *et al.* 2009) [14].

Conservation agriculture has emerged as a new paradigm to achieve the goals of sustainable agricultural production. It involves the new and innovative ways of generating and promoting technologies that focus on resource conservation as a way to enhance productivity in a sustainable manner. Conservation agriculture aims at reversing the process of degradation inherent to the conventional agricultural practices like intensive cultivation and burning or removal of crop residues (Ghosh *et al*., 2015) [6]. Aggressive seed bed preparation with heavy machinery lead to declining soil fertility, biodiversity and erosion. The nutrient needs of the Indian agriculture are so large that no single plant nutrient source be it fertilizers, organic manures, green manures or bio fertilizers is in position to meet the entire plant nutrient demand. Therefore, resource conservation becomes a top priority and restoration of precious soil resource by way of innovative means of management is the need of the day.

High and sustainable productivity of cotton is associated with balanced nutrition and availability of nutrients in the soil. Nutrient supply systems can be improved by adopting Integrated Nutrient Management (INM) practices. Development of appropriate nutrient management strategies becomes crucial in terms of enhancing soil health and quality. Integration of organics and inorganics needs to be incorporated in cotton manurial schedule. Farmyard manure, which is a treasure house of nutrients, not only supplies major nutrients but also acts as a reservoir of micronutrients (Kumar *et al*., 2013) [10]. It is both enhancing the organic matter content of soils, as well as the water holding capacity of the soil. In general, farmyard

Cotton, the most important fibre crop has been cultivated in India over an area of 12.06 million hectares. Huge quantity of cotton stalks is left after the harvest of cotton. About 25-30 MT of cotton stalks is generated in India with an average production of 2-3 t ha^{-1} (Ramanjaneyulu *et al*., 2021) [11]. The general practice is to remove the stalks manually and burn them. Cotton contributes to about 8 per cent of total residue burnt in the country (Zhang *et al*., 2019) [16]. This involves lot of labour and increase the cost of cultivation of the succeeding crop. Instead of removing from the field, if the stocks are incorporated in situ, the same may reduce the labour cost apart from adding valuable organic matter to the soil. Residue recycling is a key measure to enhance the soil fertility and productivity in crop production systems. The plant nutrient availability in a soil is a measure of soil fertility, while the soil physical environment is the king pin regulating the retention and movement of soil moisture, air, nutrients and temperature. Hence, soil physical environment directly or indirectly governs the factors influencing the plant growth and in turn the production potential of the crop. Tillage and addition of organic matter improves the soil physical properties. Incorporation of cotton stubbles favourably improved the soil physical properties like bulk density, porosity and hydraulic conductivity.

With this background, the present experiment was planned and executed to investigate the effects of cotton residue incorporation with conservation tillage and integrated nutrient management in *Bt* cotton with the following objectives.

2. Materials and methods

A field experiment was conducted during *kharif* 2020-21 at AICRP on dryland farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to evaluate the cotton residue incorporation with conservation tillage and integrated nutrient management in *Bt* cotton. The texture of the soil was clayey. The soil was alkaline in reaction (8.01 pH), low in salt content (0.30 dSm^{-1}) with high calcium carbonate content (46.95 g kg^{-1}) during 2020-21. The soil organic carbon of 5.53 g kg^{-1}. The soil available nitrogen was low (174.53 kg ha^{-1}), available phosphorus was medium (12.62 kg ha^{-1}) and available potassium was very high (545.45 kg ha^{-1}) during 2020-21.

In all, fifteen treatment combinations, consisting of three tillage practices (conventional tillage, reduced tillage and zero tillage) and five integrated nutrient management practices (100% RDF (120:60:60 kg NPK ha^{-1}), 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}, 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}, 50% RDF + FYM 12 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} and control) were evaluated in split plot design with three replications. Before the experiment, pigeon pea was grown in the field and harvested in January and kept fallow prior to cotton sowing. The cotton variety NHH-44 was sown on June 18, 2020. A row to row distance of 120 cm and plant to plant distance of 45 cm was maintained to obtain a plant population of 18500 plants per hectare. Sowing was done manually by dibbling maintaining plant to plant spacing of 45 cm.

The well-decomposed FYM was applied uniformly to respective plots before sowing as per the treatments. The fertilizers were applied to each plot according to the treatments. About 40 per cent of nitrogen and full dose of phosphorus and potassium were applied as basal dose at the time of sowing. After 30 DAS, and 60 DAS, top dressings of the remaining 40% and 20% nitrogen, respectively, were administered by urea. For nitrogen, phosphorus, and potassium, the sources of nutrients were urea (46% N), single super phosphate (16% P_2O_5), and muriate of potash (60% K_2O), respectively.

The data on different growth rates were recorded at an interval of 30 Days from the date of sowing up to harvesting. Different growth rates were calculated by using the formulae given below

2.1. Absolute growth rate (AGR)

The rate of in a growth variable *i.e.* height (H) or dry weight (W) by a plant at a specific time interval (t) is called as absolute growth rate. It is expressed as cm per day in case of plant height and g per day in case in case of dry matter accumulation per plant. The AGR of two growth variables *viz.*, plant height and total dry matter per plant were computed by the formula given by Richards (1969) [12].

$$\text{AGR (Height) (cm day}^{-1}) = \frac{H_2 - H_1}{t_2 - t_1}$$

$$\text{AGR (Dry matter) (g day}^{-1}) = \frac{W_2 - W_1}{t_2 - t_1}$$

Where
H_2 and H_1 are plant heights, while W_2 and W_1 are dry matter weights per plant at t_2 and t_1 times, respectively.

2.2. Crop growth rate (CGR)
The crop growth rate is commonly used for the determination of production efficiency of plant stand. CGR represents total dry matter productivity of the community per unit land area over a certain time span. CGR enables comparison to be made between stand communities of different types in different habitat (Hunt, 1978). This is determined by using the following formula.

$$\text{CGR (g day}^{-1}\text{ m}^{-2}) = \frac{W_2 - W_1}{t_2 - t_1} \text{ x number of plants m}^{-2}$$

Where
W_2 = dry weight of plant at time t_2 (g plant^{-1})
W_1 = dry weight of plant at time t_1 (g plant^{-1})

2.3. Relative growth rate (RGR)
Blackman (1919) pointed out that the increase in dry matter of plant is a process of continuous compound interest wherein the increment in any interval adds to the capital for the subsequent crop growth. This rate of increment is known as relative growth rate (RGR), which was worked out by the formula given by Fisher (1921).

$$\text{RGR (g g}^{-1}\text{ day}^{-1}) = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{t_2 - t_1}$$

Where
W_1 and W_2 are the weights of dry matter in g per plant at times t_1 and t_2, respectively and t_2- t_1 is the time interval in days.

Log_e = natural logarithm to the base 'e' = 2.3026.

2.4. Net assimilation rate (NAR)
Gregory (1917) introduced the concept of net assimilation rate (NAR) to obtain simple growth measurement as an estimate of the assimilatory efficiency of leaves. It is the rate of increase in whole plant dry weight per unit leaf area. It indicates rate of net photosynthesis and is expressed as

$$\text{NAR (g dm}^{-2}\text{ day}^{-1}) = \frac{(W_2 - W_1)\ (\text{Log}_e A_2 - \text{Log}_e A_1)}{(t_2 - t_1)\ (A_2 - A_1)}$$

Where
W_2 = dry weight of plant at time t_2 (g plant^{-1})
W_1 = dry weight of plant at time t_1 (g plant^{-1})
A_2 = leaf area plant^{-1} at time t_2 (dm^2)
A_1 = leaf area plant^{-1} at time t_1 (dm^2)
Log_e = natural logarithm to the base 'e' = 2.3026

2.5. Leaf area index (LAI)
Leaf area ratio is the ratio of surface leaf area (one side only) to the ground area occupied by the crop plant. Crop yield in general is assessed based on per unit of ground area instead of per plant. The leaf area index was determined by using the formula given by Watson (1952) [15].

$$\text{LAI} = \frac{\text{Leaf area per plant (dm}^2)}{\text{Ground area per plant (dm}^2)}$$

3. Results
The results of the present study have been summarised under following heads.

3.1. Absolute growth rate (AGR) for plant height (cm day^{-1} plant^{-1})
The mean absolute growth rate (AGR) for plant height (cm day^{-1} plant^{-1}) of *Bt* cotton was influenced by different tillage practices. From the data given in Table 1, it was evident that the mean absolute growth rate (AGR) values for plant height (cm day^{-1} plant^{-1}) was maximum under conventional tillage (T_1) at all growth interval stages, which was followed by reduced tillage (T_2). The highest mean AGR values of 1.397 cm day^{-1} was recorded between 61-90 DAS under conventional tillage (T_1), while zero tillage (T_3) recorded lower values of 1.088 cm day^{-1} at same growth interval.
Among different integrated nutrient management practices, the application 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2) resulted in maximum mean absolute growth rate (AGR) for plant height (cm day^{-1} plant^{-1}) at all growth interval stages. It was followed by 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_3) and 100% RDF (120:60:60 kg NPK ha^{-1}) (N_1) during both the years of study. The highest mean AGR values of 1.455 cm day^{-1} was recorded between 61-90 DAS under 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2), while control (N_5) recorded lowest values of 0.850 cm day^{-1} at same growth interval.

3.2. Absolute Growth Rate (AGR) for dry matter (g day^{-1} plant^{-1})
The mean absolute growth rate (AGR) for dry matter (g day^{-1} plant^{-1}) of *Bt* cotton was influenced by different tillage practices. It was evident from the data given in Table 1, that the mean absolute growth rate (AGR) values for dry matter (g day^{-1} plant^{-1}) was maximum under conventional tillage (T_1) at all growth interval stages, which was followed by reduced tillage (T_2). The highest mean AGR value of 3.393 g day^{-1} plant^{-1} were recorded between 91-120 DAS under conventional tillage (T_1), while zero tillage (T_3) recorded lower value of 2.739 g day^{-1} at same growth interval.
The maximum mean absolute growth rate (AGR) for dry matter was observed under 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2) at all growth interval stages. It was followed by 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_3) and 100% RDF (120:60:60 kg NPK ha^{-1}) (N_1). The highest mean AGR value of 3.359 g day^{-1} was recorded between 91-120 DAS under 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2), while control (N_5) recorded lowest value of 2.726 g day^{-1} at same growth interval.

3.3 Crop growth rate (CGR) for dry matter (g day^{-1} m^{-2})
The conventional tillage (T_1) resulted in maximum mean crop growth rate (CGR) for dry matter at all the growth intervals

from sowing up to harvest, while zero tillage (T_3) recorded lowest CGR (Table 2). However, the highest CGR value of 6.277 g day^{-1} m^{-2} were recorded under conventional tillage, while zero tillage (T_3) recorded minimum CGR value of 5.067 g day^{-1} m^{-2} between 91-120 DAS.

The maximum mean crop growth rate (CGR) for dry matter was observed under 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2) at all growth interval stages. It was followed by 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_3) and 100% RDF (120:60:60 kg NPK ha^{-1}) (N_1). The highest mean CGR value of 6.215 g day^{-1} m^{-2} was recorded between 91-120 DAS under 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2), while control (N_5) recorded lowest value of 5.043 g day^{-1} m^{-2} at same growth interval.

3.4 Relative growth rate (RGR) for dry matter (g g^{-1} day^{-1})

The mean relative growth rate (RGR) for dry matter (g g^{-1} day^{-1}) of *Bt* cotton was influenced by tillage practices. The conventional tillage (T_1) resulted in maximum mean relative growth rate (RGR) for dry matter at all the growth intervals from sowing up to harvest, while zero tillage (T_3) recorded lowest RGR. However, the highest RGR value of 0.0727 g g^{-1} day^{-1} was recorded under conventional tillage, while zero tillage (T_3) recorded minimum RGR value of 0.0692 g g^{-1} day^{-1} between 31-60 DAS.

Among different integrated nutrient management practices, application of 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2) resulted in maximum mean relative growth rate (RGR) value at all growth interval stages. It was followed by 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_3) and 100% RDF (120:60:60 kg NPK ha^{-1}) (N_1). The highest mean RGR value of 0.0734 g g^{-1} day^{-1} was recorded between 31-60 DAS under 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2), while control (N_5) recorded lowest value of 0.0664 g g^{-1} day^{-1} at same growth interval.

3.5 Net assimilation rate (NAR) (g dm^{-2} day^{-1})

The mean net assimilation rate (NAR) (g dm^{-2} day^{-1}) of *Bt* cotton was influenced by tillage practices. The conventional tillage (T_1) resulted in maximum mean net assimilation rate (NAR) at all the growth intervals from sowing up to harvest, while zero tillage (T_3) recorded lowest RGR. The highest NAR value of 0.0747 g dm^{-2} day^{-1} was recorded under conventional tillage, while zero tillage (T_3) recorded minimum NAR value of 0.0728 g dm^{-2} day^{-1} between 31-60 DAS.

Among different integrated nutrient management practices, application of 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2) resulted in maximum mean net assimilation rate (NAR) value at all growth interval stages. It was followed by 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_3) and 100% RDF (120:60:60 kg NPK ha^{-1}) (N_1). The highest mean NAR value of 0.0744 g dm^{-2} day^{-1} was recorded between 31-60 DAS under 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2), while control (N_5) recorded lowest value of 0.0737 g dm^{-2} day^{-1} at same growth interval.

3.6 Leaf area index (LAI)

Appraisal of data in Table 3 revealed that the conventional tillage (T_1) resulted in highest leaf area index (LAI) value, which was followed by reduced tillage (T_2). Among different tillage treatments, highest leaf area index value of 3.249 was recorded under conventional tillage (T_1), while the lowest value of 2.426 was recorded under zero tillage (T_3) at 91-120 DAS.

Application of 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2) resulted in maximum leaf area index (LAI) value at all growth interval stages. It was followed by 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_3) and 100% RDF (120:60:60 kg NPK ha^{-1}) (N_1). The highest LAI value of 3.382 was recorded under 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2), while control (N_5) recorded lowest value of 1.812 at 120 DAS.

4. Discussion

The improved soil physical properties under conventional tillage due to ploughing followed by rotavator and cultivator, which resulted in favourable soil environment *viz*., favourable seedbed, loose and friable soil tilth with proper soil aeration the enhanced the root proliferation subsequently providing better water and nutrient uptake resulting in increased plant growth. The tillage operations also have helped to infiltrate more water into soil, thus resulting in higher water and nutrient uptake by the crop resulting in higher growth. The increase in plant height, number of monopodial and sympodial branches, number of functional leaves and leaf area contributed to increased plant dry matter accumulation (Pawar *et al.*, 2022). Thus increase in plant height as well as dry matter accumulation resulted in higher growth rates.

Higher growth rates under 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} (N_2) was attributed to higher nutrient supply which enhanced the plant growth by participating in cell division and cell elongation in plants. Chemical fertilizers integrated with cotton residue prolonged the release of nutrients besides improving the soil physical properties *i.e.* soil aeration, water holding capacity and bulk density of soil. It was correlated with the increase in various crop growth attributes *viz.*, plant height, number of monopodial and sympodial braches, number of functional leaves, leaf area and dry matter accumulation. Thus higher plant height as well as dry matter accumulation, the growth rates were higher.

Table 1: Mean Absolute Growth Rate (AGR) for plant height (cm day^{-1} plant^{-1}) and for dry matter (g day^{-1} plant^{-1}) of *Bt* cotton hybrid as influenced by tillage and integrated nutrient management practices

Treatments	Mean Absolute Growth Rate (AGR) for plant height (cm day^{-1} plant^{-1})						Mean Absolute Growth Rate (AGR) for dry matter (g day^{-1} plant^{-1})					
	0-30 DAS	31-60 DAS	61-90 DAS	91-120 DAS	121-150 DAS	151-At harvest	0-30 DAS	31-60 DAS	61-90 DAS	91-120 DAS	121-150 DAS	151-At harvest
A) Main plot treatments (Tillage practices)												
T_1 – Conventional tillage	0.814	1.286	1.397	0.790	0.462	0.109	0.230	1.805	2.557	3.393	1.071	-2.288
T_2 – Reduced tillage	0.801	1.219	1.342	0.767	0.437	0.102	0.227	1.772	2.513	3.319	1.033	-2.250

T_3 – Zero tillage	0.740	0.915	1.088	0.677	0.347	0.099	0.223	1.559	2.219	2.739	0.898	-1.860
B) Sub plot treatments (Integrated nutrient management practices)												
N_1 – 100% RDF (120:60:60 kg NPK ha^{-1})	0.803	1.285	1.347	0.802	0.413	0.113	0.228	1.780	2.526	3.292	1.059	-2.159
N_2- 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}	0.818	1.345	1.455	0.861	0.484	0.120	0.232	1.866	2.614	3.359	1.064	-2.196
N_3 – 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}	0.807	1.313	1.409	0.835	0.449	0.114	0.230	1.821	2.560	3.328	1.062	-2.184
N_4 – 50% RDF + FYM 12 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}	0.782	1.196	1.307	0.752	0.372	0.107	0.225	1.714	2.375	3.044	1.002	-2.150
N_5 – Control	0.715	0.571	0.850	0.474	0.361	0.064	0.218	1.379	2.074	2.726	0.815	-1.973
General mean	0.785	1.140	1.275	0.745	0.416	0.103	0.227	1.712	2.430	3.150	1.001	-2.133

Table 2: Mean Crop Growth Rate (CGR) (g day^{-1} m^{-2}) and mean Relative Growth Rate (RGR) (g g^{-1} day^{-1}) of *Bt* cotton hybrid as influenced by tillage and integrated nutrient management practices

Treatments	Mean Crop Growth Rate (CGR) (g day^{-1} m^{-2})						Mean Relative Growth Rate (RGR) (g g^{-1} day^{-1})					
	0-30 DAS	31-60 DAS	61-90 DAS	91-120 DAS	121-150 DAS	151-At harvest	0-30 DAS	31-60 DAS	61-90 DAS	91-120 DAS	121-150 DAS	151-At harvest
A) Main plot treatments (Tillage practices)												
T_1 - Conventional tillage	0.425	3.340	4.730	6.277	1.981	-4.232	0.0643	0.0727	0.0272	0.0186	0.0044	-0.0098
T_2 - Reduced tillage	0.420	3.278	4.648	6.140	1.910	-4.162	0.0639	0.0725	0.0271	0.0184	0.0041	-0.0097
T_3 - Zero tillage	0.413	2.885	4.105	5.067	1.661	-3.441	0.0634	0.0692	0.0270	0.0172	0.0040	-0.0093
B) Sub plot treatments (Integrated nutrient management practices)												
N_1 - 100% RDF (120:60:60 kg NPK ha^{-1})	0.422	3.293	4.673	6.091	1.959	-3.995	0.0641	0.0725	0.0270	0.0181	0.0042	-0.0093
N_2- 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}	0.430	3.453	4.835	6.215	1.969	-4.063	0.0647	0.0734	0.0277	0.0185	0.0043	-0.0092
N_3 - 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}	0.425	3.369	4.735	6.157	1.965	-4.040	0.0643	0.0730	0.0271	0.0182	0.0042	-0.0093
N_4 - 50% RDF + FYM 12 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}	0.417	3.171	4.394	5.631	1.854	-3.978	0.0637	0.0718	0.0270	0.0179	0.0041	-0.0099
N_5 - Control	0.403	2.551	3.837	5.043	1.508	-3.650	0.0625	0.0664	0.0267	0.0178	0.0040	-0.0107
General mean	0.419	3.167	4.495	5.828	1.851	-3.945	0.0639	0.0715	0.0271	0.0181	0.0042	-0.0096

Table 3: Mean Net Assimilation Rate (NAR) (g dm^{-2} day^{-1}) and Mean Leaf Area Index (LAI) of *Bt* cotton hybrid as influenced by tillage and integrated nutrient management practices

Treatments	Mean Net Assimilation Rate (NAR) (g dm^{-2} day^{-1})						Mean Leaf Area Index (LAI)					
	0-30 DAS	31-60 DAS	61-90 DAS	91-120 DAS	121-150 DAS	151-At harvest	0-30 DAS	31-60 DAS	61-90 DAS	91-120 DAS	121-150 DAS	151-At harvest
A) Main plot treatments (Tillage practices)												
T_1 - Conventional tillage	0.0683	0.0747	0.0279	0.0260	0.0079	-0.0212	0.114	1.061	2.438	3.249	2.080	1.263
T_2 - Reduced tillage	0.0678	0.0741	0.0278	0.0257	0.0078	-0.0208	0.112	1.008	2.328	3.090	1.904	1.178
T_3 - Zero tillage	0.0675	0.0728	0.0274	0.0252	0.0073	-0.0186	0.107	0.813	1.842	2.426	1.384	0.912
B) Sub plot treatments (Integrated nutrient management practices)												
N_1 - 100% RDF (120:60:60 kg NPK ha^{-1})	0.0681	0.0740	0.0276	0.0255	0.0077	-0.0199	0.112	1.030	2.360	3.157	1.948	1.197
N_2- 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}	0.0689	0.0744	0.0287	0.0278	0.0079	-0.0194	0.115	1.123	2.565	3.382	2.142	1.320
N_3 - 75% RDF + FYM 6 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}	0.0683	0.0743	0.0284	0.0260	0.0078	-0.0197	0.114	1.085	2.474	3.278	2.032	1.263
N_4 - 50% RDF + FYM 12 t ha^{-1} + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}	0.0676	0.0738	0.0272	0.0251	0.0077	-0.0206	0.110	0.973	2.236	2.979	1.767	1.135
N_5 - Control	0.0664	0.0737	0.0271	0.0248	0.0070	-0.0240	0.103	0.594	1.378	1.812	1.058	0.669
General mean	0.0679	0.0739	0.0277	0.0256	0.0077	-0.0204	0.111	0.961	2.203	2.922	1.789	1.118

5. Conclusion

Conventional tillage with application of 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1} resulted maximum AGR for plant height (cm day^{-1} plant^{-1}) and dry matter (g day^{-1} plant^{-1}). Mean Crop Growth Rate (CGR), Relative Growth Rate (RGR), Net Assimilation Rate (NAR) and Leaf Area Index (LAI) were also maximum under conventional tillage with application of 100% RDF + cotton residue @ 3 t ha^{-1} + DM @ 12 kg ha^{-1}.

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