Evaluation of Growth rates of *Bt.* cotton (*Gossypium hirsutum* L.) hybrid NHH-44 as influenced by High density planting and weed management practices under rainfed conditions.

Comment [A1]: Rates

Abstract

A field experiment was conducted at experimental farm, AICRP on Integrated Farming Systems, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.) during *kharif* seasons of 2020-21 on to study the "Impact of high density planting and weed management practice on growth and yield of *Bt.* cotton. (*Gossypium hirsutum* L.)" Treatment consist of Twelve treatment combinations comprising Three planting densities in main plot that is (S_1-120 cm x 45 cm (18518 plants ha^{-1}), S_2- 80 cm x 60 cm(20833 plants ha^{-1}) and S_3- 90 cm x 45 cm (24691plants ha^{-1}) and four weed management practices that is W_1 - Stale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfop-ethyl 5% EC @ 50 g ha^{-1} + Straw mulching, W_2 - Stale seed bed technique +PoE Glufosinate ammonium 13.5% SL @ 0.7 kg ha^{-1} + Hand weeding, W_3 - Weed Free and W_4 - Weedy Check.

Comment [A2]: Stale seedbed

The mean maximum AGR for plant height were recorded under high density planting 90 cm x 45 cm. Among different growth intervals 61-90 DAS recorded maximum AGR for plant height (1.664 cm day^{-1} $plant^{-1}$), while mean maximum AGR for dry matter (2.358 g day^{-1} $plant^{-1}$) were recorded between 91-120 DAS under high density planting 120 cm x 45 cm. Among weed management practices, weed free treatment recorded mean maximum AGR for plant height (1.645 cm day^{-1} $plant^{-1}$) 61-90 DAS interval, while mean maximum AGR for dry matter (2.441 g day^{-1} $plant^{-1}$) were recorded between 91-120 DAS. The mean CGR, RGRand LAI were also maximum under weed free treatment.

1.Introduction

Cotton (*Gossypium* spp.) is a key fibre crop in India, accounting for 85per centof the textile industry's raw materials. Cotton is grown commercially as a cash crop 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 is thought to have originated in the ancient world and was domesticated approximately 3000 B.C. The four lint-bearing *Gossypium* spp., *G. hirsutum*, *G. herbaceum*, *G. arboreum*,and *G. Barbadense* are

Comment [A3]: percent

Comment [A4]: worldwide

grown in a diverse of agro-climatic conditions and contributes nearly 65 percent of the textile industry's total raw material demands. Cotton (*Gossypium hirsutum* L.) is a important cash crop and one of the oldest among the world's commercial crops and it is also considered as a backbone of the textile industry, owing to its lint contents.

Cotton is important for it's oil as well as its fibre and cotton seed cake (by products of the cotton oil mill) is an important livestock feed. Cotton seeds contain 15 to 25 per cent oil which is used in the soap industry after refining. Cotton seed cake is obtained after the oil is extracted, which provides a healthy feed for cattle as well as concentrated organic manure. It has nitrogen content of 6.4 per cent, phosphorus content of 2.9 per cent, and potassium content of 2.2 per cent. Besides from its vital role in the national economy, it makes a significant contribution to foreign exchange. Almost one third of India's exports are from other countries earnings is from textile sectors of which cotton alone constitutes nearly 70 per cent of raw material.

Comment [A5]: and

Comment [A6]: percent

Comment [A7]: Besides its vital role in the national economy, it significantly contributes to foreign exchange.

The highdensityplanting system is now being conceived as an alternate production system having a potential for improving productivity and profitability, increasing efficiency, reducing input costs and minimizing risks associated with India's cotton production system. A system of highdensityplanting, leading to more rapid canopy closure and decreased soil water evaporation, is becoming popular to address water scarcity challenges. Development and deployment of high-density planting to maximize yield potential, popularizing the system and mechanization of cotton picking and harvesting is the way forward for *Bt* cotton in India to stabilize the cotton production.

Comment [A8]: A high density planting system, leading

Proper spacing between plant is an important agronomic factor which affect optimal use of resources and increase crop productivity. Plant density is a key factor for optimizing structure and increasing the photosynthetic capacity of the cotton canopy. Crop geometry and plant density are agronomic factors which enhance yield and profitability. Plant density affects light interception, moisture availability and wind movement which further affect plant height, architecture, boll behavior, crop maturity and yield. An optimal plant density not only enhances the yield and fiber quality of cotton but also reduces fertilizer application and labor cost as compared to high plant densities without compromising yield. Fertilizer and irrigation can also be efficiently utilized in optimal plant density regimes. Globally, high planting density has become common in the cotton production systems. High plant density has more leaf shedding in late season along with lower weight boll production.Shashi Kumar*et. al.* (2019).

Comment [A9]: Proper spacing between plants is an important agronomic factor that affects optimal resource use and increases crop productivity.

High plant density produces more bolls per unit area and contributes to final yield, however, it also leads to a decrease in individual plant yield. Cotton growth, yield and quality perfection through optimal management practice is the continuous goal of cotton agronomists.

Plant density and boll retention have a direct and complex relationship which is influenced by many factors like temperature, nutrition, physiology, genotype, water stress, competition for photosynthates, insects. Biomass production is also the prerequisite of cotton yield and biomass partitioned to reproductive organs contributes to the final yield. Due to its indeterminate growth, cotton accumulates high vegetative biomass. The biomass accumulation in cotton increases as cotton crops change from one growth stage to another; however, in the last growth stages, biomass decreases due to fruit and leaves shedding. In early growth phases, more light intercepts to lower parts of the plant due to a less dense canopy which helps in the establishment of a good stand and increases the biomass.(Pathrikar, *et. al.*2018).

Comment [A10]: establish

Yield in cotton depends on the climatic conditions, rainfall pattern, weed competition, mineral nutrients and incidence of pests and diseases. Weeds extract 5 to 6 times of Nitrogen, 5 to 12 times of Phosphorous and 2 to 5 times of Potassium more than cotton crop and thus reduces the cotton yield from 54 to 80%. Initial slow growth, wide row spacing, high dose of chemical fertilizers combined with prostate nature of its growth permit early and severe crop-weed competition resulting in loss of yield to the tune of 45 to 80per cent. At present, manual weeding has become costly due to insufficiency of laborer's and hence, it become enormously difficult to keep the crop weed free. Effective and economical weed control in irrigated cotton is possible through integrating pre- and post-emergence herbicides along with hand weeding and inter-culturing.

Comment [A11]: percent

Comment [A12]: Manual weeding has become costly due to insufficiency of laborer's and hence, it becomes enormously difficult to keep the crop weed free.

Herbicides have play important role in handling weeds in cotton. Herbicides make the weed control in cotton easy, efficient and economical. Pre-emergence herbicides are the primary option for chemical weed control in cotton. Some early post-emergence herbicides are also available for application in cotton. In addition, lay-by application of non-selective herbicides for weed control in cotton has also been reported. Introduction of glyphosate, dicamba and glufosinate resistant cotton helped to the weed control in cotton. Knowledge about the current weeds infesting a cotton field is important for determining the most appropriate herbicide. Information regarding the kind of weeds, their growth stage and density will help to select the proper chemical treatment. All this information should be obtained through mapping weeds discretely in each field in a particular farm. Pre-emergence herbicides are usually applied immediately after cotton sowing. Moisture content is important for herbicide activity in the soil. (Leela Rani*et. al.*2016).

Weed management practices in cotton it includes stale seed bed techniques, hand weeding and straw mulching is useful for controlling weed growth. Stale seed bed is based on the principle of flushing out germinated weed seeds prior to planting of the crops depleting the seed bank in the surface layer of soil and reduction of subsequent weed seedling emergence. Weed population could be reduced by utilizing stale seed bed preparation to provide less competitive environment for crops during earliar growth stages of *Bt* cotton. Stale seed bed is formed trough slight hoeing operation by bullock pair or tractor drawn hoeing implements.(Sanbagavallis 2016).

Comment [A13]: Stale seed bed is based on the principle of flushing out germinated weed seeds before planting the crops depleting the seed bank in the soil surface layer and reducing subsequent weed seedling emergence.

Post emergence herbicide it include Pyrithiobac sodium 10% EC, Quizolfop-ethyl 5 % EC and Glufosinate ammonium 13.5 % SL etc. Play important role for controlling weed growth in *Bt* cotton.

Cotton crop has long growth cycle, it has to pass through frequent rains/irrigations and therefore, weed problem is a serious production constraint. Losses caused by weeds in cotton range from 50-85per centdepending upon the nature and intensity of weeds. The critical period of weed competition in cotton was found to be 15-60 days. Weeds can reduce lint quality due to additional trash and staining of fibers leading to low grades and discounted prices. To be successful, weed management systems require advance planting and timely execution. Any delay in application may mean reduced control, higher herbicide use rates and herbicide costs. Majority of herbicides available in the market are not broadspectrum herbicides. Hence we need to go for combination of herbicides or herbicide mixtures for broad spectrum weed control. The mixture of pyrithiobac sodium 10% EC + Quizolfop ethy l5% EC was control broad leaved and grassy weed respectively. (Madavi *et. al* 2017).

Comment [A14]: percent

Comment [A15]: combine

Glufosinate ammonium 13.5SL is post emergence contact herbicide. As contact herbicide Glufosinate ammonium is effective only where its come into contact with the plant. The primary mode of action of Glufosinate ammonium is the inhibition of enzyme glutamine synthetase.

2.Materials and methods.

A Field experiment was conducted during *Kharif* seasons of 2020-21 and 2021-22 at experimentalfarm,AICRPonIntegratedFarmingSystems,VasantraoNaik MarathwadaKrishiVidyapeeth, Parbhani to evaluate the impact of high density planting and weed management practices on Growth and yield of *Bt* cotton. The site ofexperiment was clayey in texture with slightly alkaline in reaction (pH 8.0) The available nitrogen was in the range of low (222.40 kgha^{-1}), P_2O_5 medium (17.54 kg ha^{-1}) and K_2O was high(545.52 kg ha^{-1}).The experiment was laid out in split plot design with threereplications. Treatment consists In allTwelve treatment combinations consist ofthree planting density (S_1-120 cm x 45 cm (18518 plants ha^{-1}), S_2- 80 cm x 60 cm(20833 plants ha^{-1}) and S_3- 90 cm x 45 cm (24691plants ha^{-1}in main plot and four weed managementpractices .W_1 - Stale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfop-ethyl 5% EC @ 50 g ha^{-1} + Straw mulching, W_2 - Stale seed bed technique +PoE Glufosinate ammonium 13.5% SL @ 0.7 kg ha^{-1} + Hand weeding, W_3 - Weed Free and W_4 - Weedy Check.)Recommended dose of fertilizers 120:60:60 NPK kg ha-1 wasapplied during both the years of study. The *Bt.* cotton wassown by dibbling method on 05-07-2020 and 02-07-2021 after receipt of sufficient monsoonrains. Thesoil was medium deep black and well drained.Thetopography of the experimental field was fairly uniform andlevelled. The 40 per cent of nitrogen and full dose ofphosphorus and potash were applied as basal application atthe time of sowing. At various growth stages, observations onplant growth and yield contributing characters were recorded.

Comment [A16]: Observations on plant growth and yield contributing characters were recorded at various growth stages.

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).

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

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

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 drymatter 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.

Comment [A17]: CGR enables comparison between stand communities of different types in different habitats

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

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).**

Comment [A18]: plant dry matter

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

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 unitleaf area. It indicates rate of net photosynthesis and is expressed as

Comment [A19]: to estimate

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

$$(t_2 - t_1)\ (A_2 - A_1)$$

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).

Comment [A20]: The leaf area index was determined using the formula Watson gave (1952).

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

1. Results

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

1.1 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 planting densities. 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 (S_3)- 90 cm ×45 cmat all growth interval stages, which was followed by 801 cm x 60 cm (S_2). The highest mean AGR values of 1.664 cm $day^{-1}$was recorded between 61-90 DAS under 90 cm x 45 cm (S_3), while 120 cm x 45 cm (S_1) recorded lower values of 1.422 cm day^{-1} at same growth interval.

Comment [A21]: different planting densities influenced cotton.

Among different weed management practices, the application weed free treatment (W_3) 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 Stale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfopethyl 5%EC@50g ha^{-1} + Straw mulching(W_1) during both the years of study. The highest mean AGR values of 1.645 cm day^{-1}was recorded between 61-90 DAS under weed free treatment (W_3), while weedy check (W_4) recorded lowest values of 1.446cm day^{-1} at same growth interval.

1.2 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 120 cm x 45 cm (S_1) at all growth interval stages, which was followed by 80 cm x 60 cm (S_2). The highest mean AGR value of 2.358g day^{-1} plant^{-1}were recorded between 91-120 DAS under 120 cm x 45 cm (S_1), while 90 cm x 45 cm (S_3) recorded lower value of 2.197g day^{-1} at same growth interval.

The maximum mean absolute growth rate (AGR) for dry matter was observed under weed free treatment (W_3) at all growth interval stages. It was followed by Stale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfopethyl 5%EC@50g ha^{-1} + Straw mulching(W_1)and Stale seed bed technique +PoE Glufosinate ammonium 13.5% SL @ 0.7 kg ha^{-1} + Hand weeding(W_2).The highest mean AGR value of 2.449g day^{-1}was recorded between 91-120 DAS under weed free treatment (W_3), while weedy check (W_4) recorded lowest value of 2.004g day^{-1} at same growth interval.

3.3 Crop growth rate (CGR) for dry matter (g day^{-1} m^{-2})

The 90 cm x 45 cm (S_3) resulted in maximum mean crop growth rate (CGR) for dry matter at all the growth intervals from sowing up to harvest, while 120 cm x 45 cm (S_1) recorded lowest CGR (Table 2). However, the highest CGR value of 5.404g day^{-1} m^{-2} were recorded under 90 cm x 45 cm (S_3), 120 cm x 45 cm (S_1) recorded minimum CGR value of 4.363g day^{-1} m^{-2} between 91-120 DAS.

The maximum mean crop growth rate (CGR) for dry matter was observed under weed free treatment (W_3)at all growth interval stages. It was followed byStale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfopethyl 5%EC@50g ha^{-1} + Straw mulching(W_1). The highest mean CGR value of 5.214g day^{-1} m^{-2} was recorded between 91-120 DAS under weed free treatment (W_3), while weedy check (W_5) recorded lowest value of 4.268g 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 high density planting. The 120 cm x 45 cm (S_1) resulted in maximum mean relative growth rate (RGR) for dry matter at all the growth intervals from sowing up to harvest, while 90 cm x 45 cm (S_3) recorded lowest RGR. However, the highest RGR value of 0.0761g g^{-1} day^{-1} was recorded under 120 cm x 45 cm (S_1), while 90 cm x 45 cm (S_3) recorded minimum RGR value of 0.0702g g^{-1} day^{-1} between 31-60 DAS.

Among different weed management practices, application of weed free treatment (W_3) resulted in maximum mean relative growth rate (RGR) value at all growth interval stages. It was followed byStale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfopethyl 5%EC@50g ha^{-1} + Straw mulching(W_1) andStale seed bed technique +PoE Glufosinate ammonium 13.5% SL @ 0.7 kg ha^{-1} + Hand weeding(W_2).The highest mean RGR value of 0.0716g g^{-1} day^{-1} was recorded between 31-60 DAS under weed free treatment (W_3), while weedy check (W_4) recorded lowest value of 0.0664g g^{-1} day^{-1} at same growth interval.

3.5Leaf area index (LAI)

Appraisal of data in Table 3 revealed that the 90 cm x 45 cm (S_3) resulted inhighest leaf area index (LAI) value, which was followed by 80 cm x 60 cm (S_2). Among different planting density treatments, highest leaf area index valueof 4.228 was recorded under 90 cm x 45 cm (S_3), while the lowest value of 3.458 was recorded under 120 cm x 45 cm (S_1) at 91-120 DAS.

Application of weed free treatment (W_3) resulted in maximum leaf area index (LAI)value at all growth interval stages. It was followed byStale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfopethyl 5%EC@50g ha^{-1} + Straw

Comment [A22]: The application of weed-free mulching (W_1) and Stale seed bed technique +PoE Glufosinate ammonium 13.5% SL @ 0.7 kg ha^{-1} + Hand weeding(W_2).The highest LAI value of 4.057was recorded under weed free treatment (W_3), while weedy check (W_4) recorded lowest value of 3.398 at 120 DAS.

4. Discussion

The growth characters *viz.* plant height (cm), number of functional leaves, leaf area (dm^2), dry matter per plant (g), number of monopodial and sympodial branches per plant, were substantially influenced by plant densities. The significantly taller plant was recorded with plant spacing of 90 cm × 30 cm (S_3) as compared to other plant spacings. The plant density of 120 cm × 45 cm (S_1) recorded maximum increased number of monopodial branches, sympodial branches per plant, functional leaves, leaf area, dry matterAGR and RGR as compared to other plant densities during both the years.

The growth characters *viz.* plant height (cm), numbers of functional leaves, leaf area (dm^2), dry matter per plant (g), numbers of monopodial and sympodial branches per plant, were substantially influenced by weed management practices. Significantly taller plant was recorded with weed free (W_3) which was at par with the Stale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfop-ethyl 5% EC @ 50 g ha^{-1} + Straw mulching (W_3). Lowest growth characters of *Bt.* cotton was noticed with the weedy check (W_4). The weed free (W_3) recorded maximum numbers of monopodial and sympodial branches per plant, numbers of functional leaves, leaf area, dry matter, AGR, RGR, LAI and CGR as compared to other weed management practices during both the years.

5. Conclusion

High density planting 90 cm x 45 cm (S_3) with application of weed free treatment resulted maximum AGR for plant height (cm day^{-1} plant^{-1})and Mean crop growth rate CGR (g/day/m^2). AGR of Dry matter (g day^{-1} plant^{-1}) was found to be maximum under 120 cm x 45 cm with weed free treatment. Relative Growth Rate (RGR)were also maximum under 120 cm x 45 cm (S_1) with application of weed free treatment.Leaf Area Index (LAI) was found to be maximum under high density planting 90 cm x 45 cm.

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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 high density planting and weed 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 –planting densities.												
S_1 – 120 cm × 45 cm (18518 plants ha^{-1})	0.758	1.103	1.422	0.600	0.303	0.067	0.144	1.268	1.377	2.358	0.931	-1.364
S_2 – 80 cm × 60 cm (20833 Plants ha^{-1})	0.794	1.158	1.533	0.606	0.331	0.114	0.142	1.167	1.276	2.258	0.771	-1.166
S_3 - 90 cm × 45 cm (24691 Plants ha^{-1})	0.831	1.247	1.664	0.644	0.342	0.133	0.140	1.009	1.251	2.197	0.451	-0.806
B) Sub plot treatments (Integrated nutrient management practices)												
W_1 - Stale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfopethyl 5%EC@50g ha^{-1} + Straw mulching.	0.815	1.330	1.556	0.685	0.348	0.115	0.146	1.317	1.387	2.331	0.852	-1.344
W_2 - Stale seed bed technique +PoE Glufosinate ammonium 13.5% SL @ 0.7 kg ha^{-1} + Hand weeding.	0.785	1.192	1.504	0.533	0.326	0.093	0.145	1.096	1.349	2.299	0.811	-1.248
W_3 - Weed free.	0.822	1.366	1.645	0.730	0.356	0.156	0.147	1.394	1.443	2.449	0.911	-1.504
W_4 - Weedy check.	0.756	0.789	1.456	0.519	0.270	0.055	0.129	0.786	1.026	2.004	0.296	-0.351
General Mean	**0.794**	**1.169**	**1.540**	**0.531**	**0.325**	**0.105**	**0.142**	**1.148**	**1.301**	**2.271**	**0.718**	**-1.112**

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 high density planting and weed 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 –planting densities.												
S_1 – 120 cm × 45 cm (18518 plants ha^{-1})	0.267	2.346	2.547	4.363	1.109	-2.523	0.0488	0.0761	0.0246	0.0217	0.0055	-0.0085
S_2 – 80 cm × 60 cm (20833 Plants ha^{-1})	0.294	2.427	2.653	4.696	1.604	-2.425	0.0482	0.0741	0.0235	0.0209	0.0049	-0.0078
S_3 - 90 cm × 45 cm (24691 Plants ha^{-1})	0.344	2.483	3.077	5.404	1.722	-1.983	0.0478	0.0702	0.0227	0.0204	0.0031	-0.0058
B) Sub plot treatments (Integrated nutrient management practices)												
W_1 - Stale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfopethyl 5%EC@50g ha^{-1} + Straw mulching.	0.311	2.762	2.949	4.961	1.740	-2.817	0.0493	0.0768	0.0245	0.0212	0.0051	-0.0084
W_2 - Stale seed bed technique +PoE Glufosinate ammonium 13.5% SL @ 0.7 kg ha^{-1} + Hand weeding.	0.309	2.304	2.855	4.841	1.655	-2.529	0.0490	0.0716	0.0240	0.0200	0.0045	-0.0082
W_3 - Weed free.	0.313	2.953	3.044	5.214	1.901	-3.165	0.0495	0.0783	0.0251	0.0236	0.0052	-0.0090
W_4 - Weedy check.	0.274	1.665	2.188	4.268	0.617	-0.730	0.0451	0.0653	0.0220	0.0205	0.0024	-0.0072
General Mean	**0.301**	**2.418**	**2.759**	**4.821**	**1.478**	**-2.310**	**0.0482**	**0.0732**	**0.0238**	**0.0212**	**0.0044**	**-0.0072**

Treatment	Between days after sowing					
	0-30	**31-60**	**61-90**	**91-120**	**121-150**	**151-At harvest**
A) Main plot –planting densities						
S_1 – 120 cm × 45 cm (18518 plants ha^{-1})	0.124	0.992	2.44	3.458	1.835	1.097
S_2 – 80 cm × 60 cm (20833 Plants ha^{-1})	0.126	1.060	2.61	3.714	1.948	1.149
S_3 - 90 cm × 45 cm (24691 Plants ha^{-1})	0.135	1.171	2.92	4.228	2.158	1.224
B) Sub plot - Weed management practices						
W_1 - Stale seed bed technique + PoE Pyrithiobac Sodium 10% EC @ 62.5 g ha^{-1} + Quizolfopethyl 5%EC@50g ha^{-1} + Straw mulching.	0.133	1.116	2.816	3.995	2.112	1.192
W_2 - Stale seed bed technique +PoE Glufosinate ammonium 13.5% SL @ 0.7 kg ha^{-1} + Hand weeding.	0.130	1.076	2.607	3.750	1.984	1.095
W_3– Weed free.	0.136	1.150	2.916	4.057	2.200	1.240
W_4 - Weedy check.	0.114	0.957	2.296	3.398	1.625	1.100
General Mean	**0.128**	**1.074**	**2.658**	**3.800**	**1.980**	**1.156**

Table 3: Mean Leaf Area Index (LAI) of *Bt.* cotton hybrid as influenced by high density planting and weed management practices.