International Research Journal of Agricultural Economics and Statistics
Volume 4 | Issue 1 | March, 2013 | 42-46

Research Paper

Absolute growth rate, relative growth rate, net assimilation rate as influenced on dry matter weight of Bt cotton

■ P.L. GHULE, V.V. DAHIPHALE, J.D. JADHAV AND D.K. PALVE

See end of the paper for authors' affiliations

Correspondence to :
J.D. JADHAV
Zonal Agricultural Research Station,
SOLAPUR (M.S.) INDIA

Paper History :
Received : *05.10.2012;*
Revised : *23.01.2013;*
Accepted: *24.02.2013*

ABSTRACT : The experiment was laid out in split plot design with three replications. There were twelve treatment combinations comprising three plant geometries *viz*., 90 cm x 60 cm, 120 cm x 45 cm and 180 cm x 30 cm and four nutrient levels *viz*., 80:40:40, 100:50:50, 120:60:60 kg NPK/ha and 75 per cent RDF + 5 t FYM/ha. The plant geometries are allotted to main plot and nutrient levels were accommodated in sub plots. Among growth parameters, the growth in terms of dry matter/plant was very slow during initial stage upto 30 DAS. At the end of this phase, the number of functional leaves and leaf area/plant were reduced considerably because of leaf senescence and thereby total dry matter/plant. Total dry matter accumulation per plant at all the crop growth stages was influenced due to different plant geometries. It was revealed from data that plant geometry of 180 cm x 30 cm recorded maximum dry matter accumulation per plant as against plant geometry of 90 cm x 60 cm. The more biomass production in 180 cm x 30 cm geometry might be due to wider inter row spacings. More accumulation of dry matter with wider inter row spacing may be attributed to utilization of available nutrients, sunlight and moisture at higher level because of more available space per plant. The increase in dry matter might be due to more availability of nutrients which in turn increased the plant height, number of leaves and leaf area which ultimately enhanced production of photosynthates and their subsequent accumulation in plant. Mean values of AGR based on dry matter (g/day) obtained at various crop growth stages during the crop period which indicated that AGR, RGR,NAR based on total dry matter accumulation per plant per day was very slow during 0 to 30 DAS and very fast during 61 to 90 DAS and slowed down thereafter.

KEY WORDS : AGR, RGR, NAR, Bt Cotton

HOW TO CITE THIS PAPER : Ghule, P.L., Dahiphale, V.V., Jadhav, J.D. and Palve, D.K. (2013). Absolute growth rate, relative growth rate, net assimilation rate influenced on dry matter weight of Bt cotton, *Internat. Res. J. agric. Eco. & Stat.*, **4** (1) : 42-46.

INTRODUCTION

Cotton (*Gossypium* spp.) is one of the important cash crops of India, which is sub-tropical crop grown with rainfall of 600 mm to 2500 mm. It tolerates high temperature upto 45^0C to 46^0C but temperature below 25^0C is not conductive to this crop, temperature between 27^0C to 32^0C is optimum for boll development and maturation but above 38^0C, yield is reduced. Its length of growing period varies from 150 to 240 days depending upon the genotype, soil and prevailing environment. Cotton is grown on wide range of soils but medium and heavy textured soils are preferred for cultivation of cotton crop. Cotton needs about 700 to 1300 mm water to meet its evaporative demand. With this preamble, a field experiment was designed and conducted on experimental Farm during *Kharif* season of 2009-2010 with the objectives of to know the absolute growth rate, relative growth rate, net assimilation rate as influenced on dry matter weight of Bt. cotton

MATERIALS AND METHODS

The details of materials used and the methods adopted during the course of investigation are given in this chapter under appropriate heads. The topography of experimental field was fairly uniform, leveled and had a good drainage. The soil samples from 0-30 cm soil strata were taken at random all over the experimental area after layout but before the application of fertilizers. A composite soil sample of about 1 kg from gross samples prepared and analyzed for various physico-chemical properties. The experiment was laid out in a Split Plot Design

with three replications. There were twelve treatment combinations. The combination of three plant geometries were included in the main plots and four nutrient levels in sub plots. The gross plot size was 7.2 m x 5.4 m whereas, net plot size was 5.4 m x 4.5 m.

The weight of dry matter accumulated in plant is an index of the plant growth. The roots of the plant uprooted for dry matter study, were removed and after removing the roots the plant were air dried under sun for eight days and subsequently dried in the thermostatic oven at 65 ± 2^0C, till they were completely dried. The final constant dry weight was recorded as total dry matter weight in gram per plant.

Absolute growth rate (AGR):

The rate of increase in growth variable at time 't' is called as AGR. It was measured by differential coefficient of 'w' with respect of time 't'. Absolute growth rate was calculated for two growth variables by using following formula (Reford, 1967):

$$\text{AGR (plant height)} = \frac{H_2 - H_1}{t_2 - t_1}$$

$$\text{AGR (dry matter)} = \frac{W_2 - W_1}{t_2 - t_1}$$

H_1, H_2 and W_1 W_2 refer to the plant height (cm) and dry matter weight (g) at the time t_1 and t_2, respectively.It was expressed in cm/day in case of plant height and g/day in case of dry matter production per plant.

Relative growth rate (RGR):

The parameter indicates rate of growth per unit dry mater. It is similar to compound interest wherein the increment in any interval adds to the capital for subsequent growth. This rate of increment is known as relative growth rate (Fisher, 1921) :

$$\text{RGR} = \frac{(\log_e W_2 - \log_e W_1)}{t_2 - t_1}$$

where,

W_1 = Weight of dry matter (g) at time t_1

W_2 = Weight of dry matter (g) at time t_2

t_2-t_1 = The interval in days

$\log_e$ = Natural logarithms (Logarithms to the base of 2.3026)

Relative growth rate is expressed in g/plant/day

Net assimilation rate (NAR):

It is defined as the rate of increase in the plant dry matter per unit of assimilatory surface per unit time.

$$\text{NAR} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\log_e A_2 - \log_e A_1}{A_2 - A_1} \text{ (g/cm}^2\text{/day)}$$

where,

A_1 and A_2 are the leaf areas recorded in cm^2 and W_1 and W_2 are total dry matter, recorded in gram at time t_1 and t_2, respectively.

The data recorded on various variables were statistically analysed by using technique of analysis of variance and significance was determined as given by Panse and Sukhatme (1967).

RESULTS AND DATA ANALYSIS

The findings obtained from the present study are presented below:

The various growth aspects and yield of Bt cotton hybrid NCS-145 (Bunny Bt.) as influenced by various plant geometries and nutrient levels under dryland conditions have been studied and the results of these findings have been presented in this paper.

Mean total dry weight per plant :

Data on total dry matter weight per plant recorded at various crop growth stages are given in Table 1. The mean total dry matter per plant was increased continuously upto 150 DAS and reduced at harvest. The rate of increase was fast during 60 to 90 DAS and it was lowered during 120 to 150 DAS. Total dry matter was reduced at harvest due to leaf senescence.

Plant geometry:

Data on total dry matter per plant are presented in Table 1. It showed that plant geometry of 180 cm x 30 cm was significantly superior than 120 cm x 45 cm and 90 cm x 60 cm geometry.Total dry matter at 30 DAS was not influenced significantly due to different plant geometries.

Nutrient level:

Data in Table 1 recorded that fertilizer dose of 120:60:60 kg NPK/ha recorded significantly higher total dry matter per plant over 75 per cent RDF + 5 t FYM/ha and 80:40:40 kg NPK/ha at 60 DAS and it was at par with 100:50:50 kg NPK/ha at 120 DAS and 150 DAS. Total dry matter at 30, 90 and at harvest was not influenced significantly due to different nutrient levels.

Absolute growth rate (AGR) for plant height (m/day):

Mean values of absolute growth rate (AGR) based on plant height (cm/day) obtained at various crop growth stages during the crop period are presented in Table 2.Data presented in Table 2 reveal that AGR based on plant height was maximum between 30 days and thereafter it was decreased gradually.

Plant geometry:

In plant geometry better, AGR of 180 cm x 30 cm upto 31-60 DAS, 90 cm x 60 cm of 61 to 90 DAS, 121 to 150 DAS and 151 DAS to at harvest. 120 cm x 45 cm recorded better AGR at 91 to 120 DAS and 121 to 150 DAS.

Table 1 : Mean total dry matter weight (g) per plant as influenced by different treatments at various growth stages

Treatments	Days after sowing					
	30	60	90	120	150	At harvest
Plant geometry (G)						
S_1- 90 cm x 60 cm	3.47	23.56	89.37	113.43	128.32	110.30
S_2- 120 cm x 45 cm	3.57	24.54	90.51	114.82	129.85	110.49
S_3- 180 cm x 30 cm	3.58	27.12	92.58	115.93	130.88	114.84
S.E. ±	0.10	0.14	0.45	0.07	0.10	0.24
C.D. (P=0.05)	NS	0.41	1.35	0.22	0.32	0.72
Nutrient levels (NPK kg/ha)						
F_1- 80:40:40	3.43	24.78	90.48	112.81	127.87	110.65
F_2- 100:50:50	3.60	24.96	90.97	115.30	130.23	112.23
F_3- 120:60:60	3.60	25.62	91.19	115.89	130.87	112.51
F_4- 75% RDF + 5 t FYM/ha	3.52	24.95	90.63	114.91	129.78	112.12
S.E. ±	0.10	0.20	0.18	0.26	0.24	0.52
C.D. (P=0.05)	NS	0.60	NS	0.77	0.72	NS
Interaction (GxF)						
S.E. ±	0.18	0.35	0.32	0.45	0.42	0.90
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
G.mean	3.54	25.07	90.82	114.73	129.69	111.87

Interaction: The interaction effects was not found significant NS=Non-significant

Table 2 : Absolute growth rate (AGR) cm/day based on plant height as influenced by different treatments at various growth stages

Treatments	Days after sowing					
	30	60	90	120	150	At harvest
Plant geometry (G)						
S_1- 90 cm x 60 cm	0.629	0.477	0.288	0.211	0.299	0.193
S_2- 120 cm x 45 cm	0.642	0.576	0.201	0.298	0.299	0.116
S_3- 180 cm x 30 cm	0.689	0.585	0.216	0.282	0.298	0.139
Nutrient levels (NPK kg/ha)						
F_1- 80:40:40	0.63	0.525	0.252	0.247	0.296	0.157
F_2- 100:50:50	0.643	0.576	0.208	0.292	0.300	0.129
F_3- 120:60:60	0.704	0.558	0.228	0.272	0.297	0.159
F_4- 75% RDF + 5 t FYM/ha	0.638	0.525	0.253	0.244	0.300	0.152
G.mean	0.653	0.546	0.235	0.263	0.298	0.149

Nutrient level:

In nutrient level, 100:50:50 kg NPK/ha recorded maximum AGR for height at 60, 120 and 150 days. Nutrient level 120:60:60 kg NPK/ha recorded maximum AGR for height at 30 days and at harvest. Nutrient level 75 per cent RDF + 5 t FYM/ha/ha recorded maximum AGR for height at 90 and 150 DAS.

Absolute growth rate for dry matter (g/day):

Mena values of AGR based on dry matter (g/day) obtained at various crop growth stages during the crop period are presented in Table 3, which indicated that AGR based on total dry matter accumulation per plant per day was very slow during 0 to 30 DAS and very fast during 61 to 90 DAS and slowed down thereafter.

Plant geometry:

Plant geometry 180 cm x 30 cm recorded higher AGR at 0 to 30 DAS, 31 to 60 DAS and 151 DAS to harvest days. 120 cm x 45 cm recorded higher AGR for dry matter at 60 to 90, 90 to 120 and 120 to 150 DAS.

Nutrient level:

Nutrient level 120:60:60 kg NPK/ha recorded maximum AGR for dry matter at 60 DAS. Nutrient level 75 per cent RDF + 5 t FYM/ha recorded maximum AGR for dry matter at 30 DAS. Nutrient level 100:50:50 kg NPK/ha recorded maximum AGR for dry matter at 90 and 120 DAS. Nutrient level 80:40:40 kg NPK/ha recorded maximum AGR for dry matter at 150 DAS.

Relative growth rate (RGR) (g/day):

Data computed on mean RGR at various crop growth stages are shown in Table 4. The studies showed that the RGR was increased continuously from 0 to 30 DAS to 61 to 90 DAS and decreased thereafter.

Plant geometry:

In plant geometry, maximum RGR was recorded in geometry 120 cm x 45 cm at 0 to 30 DAS, 61 to 90 DAS, 91 to 120 DAS and 121 to 150 DAS.

Nutrient level:

In nutrient levels maximum RGR was recorded at 120:60:60 kg NPK/ha at 30, 60 and 120 DAS. Nutrient level 100:50:50 kg NPK/ha recorded maximum RGR at 90 DAS. Nutrient level 80:40:40 kg NPK/ha recorded maximum RGR at 150 DAS.

Net assimilation rate (NAR) (g/dm^2/day):

Data on mean values of NAR obtained at different crop growth stages presented in Table 5 indicated that NAR increased from 0 to 30 DAS to 61 to 90 DAS and decreased thereafter.

Plant geometry:

In plant geometry maximum NAR recorded at 180 cm x 30 cm at 0 to 30 DAS, 31 to 60 DAS and 151 DAS to at harvest.

Nutrient level:

In nutrient levels maximum NAR recorded 120:60:60 kg NPK/ha at 30 and 60 DAS. Nutrient levels 100:50:50 kg NPK/ha at 30, 90 and 120 DAS. Nutrient levels 80:40:40 kg NPK/ha at 150 DAS.

The results of present investigation are discussed briefly.

General growth:

The first growth phase started from emergence upto 30 DAS in which growth in terms of plant height, number of functional leaves, leaf area and dry matter/plant were recorded as 19.62 cm, 11.43, 5.06 dm^2 and 3.54 g/plant, respectively. Among growth parameters, the growth in terms of dry matter/plant was very slow during initial stage upto 30 DAS. At the end of this phase the number of functional leaves and leaf area/plant were reduced considerably because of leaf senescence and thereby total dry matter/plant.

Table 3 : Absolute growth rate (AGR) g/day based on dry matter as influenced by different treatments at various growth stages

Treatments	Days after sowing					
	0-30	31-60	61-90	91-120	121-150	At harvest
Plant geometry (G)						
S_1- 90 cm x 60 cm	0.115	0.669	2.193	0.802	0.496	-0.450
S_2- 120 cm x 45 cm	0.119	0.699	2.199	0.810	0.501	-0.484
S_3- 180 cm x 30 cm	0.119	0.784	2.182	0.778	0.498	-0.401
Nutrient levels (NPK kg/ha)						
F_1- 80:40:40	0.114	0.711	2.19	0.744	0.502	-0.430
F_2- 100:50:50	0.12	0.712	2.20	0.827	0.497	-0.450
F_3- 120:60:60	0.120	0.734	2.18	0.823	0.499	-0.459
F_4- 75% RDF + 5 t FYM/ha	0.117	0.714	2.18	0.809	0.495	-0.441
G.mean	0.117	0.713	2.191	0.796	0.498	0.445

Table 4 : Relative growth rate (RGR) g/day based on dry matter as influenced by different treatments at various growth stages

Treatments	Days after sowing					
	0-30	31-60	61-90	91-120	121-150	At harvest
Plant geometry (G)						
S_1- 90 cm x 60 cm	0.266	1.541	5.051	1.846	1.142	-1.037
S_2- 120 cm x 45 cm	0.274	1.609	5.063	1.865	1.153	-1.114
S_3- 180 cm x 30 cm	0.274	1.806	5.024	1.792	1.147	-0.923
Nutrient levels (NPK kg/ha)						
F_1- 80:40:40	0.263	1.638	5.04	1.713	1.555	-0.991
F_2- 100:50:50	0.276	1.639	5.06	1.867	1.145	-1.036
F_3- 120:60:60	0.276	1.690	5.03	1.895	1.149	-1.056
F_4- 75% RDF + 5 t FYM/ha	0.270	1.644	5.04	1.863	1.141	-1.016
G.mean	0.271	1.652	5.036	1.834	1.147	-1.005

Table 5 : Net assimilation rate (NAR) g/dm2/day as influenced by different treatments at various growth stages

Treatments	Days after sowing					
	0-30	31-60	61-90	91-120	121-150	At harvest
Plant geometry (G)						
S_1- 90 cm x 60 cm	0.264	1.540	5.049	1.846	1.142	-1.036
S_2- 120 cm x 45 cm	0.274	1.609	5.063	1.865	1.153	-1.114
S_3- 180 cm x 30 cm	0.274	1.805	5.024	1.791	1.146	-0.923
Nutrient levels (NPK kg/ha)						
F_1- 80:40:40	0.262	1.637	5.042	1.713	1.155	-0.981
F_2- 100:50:50	0.276	1.639	5.065	1.904	1.144	-1.036
F_3- 120:60:60	0.276	1.690	5.019	1.895	1.148	-1.056
F_4- 75% RDF + 5% FYM	0.269	1.644	5.019	1.862	1.139	-1.015
G.mean	0.270	1.652	5.044	1.834	1.146	-1.024

Plant geometry:

The information regarding effect of plant geometry on various growth parameters and yield attributing characters and yield is being discussed below.

Total dry matter accumulation per plant at all the crop growth stages was influenced due to different plant geometries. It was revealed from data (Table 1) that plant geometry of 180 cm x 30 cm recorded maximum dry matter accumulation per plant as against plant geometry of 90 cm x 60 cm. The more biomass production in 180 cm x 30 cm geometry might be due to wider inter row spacings. More accumulation of dry matter with wider inter row spacing may be attributed to utilization of available nutrients, sunlight and moisture at higher level because of more available space per plant. Similar results have been reported by Hake *et al*. (1992), Venugopalan and Blaise (2001), Nehra *et al*. (2004) and Ram and Giri (2006) also found that with increase in intra row spacing, total dry matter accumulation per plant was increased.

Response to nutrient levels:

The increase in dry matter might be due to more availability of nutrients which in turn increased plant height, number of leaves and leaf area which ultimately enhanced production of photosynthates and their subsequent accumulation in plant. The increase in dry matter due to application of higher level of fertilizers was also reported by Halemani *et al*. (2004), Hallikeri *et al*. (2004) and Ram and Giri (2006).

Authors' affiliations:
P.L. GHULE, V.V. DAHIPHALE AND D.K. PALVE, Marathwada Krishi Vidyapeeth, PARBHANI (M.S.) INDIA

LITERATURE CITED

Fisher, R.A. (1921). *Statistical method for research works.* Oliver and Boyd and Co. Inc. Endinburgh, UNITED KINGDOM.

Hake, D.A., Bharade, G.M., Kohale, S.K. and Nagdeve, M.B. (1992). Effect of plant population on growth and yield of pre-monsoon cotton (*Gossypium hirsutum*) under drip irrigation system. *Indian J. Agron.*, **37**(2):375-393.

Halemani, H.L., Hallikeri, S.S., Nandagavi, R.A. and Nooli, S.S. (2004). Performance of Bt. cotton hybrids at different levels of fertilizers under protective irrigation. Intern. Symp. on "Strategies for sustainable cotton production – A Global Vision" 2. Crop Production, 23-25 November, 2004, UAS, Dharwad, pp. 153-155.

Hallikeri, S.S., Halemani, H.L., Nandagavi, R.A. and Nooli, S.S. (2004). Response of Mahyco Bt. cotton hybrids to levels of fertilizer under protective irrigation. Intern. Symp. on "Strategies for sustainable cotton production – A Global vision" 2. Crop Production, 23-25 November, 2004, UAS, Dharwad, pp. 139-141

Nehra, P.L., Nehra, K.C. and Kumawat, P.D. (2004). Performance of Bt cotton hybrids at different spacing in canal command area of North Western Rajasthan. *J. Cotton Res. Dev.*, **18**(2):189-190.

Panse, V.G. and Sukhatme, P.V. (1967). *Statistical methods for agricultural workers* (1st Ed.), ICAR, New Delhi, INDIA.

Ram, M. and Giri, A.N. (2006). Response of newly released cotton (*Gossypium hirsutum*) varieties to plant densities and fertilizer levels. *J. Cotton Res. Dev.*, **20**(1):85-86.

Redford, P.J. (1967). Growth analysis formulae their use and abuse. *Crop Sci.*, **7** : 171-175.

Venugopalan, M.V. and Blaise, D. (2001). Effect of planting density and nitrogen levels on productivity and N-use efficiency of rainfed upland cotton (*G. hirsutum*). *Indian J. Agron.*, **46**(2):346-353.

——*—*—*—*—*—*