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EFFECT OF *BT* (CRY1AC) AND BGII (CRY1AC + CRY2AB) COTTON HYBRIDS ON CONSUMPTION-UTILIZATION INDICES OF *EARIAS VITTELLA* (FABRICIUS)

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ABSTRACT
Effect of BGII, *Bt* and non *Bt* cotton hybrids on the consumption-utilization indices of *Earias vittella* (Fabricius 1794) at different days after sowing (70, 100, 120), were studied using six hybrids namely BIO 6488 *Bt*, BIO 6488 BGII, BIO 6488 non *Bt,* RCH 134 *Bt,* RCH 134 BGII and RCH 134 non *Bt*, on squares and bolls. Lowest CI, 0.13 and 0.14 was recorded on BIO6488 BGII on 70 and 100 DAS respectively. GR ranged from 0.11 to 0.20 mg/day on squares and 0.28 to 0.39 mg/day on bolls of *Bt* (*Bt* & BGII) while lowest ECI, 11.93% at 70 DAS on squares of RCH134BGII. AD/AE remain highest on non *Bt* (64.46-63.53%) and ranged from 30.42% (RCH134BGII) to 33.42% (BIO6488BGII) on bolls of *Bt*. All the parameters effected adversely from 70 to 120 DAS which may be a mixed effect of aging and decreased toxin expression. Values of ECD, 18.60 % at 70 DAS and 19.78% at 120DAS on BIO6488BGII is in accordance with above

INTRODUCTION

Cotton (*Gossypium* spp.) is an important fibre crop in India. Cotton provides livelihood to more than 60 million people in India by way of support in agriculture, processing and by its use in textiles and contributes around 30% to the gross domestic product of Indian agriculture. Cotton accounts for the consumption of 50% of total pesticide usage in the country worth about Rs. 1600 million (Dhaliwal *et al.,* 2004). Though cultural practices, resistant traits (Sadras 1995) and beneficial fauna activity (Wilson *et al.,* 1994) make it possible to reduce insect pest damage, yet the economic sustainability of the cotton crop is not realised. The main thrust of Indian growers has so far been towards the repeated application of synthetic pesticides to control these pests.

Spotted bollworm, *E. vittella* is an important component of the lepidopteran pest complex of cotton in India. It is generally an early to mid-season pest that causes damage by attacking tender terminal shoots, boring into the stem, feeding on squares and green bolls. As a result, the quality and quantity of cotton is adversely affected. The repeated applications of insecticides do not provide satisfactory control of this pest due to its internal feeding habit and overlapping generations during crop season.

Of late, the cultivation of *Bt* cotton, especially that of BGII is gained so much momentum that it has reached almost all the corners of the country & the same is true for Haryana state. However, information with respect to the effectiveness of this new BGII (Cry1Ac and Cry2Ab) with age of the plant is unavailable as far as *E. vittella* is concerned. Keeping all this in view, this study was proposed with objective of evaluation of consumption- utilization indices of *E. vittella*.

MATERIALS AND METHODS

Cotton hybrids used for evaluation

Six cotton hybrids namely BIO 6488 Bt, BIO 6488 BGII, BIO 6488 non Bt, RCH 134 Bt, RCH 134 BGII and RCH 134 non Bt were sown in the 2nd fortnight of May 2011 by dibbling method keeping spacing of 67.5 cm x 60 cm (plant to plant, row to row) at the Research Farm, Department of Entomology, CCS Haryana Agricultural University, Hisar, India. The experiment was laid out in randomized block design (RBD), replicated thrice with a plot size of 7m x 4m. Thinning of plants was undertaken after one month of sowing to maintain proper plant population. All other cultural practices like fertilizer application, weeding, hoeing, irrigation, etc., were adopted as per the recommendations made in Package and Practice of Kharif crops(Anonymous 2011).

Rearing of spotted bollworm, *Earias vittella* (Fabricius) under laboratory conditions

Larvae of *E. vittella* were collected from okra fields of the Research Farm of CCS Haryana Agricultural University, Hisar, India, for mass multiplication. Larvae were reared in glass jars (20 cm x 15 cm) on okra fruits. Pupae were transferred into glass jars for adult emergence. Adults emerging from such pupae were transferred to separate jars for egg laying. Cotton swabs, dipped in 16 per cent sugar solution were provided as

food for adults. Zigzag folded paper strips were provided as oviposition substrate (Saini, 2013). Neonates of *E. vittella* larvae were transferred to young okra fruits with the help of wet camel hair brush and kept in petri plates (10 cm diameter) and the food was changed on alternate days.

Effect of transgenic *Bt* cotton squares and bolls of plants of different ages on consumption and utilization indices of fourth instar larvae of *Earias vittella* (Fabricius)

The experiment was conducted in battery jars (20 cm x 15 cm) in which the respective foods (squares/bolls) were kept. Two plant parts *viz*., squares and bolls, collected from 70, 100 and 120 days after sowing of crop, were fed to the fourth instar larvae of *E. vittella*. The experiment was replicated three times. In this experiment each replication consisted of 10 larvae. These larvae were starved for about four hours and weighed individually before releasing them on the squares and bolls in the battery jars (Basavraj *et al*. (2008b)). The fresh weight of the food in each jar was also recorded before the larvae were released on it. After 48 hours uneaten food material, larvae and faecal matter were separated and weighed. The weight gained (mg) by the larvae after feeding and mean weight (mg) of larvae during feeding period (mg) were also worked out. The data so generated was utilized to compute consumption-utilization indices *viz*., Consumption Index (CI), Growth Rate (GR), Efficiency of Conversion of Ingested food (ECI), Approximate Digestibility/Assimilation Efficiency (AD/AE) and Efficiency of Conversion of Digested food (ECD) with the help of following formulae (Waldbauer 1968).

Formulae used

Consumption Index (CI)

$$CI = \frac{\text{weight (mg) of food ingested}}{\text{duration of feeding period (days)} \times \text{mean body weight (mg) of larva during feeding period}}$$

$$\text{Mean Body Weight} = \frac{\text{initial weight (mg) of larva} + \text{final weight (mg) of larva}}{2}$$

Growth Rate (GR)

$$GR = \frac{\text{weight (mg) gained by larva}}{\text{duration of feeding period (days)} \times \text{mean body weight (mg) of larva during feeding period}}$$

Efficiency of Conversion of Ingested food (ECI)

$$ECI = \frac{\text{weight (mg) gained by larva}}{\text{weight (mg) of food ingested by larva}} \times 100$$

Approximate Digestibility/ Assimilation Efficiency (AD/AE)

$$AD/AE = \frac{\text{weight (mg) of food ingested - weight (mg) of faeces}}{\text{weight (mg) of food ingested by larva}} \times 100$$

Efficiency of Conversion of Digested food

$$ECD = \frac{\text{weight (mg) gained by larva}}{\text{weight (mg) of food eaten - weight (mg) of faeces}} \times 100$$

RESULTS

Effect of squares

Consumption-utilization indices of *E. vittella* fourth instar larvae on squares of *Bt*, BGII and non-*Bt* hybrids are presented in Table 1 and 2. At 70 days after sowing of crop the consumption index (CI) of larvae ranged from 0.13 to 0.35 on *Bt* and BGII hybrids and 0.81 to 0.83 on non *Bt* hybrids (Table 1). BGII hybrids BIO 6488 (0.13) and RCH 134 (0.14) recorded minimum CI. Growth rate of larvae ranged from 0.11 to 0.18 mg/day on *Bt* and BGII hybrids and 0.22 to 0.25 mg/day on non-*Bt* hybrids. Among the hybrids the lowest growth rate (0.11 mg/day) was recorded on RCH 134 BGII, while highest (0.25 mg/day) on RCH 134 non-*Bt*. Lower growth rate was noticed on RCH 134 BGII (0.11 mg/day) followed by BIO 6488 BGII (0.13 mg/day), RCH 134 *Bt* (0.15 mg/day) and BIO 6488 *Bt* (0.18 mg/day) respectively. Efficiency of conversion of ingested food (ECI) ranged from 11.93 to 18.86 per cent on *Bt* and BGII hybrids and 30.36 to 32.13 per cent on non-*Bt* hybrids (Table 2). It was highest on BIO 6488 non-*Bt* (32.13%) and RCH 134 non-*Bt* (30.36%). Lowest ECI was observed on BGII hybrids RCH 134 (11.93%) and BIO 6488 (13.18%). Further, Approximate digestibility or Assimilation efficiency (AD/AE) ranged from 22.43 to 39.41 per cent on *Bt* and BGII hybrids and 58.66 to 59.13 per cent on non-*Bt* hybrids. AD/AE was found to be highly suppressed on BGII hybrids (22.43% and 23.52%) followed by *Bt* hybrids (38.32% and 39.41%) and higher in case of non-*Bt* hybrids (58.66% and 59.13%).Efficiency of conversion of digested food (ECD) ranged from 13.76 to 28.43 per cent on *Bt* and BGII hybrids and 55.36 to 55.72 per cent on non-*Bt* hybrids. Among the hybrids the lowest ECD (13.76%) was recorded on RCH 134 BGII, while highest (55.72%) on BIO 6488 non-*Bt*. At 100 days after sowing of crop the variations on various consumption and utilization indices *viz*., CI, GR, ECI, AD/AE and ECD on *Bt*, BGII and non-*Bt* hybrids were significantly different (Table 1, 2) and the trend was similar to that on crop age of 70 days after sowing. At 120 days of crop age the consumption index (CI) ranged from 0.21 to 0.48 on *Bt* and BGII hybrids and 0.83 to 0.84 on non *Bt* hybrids (Table 1). On *Bt* hybrids the CI was significantly less than non-*Bt* hybrids. BGII hybrids RCH 134 (0.21) and BIO 6488 (0.23) recorded minimum CI. Growth rate of larvae ranged from 0.12 to 0.20 mg/day on *Bt* and BGII hybrids and 0.20 to 0.25 mg/day on non-*Bt* hybrids. Lower growth rate was noticed on RCH 134 BGII (0.12 mg/day) followed by BIO 6488 BGII (0.13 mg/day), RCH 134 *Bt* (0.18 mg/day) and BIO 6488 *Bt* (0.20 mg/day), respectively. Efficiency of conversion of ingested food (ECI) ranged from 12.26 to 22.45 per cent on *Bt* hybrids and 30.08 to 30.34 per cent on non-*Bt* hybrids (Table 2). Further, Approximate digestibility or Assimilation efficiency (AD/AE) ranged from 25.68 to 39.78 per cent on *Bt* and BGII hybrids and 59.98 to 60.22 per cent on non-*Bt* hybrids. It was found to be highly suppressed on BGII hybrids (25.68% and 26.99%) followed by *Bt* hybrids (39.22% and 39.78%) and higher in case of non-*Bt* hybrids (59.98% and 60.22%). Efficiency of conversion of digested food (ECD) ranged from 13.69 to 29.32 per cent on *Bt* and BGII hybrids and 55.70 to 68.81 per cent on non-*Bt* hybrids. Among the hybrids the lowest ECD (13.69%) was recorded on RCH 134 BGII, while highest (68.81%) on BIO 6488 non-*Bt*.

Effect of bolls

Consumption - utilization indices of *E. vittella* fourth instar larvae on bolls of *Bt*, BGII and non-*Bt* hybrids are summarised in Table 3 and 4.

Tab 1: Effect of transgenic *Bt* cotton squares of different ages on Consumption index and Growth rate of fourth instar larvae of *Earias vittella* (Fabricius) (Lepidoptera: Noctuidae)

Hybrids	Consumption- Index (CI)			Growth Rate (GR) (mg/day)		
	70 DAS*	100 DAS	120 DAS	70 DAS	100 DAS	120 DAS
RCH 134 *Bt*	0.34	0.33	0.46	0.15	0.16	0.18
RCH 134 BGII	0.14	0.15	0.21	0.11	0.12	0.12
RCH 134 non *Bt*	0.83	0.82	0.84	0.25	0.25	0.25
BIO 6488 *Bt*	0.35	0.36	0.48	0.18	0.19	0.20
BIO 6488 BGII	0.13	0.14	0.23	0.13	0.13	0.13
BIO 6488 non *Bt*	0.81	0.8	0.83	0.22	0.21	0.21
SEm(±)	0.01	0.02	0.03	0.01	0.02	0.03
CD(p = 0.05)	0.04	0.06	0.11	0.03	0.07	N.S.

*DAS- days after sowing:; **CD** denotes critical difference

Tab 2: Effect of transgenic *Bt* cotton squares of different ages on ECI, AD/AE and ECD of fourth instar larvae of *Earias vittella* (Fabricius) (Lepidoptera: Noctuidae

Hybrids	ECI (%)			AD/AE (%)			ECD (%)		
	70 DAS*	100 DAS	120 DAS	70 DAS	100 DAS	120 DAS	70 DAS	100 DAS	120 DAS
RCH 134 *Bt*	18.13(25.19)**	18.36(25.37)	22.45(28.28)	38.32(38.23)	38.78(38.50)	39.22(38.76)	28.43(32.21)	28.36(32.16)	29.32(32.77)
RCH 134 BGII	11.93(20.20)	12.02(20.28)	14.19(22.12)	22.43(28.26)	23.05(28.68)	25.68(30.04)	13.76(21.77)	13.57(21.61)	13.69(21.71)
RCH 134 non *Bt*	30.36(33.42)	31.40(34.07)	30.34(33.41)	58.66(49.97)	59.09(50.22)	60.22(50.88)	55.36(48.06)	55.19(47.96)	55.70(48.26)
BIO 6488 *Bt*	18.86(25.73)	18.98(25.82)	19.03(25.85)	39.41(38.87)	39.93(39.18)	39.78(39.09)	28.36(32.16)	27.70(31.75)	28.08(31.99)
BIO 6488 BGII	13.18(21.28)	12.98(21.11)	12.26(20.49)	23.52(29.00)	25.12(30.07)	26.99(31.29)	15.14(22.89)	15.27(23.00)	15.37(23.07)
BIO 6488 non *Bt*	32.13(34.52)	33.24(35.20)	30.08(33.25)	59.13(50.24)	59.35(50.37)	59.98(50.74)	55.72(48.27)	68.21(55.66)	68.81(56.03)
SEm(±)	(0.02)	(0.03)	(0.04)	(0.02)	(0.02)	(0.16)	(0.03)	(0.03)	(0.12)
CD(p = 0.05)	(0.05)	(0.09)	(0.12)	(0.07)	(0.07)	(0.49)	(0.08)	(0.08)	(0.37)

*DAS- days after sowing ;** Figures in parentheses are arc sine values; ECI = Efficiency of Conversion of Ingested food; AD/AE = Approximate Digestibility/Assimilation Efficiency; ECD = Efficiency of Conversion of Digested food; CD denotes critical

Table 3: Effect of transgenic *Bt* cotton bolls of different ages on Consumption index and Growth rate of fourth instar larvae of *Earias vittella* (Fabricius) (Lepidoptera: Noctuidae)

Hybrids	Consumption- Index (CI)			Growth Rate (GR) (mg/day)		
	70 DAS*	100 DAS	120 DAS	70 DAS	100 DAS	120 DAS
RCH 134 *Bt*	1.48	1.47	1.61	0.30	0.27	0.31
RCH 134 BGII	1.49	1.49	1.58	0.30	0.32	0.39
RCH 134 non *Bt*	1.95	1.95	1.99	0.42	0.43	0.44
BIO 6488 *Bt*	1.51	1.49	1.80	0.32	0.31	0.36
BIO 6488 BGII	1.39	1.40	1.63	0.28	0.29	0.32
BIO 6488 non *Bt*	2.21	2.18	2.22	0.47	0.49	0.48
SEm(±)	0.03	0.04	0.03	0.03	0.03	0.03
CD(p = 0.05)	0.09	0.13	0.09	0.11	0.11	0.11

* DAS- days after sowing; CD denotes critical difference

At 70 days after sowing of crop the consumption index (CI) ranged from 1.39 to 1.51 on *Bt* and BGII hybrids and 1.95 to 2.21 on non *Bt* hybrids (Table 3). On *Bt* hybrids the CI was significantly less than non-*Bt* hybrids. BGII hybrids BIO 6488 (1.39) and RCH 134 (1.49) recorded minimum CI. Growth rate of larvae ranged from 0.28 to 0.32 mg/day on *Bt* and BGII hybrids and 0.42 to 0.47 mg/day on non-*Bt* hybrids. Lower growth rate was recorded on BIO 6488 BGII (0.28 mg/day) followed by RCH 134 *Bt*, RCH 134 BGII (0.30 mg/day) and BIO 6488 *Bt* (0.32 mg/day), respectively.

Efficiency of conversion of ingested food (ECI) ranged from 12.93 to 14.24 per cent on *Bt* and BGII hybrids and 22.46 to 22.54 per cent on non-*Bt* hybrids (Table 4). Further, Approximate digestibility or Assimilation efficiency (AD/AE) ranged from 30.42 to 36.73 per cent on *Bt* and BGII hybrids and 63.53 to 63.57 per cent on non-*Bt* hybrids. It was found to be highly suppressed on BGII hybrids (30.42% and 30.72%) followed by *Bt* hybrids (36.54% and 36.73%) and higher in case of conventional non-*B*t hybrids (63.53% and 63.57%). Efficiency of conversion of digested food (ECD) ranged from 17.14 to 24.36 per cent on *Bt* and BGII hybrids and 57.03 to 57.30 per cent on non-*Bt* hybrids. Among the hybrids the lowest ECD (17.14%) was recorded on RCH 134 BGII, while highest (57.30%) on BIO 6488 non-*Bt*.

At 100 days after sowing the variations on various consumption and utilization indices *viz*., CI, GR, ECI, AD/AE and ECD on *Bt*, BGII and non-*Bt* hybrids were significant (Table 3, 4) and the trend was similar to that on crop of age 70 days after sowing.

At 120 days of crop age the consumption index (CI) ranged from 1.61 to 1.80 on *Bt* and BGII hybrids and 1.99 to 2.22 on non *Bt* hybrids (Table 3). BGII hybrids of RCH 134 (1.58) recorded minimum CI. Growth rate of larvae ranged from 0.31 to 0.39 mg/day on *Bt* and BGII hybrids and 0.44 to 0.48 mg/day on non-*Bt* hybrids. Lower growth rate was recorded on RCH 134 *Bt* (0.31 mg/day) followed by BIO 6488 BGII (0.32 mg/day), BIO 6488 *Bt* (0.36 mg/day), and RCH 134 BGII (0.39

Table 4: Effect of transgenic *Bt* cotton bolls of different ages on ECI, AD/AE and ECD of fourth instar larvae of *Earias vittella* (Fabricius) (Lepidoptera: Noctuidae)

Hybrids	ECI (%)			AD/AE (%)			ECD (%)		
	70 DAS*	100 DAS	120 DAS	70 DAS	100 DAS	120 DAS	70 DAS	100 DAS	120 DAS
RCH 134 *Bt*	12.93(21.07)**	12.91(21.05)	14.24(22.17)	36.73(37.29)	38.03(38.06)	38.33(38.24)	24.36(29.56)	24.48(29.65)	25.24(30.15)
RCH 134 BGII	13.50(21.55)	13.48(21.53)	14.39(22.29)	30.42(33.46)	30.82(33.71)	30.90(33.76)	17.14(24.45)	17.33(24.59)	17.93(25.04)
RCH 134 non *Bt*	22.46(28.28)	22.50(28.30)	23.14(28.74)	63.53(52.83)	64.34(53.32)	64.46(53.38)	57.03(49.02)	58.24(49.73)	59.60(50.51)
BIO 6488 *Bt*	14.01(21.98)	14.01(21.98)	16.20(23.72)	36.54(37.18)	40.01(39.22)	41.24(39.94)	23.16(28.76)	25.31(30.19)	33.01(35.06)
BIO 6488 BGII	14.24(22.16)	14.26(22.18)	15.36(23.07)	30.72(33.65)	32.42(34.70)	33.42(35.31)	18.60(25.54)	19.26(26.02)	19.78(26.40)
BIO 6488 non *Bt*	22.54(28.34)	22.56(28.35)	23.26(28.83)	63.57(52.86)	64.22(53.24)	64.64(53.49)	57.30(49.18)	58.53(49.89)	58.88(50.10)
SEm(±)	(0.05)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)	(0.02)	(0.03)	(0.03)
CD(p = 0.05)	(0.17)	(0.10)	(0.08)	(0.16)	(0.09)	(0.12)	(0.07)	(0.08)	(0.10)

DAS-days after sowing ; *Figures in parentheses are arc sine values; ECI = Efficiency of Conversion of Ingested food; AD/AE = Approximate Digestibility/Assimilation Efficiency; ECD = Efficiency of Conversion of Digested food

mg/day), respectively. Efficiency of conversion of ingested food (ECI) ranged from 14.24 to 16.20 per cent on *Bt* and BGII hybrids and 23.14 to 23.26 per cent on non-*Bt* hybrids (Table 4). Further, Approximate digestibility or Assimilation efficiency (AD/AE) ranged from 30.90 to 41.24 per cent on *Bt* and BGII hybrids and 64.46 to 64.64 per cent on non-*Bt* hybrids. It was found to be highly suppressed on BGII hybrids (30.90% and 33.42%) followed by *Bt* hybrids (38.33% and 41.24%) and higher in case of conventional non-*Bt* hybrids (64.46% and 64.64%). Efficiency of conversion of digested food (ECD) ranged from 17.93 to 33.01 per cent on *Bt* and BGII hybrids and 58.88 to 59.60 per cent on non-*Bt* hybrids. Among the hybrids the lowest ECD (17.93%) was recorded on RCH 134 BGII, while highest (59.60%) on RCH 134 non-*Bt*.

DISCUSSION

Consumption - utilization indices *viz*., CI, GR, ECI, AD/AE and ECD of fourth instar larvae of *E. vittella* were calculated. Consumption index (CI) on various hybrids differed significantly at 70 DAS of crop. This indicated that consumption by *E. vittella* was variable due to *Bt,* BGII and non *Bt* hybrids. These results are also supported by Berdegue *et al*. (1996) who found significant avoidance of *Bt* toxin treated diet by *S.exigua*. Basavaraja *et al*. (2008b) also made similar observations who noticed significant reduction in consumption of *Bt* (Cry1Ac) cotton by *H. armigera*. The consumption index (CI) and growth rate (GR) of larvae in case of non *Bt* hybrids remained unaffected but growth of larvae and consumption index (0.13-1.51) was very less on *Bt* and BGII hybrids. The decreased growth rate (0.11-0.32) indicated effectiveness of *Bt* and BGII hybrids against *E. vittella*. The efficiency of conversion of ingested food (ECI) was about normal on non *Bt* hybrids but ECI on *Bt* and BGII hybrids (11.93-18.86%) remained significantly low at 70 DAS. The present findings are supported by Somasekhara *et al*. (2011) who observed greatly reduced food utilization efficiency of *Earias vittella* on squares of *Bt* and BGII cotton genotypes. Similar trend was followed in GR, ECI, AD/AE and ECD. Wu *et al*. (2009) also supported that growth rate remained lower on transgenic *Bt* cotton incase of *S. exigua*. Basavaraja *et al*. (2008b) studies are also in conformity with present findings. Prutz & Dentter (2005) also supported low growth rate and ECI of larvae of *H. armigera* on *Bt* treated maize. Approximate digestibility / Assimilation efficiency (AD/AE) was also low on *Bt* and BGII hybrids (22.43-39.41%) as compared with non *Bt* hybrids. These results are supported by Basavaraja *et al*.(2008b) who observed low AD/AE on *Bt* cotton against *H. armigera*. The efficiency of conversion of digested food (ECD) was not affected on non *Bt* genotypes but on *Bt* and BGII hybrids (13.76-28.43%) they turned out very low which further confirmed the effectiveness of *Bt* and BGII hybrids against *E. vittella* Prutz & Dentter (2005). On *Bt* and BGII hybrids, Consumption index (0.14-1.49) at 100 DAS again observed significant against *E. vittella*. All the observations at 100 DAS were similar to earlier observations at 70 DAS. Growth rate on non *Bt* hybrids was unaffected and low growth rate (0.12-0.32) was observed on *Bt* and BGII hybrids at 100 DAS. The efficiency of conversion of ingested food (12.91-18.98 %) and efficiency of conversion of digested food (13.57-25.31 %) remained low for *Bt* and BGII hybrids at both the stages. The AD/AE (23.05-40.01 %) was observed similar to 70 DAS. Studies carried out by Basavaraja *et al*. (2008b) and Wu *et al*. (2009), Somashekara *et al* (2011) supported the present investigations.

The effect of *Bt* and BGII hybrids was observed low at 120 DAS, as all the parameters like CI (0.21-1.80), GR (0.12-0.32), ECI (12.26-16.20%) and ECD (13.69-33.01%) showed increasing trends which were observed low at early stages. There was some increase in growth rate also when compared with 100 DAS observations. Basavaraja *et al*. (2008b) also observed that differences between parameters remained non significant at 130 days of crop age. Li *et al* .(2007) also noticed that leaves of *Bt* cotton at 120 days after planting (DAP) were less toxic to soybean looper, hence these studies are in accordance with present investigation. On *Bt* and BGII hybrids, efficiency of conversion ingested food and efficiency of conversion of digested food showed some increase compared with earlier observations at 70 and 100 DAS but these observations were still lower than the results achieved on non *Bt* genotypes. Basavaraja *et al* .(2008b) also noticed that *Bt* (Cry1Ac) became ineffective against *H. armigera* at 130 days of crop age and support the results achieved during present study. It was observed that parameters were increasing at 120 DAS on BGII genotypes but their values were not comparable with values of *Bt* and non *Bt* genotypes. This indicates that *Bt* toxin (Cry2Ab) might still be present in the BGII genotypes. As no assay (ELISA) was carried to find the exact level of the toxin in the crop so it is difficult to justify level of toxin. Mahon & Olsen (2009) found that in BGII genotypes cotton Cry 2Ab was present at higher level in the plant throughout the growing season.

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