The Pharma Innovation Journal 2023; 12(2): 3212-3217

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(2): 3212-3217

www.thepharmajournal.com
Received: 02-12-2022
Accepted: 09-01-2023

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# Optimizing the levels of fertilizer for *Bt* cotton hybrid: G. Cot Hy-10 (BG-II)

**Pawar SL, Sankat KB, Ramani HR and Patel MC**

**Abstract**
An experiment was conducted for three years from 2017-18 to 2019-20 at Main Cotton Research Station farm, Navsari Agricultural University, Surat (Gujarat). The purpose of the experiment was to work out optimum dose of major nutrients for *Bt* cotton hybrid (G. Cot Hy-10, BG-II) and assess the plant nutrient content, uptake by cotton crop as well as fertility status of soil. The statistical design of the experiment was factorial RBD with treatments comprising of three levels of nitrogen (N1: 180, N2: 240 and N3: 300 kg/ha) and potassium (K1: 0, K2: 30 and K3: 60 kg/ha) and two levels of phosphorus (P1: 0 and P2: 40 kg/ha). Each treatment was replicated three times. Based on the results of the three years experiment, fertilizer levels of N and P were found to significantly increase the seed cotton yield of *Bt*. cotton hybrid. Nitrogen levels N3 being at par with N2 both increased seed cotton yield as well as lint yield. Among phosphorus levels, P2 gave higher seed cotton as compared to no application of phosphorus fertilizer. Nitrogen levels significantly influenced the N content in seed and P content in stalk, while P levels significantly influenced the N content in seed and P content in both seed and stalk. Total uptakes of N and P were significantly influenced by all fertilizer levels and total K uptake by N levels only. Application of nitrogen @ 240 kg N/ha applied in 5 equal splits at 30, 60, 75, 90 and 105 DAS with basal application of phosphorus (@ 40 kg/ha) was found economical for getting higher seed cotton yield, net income with improvement in soil fertility.

**Keywords:** Optimizing, content, *Bt* cotton, N content

## Introduction
Gujarat state is a leading cotton producer in India. There has been remarkable increase in cotton area and productivity in Gujarat. During 1995-96, the area under cotton was 14.10 lakh ha with productivity of 0.265 lakh bales/ha per hectare (*Anon.*, 1995-96). At present, area under cotton is estimated to be around 22.71 hectares with productivity of 5.44 lakh bales/ha (*Anon*., 2020-21). The increase in cotton area and productivity is mainly attributed to replacing other cotton species with Bt cotton hybrids (resistant to boll worms) as well as straight varieties (non Bt cotton), better agronomic practices, development in irrigation facility. However, with the development of high yielding *Bt* cotton hybrids, the demand for soil nutrient is also another important factor to be considered. In India the increase in yield due to *Bt* cotton was up to 19-24% in cotton, due to sustainable reduction in pesticide use (Kathage and Qaim, 2012, Krishna and Qaim, 2012) [18, 21] and use of fertilizer have contributed to the yield increase over time (Gruere and Sun, 2012) [13]. Further, Kranthi and Stone (2020) [20] has recently reported fertilizer, irrigation (especially in Gujarat) and the new insecticides pushed cotton yields upward. Role of fertilizer application in cotton production is well known. Nitrogen fertilizer plays a key role in nutrition, development physiological processes, enzymatic activity, and improving fiber quality and yield of cotton crop. Nitrogen is a vital component of protein and chlorophyll production and is crucial for healthy growth and physiological development of cotton. Nitrogen promotes vegetative growth and increases the number of bolls set by increasing nodes and fruiting positions. The weight of lint has also been positively influenced by having an adequate supply of nitrogen. Phosphorus is another important factor to be considered for its role in cotton crop. It is important for root and seed development, energy transfer processes and normal growth of the crop. The third important nutrient is potassium which is directly involved in maintenance of osmotic potential and water uptake by the crop. Its role in a number of enzymes including those involved with energy transfer and improvement in quality of fibre. The cotton growing soils in South Gujarat are mostly medium to heavy black with moderate organic carbon content, medium in nitrogen, medium to high in phosphorus and high in potassium content.

Studies on available soil nutrient status in irrigated cotton in South Gujarat revealed that available N, $P_2O_5$ and $K_2O$ ranged from 171.2 to 386.0 kg $ha^{-1}$, 12.4 to 53.4 kg $ha^{-1}$ and 282 to 1180 kg $ha^{-1}$, respectively mean values of 241.3 kg $ha^{-1}$, 31.1 kg $ha^{-1}$ and 637 kg $ha^{-1}$ (Bambhaneeya *et al*., 2017) [5]. Looking to the importance nutrient role in cotton production and soil status of the major nutrients under South Gujarat, an experiment was planned to evaluate the levels of fertilizer on growth, yield and nutrients uptake of irrigated *Bt* cotton hybrid.

## Materials and Methods

The experiment was conducted at Main Cotton Research Station, NAU, Surat for three years (2017-18 to 2020-21). The design of the experiment was factorial randomized block with treatments consisting of three levels of nitrogen ($N_1$: 180, $N_2$: 240 and $N_3$: 300 kg/ha) and potassium ($K_1$: 0, $K_2$: 30 and $K_3$: 60 kg/ha) and two levels of phosphorus ($P_1$: 0 and $P_2$: 40 kg/ha). Each treatment was replicated three times. Nitrogen fertilizer (urea) was applied in five equal splits at 30, 60, 75, 90 and 105 days after sowing, while full dose of phosphorus (SSP) and potassium (MoP) fertilizers were applied as basal. The cotton hybrid seed G.Cot.Hy.10 (BG II) was selected for the experiment and sown during last week of June month at 120 cm x 45 cm plant spacing. The plant observation *viz.*, plant height, no. of sympodial branches, boll weight, no. of bolls per plant and seed cotton yield were recorded at the time of harvest of crop. Plant samples (leaf along stalk and seed) were collected and analyzed for nutrient content at harvest. Soil samples were collected at 0-30 cm depth after harvest of crop. Standard analytical procedures were followed for analysis of soil and plants as described by Jackson (1973) [17].

## Results and interpretation

**Growth parameters:** The pooled data regarding the effect of different fertilizer levels on growth parameters *viz.*, plant height (cm) and no. of sympodia are given in table 1. Nitrogen level was found to significantly affect the plant height and no. of sympodia. Significant higher plant height of 128.3 cm was recorded in $N_3$ as compared to $N_1$ (126.1 cm) and was found at par with $N_2$ (127.6 cm). Similarly, higher no. of sympodia was recorded in $N_3$ (25.7) which was found at par with $N_2$ (25.2) and significantly higher over $N_1$ (23.9). Growth and yield of cotton can be hampered due to limitation of available plant nutrients in the soil. Soomro and Waring (1987) reported significant increase in plant height due to increasing levels of N application. The sympodial branch is one of the important parameters which directly affect the cotton yield. The increase in number of sympodial branches with increasing N application rate has also been reported by Mukand *et al*. (1989) [23]. These results are in concurrence with those of Prasad (1998) [25], Alitabar *et al*. (2012) [1], Singh and Dhillon (2020) [36] who reported that increased nitrogen levels led to increased number of sympodial branches per plant. Phosphorus, potassium and other interaction effects failed to exert any significant difference on plant height and no. of sympodia.

## Yield parameters

The results of the boll weight and no. of bolls per plant as influenced by different fertilizer levels are given in table 1 (pooled over three years). Significant increase in average boll weight was recorded among the N levels. Nitrogen levels, $N_3$ (3.60 g) and $N_2$ (3.57 g) being statistically at par with each other, both recorded significantly higher boll weight as compared to $N_1$ (3.41 g). The increased leaf photosynthetic rate with the increase nitrogen rates might have resulted higher accumulation of metabolites ultimately impacted boll weight (Cadena and Cothren, 1995; Anjum *et al.*, 2007) [6, 2]. Similar findings with respect to increase in boll weight with increasing doses of N were observed by several researchers (Sawan *et al.*, 2006; Saleem *et al.*, 2010; Dong *et al*., 2012) [30, 32, 29, 8].

In case of no. of bolls, significant difference was observed due to nitrogen levels, $N_2$ (36.6) and $N_3$ (36.4) being at par with each other both recorded significant higher no. of bolls per plant as compared to $N_1$ (31.0). The increase in boll weight may be due to increase in N rate and increases mineral uptake, photosynthetic assimilation and its accumulation in sinks (Sawan *et al.*, 2006) [30]. Several studies have indicated that increase in N rates increased the no. of bolls per plant (Seadh *et al*., 2012; Zhao *et al.*, 2012; Emara and Abdel-Aal, 2017) [34, 39, 11].

## Seed cotton yield (kg/ha)

The pooled data pertaining to the effect of different fertilizer levels on seed cotton yield (SCY) is given in table 1. The crop receiving highest dose of nitrogen, $N_3$ (300 kg N/ha) recorded significant higher SCY (2339 kg/ha), closely followed by the nitrogen level $N_2$ (240 kg N/ha) which resulted seed cotton yield of 2302 kg/ha. The lowest seed cotton yield of 1921 kg/ha was recorded in crops receiving 180 kg N/ha ($N_1$). Since the difference in seed cotton yield under treatments receiving 240 kg N/ha ($N_2$) and 300 kg N/ha ($N_1$) was found non-significant, application of 240 kg N per ha was found optimum for *Bt* cotton hybrid. Several studies have indicated that higher crop yield was associated with increase N application. Gadhiya *et al.* (2009) [12] reported that the significantly higher seed cotton as well as stalk yield of Bt. cotton were recorded with higher level of N @ 240 kg/ha. Nelson (1949), Sawan *et al.* (1988) [24, 31] and Saleem *et al.* (2010) [29] showed that cotton yield and cotton seed N concentration increased linearly with increasing N fertilizer rates.

Among P levels, significant higher SCY was recorded in $P_2$ as compared to $P_1$ during. The significant higher yield recorded by $P_2$ was 2241 kg/ha as compared to $P_1$ (2134 kg/ha). In case of potassium fertilizer and interaction effect did not produce any significant difference on SCY. Phosphorus is essential element needed for cell division and has stimulating effect on increasing number of flower buds and bolls per plant (Russell, 1973) [28]. Sawan *et al.* (2008) [33] reported by that with increase in P level seed cotton yield also increased as compared to no P application.

**Lint yield (kg/ha):** The pooled results of the lint yield as influenced by different fertilizer levels are given in table 1. Significant difference in lint yield was observed due to application of different doses of nitrogen fertilizer, $N_3$ (766 kg/ha) and $N_2$ (761 kg/ha), both recorded significantly higher lint yield as compared to $N_1$ (625 kg/ha). The increase in lint yield is ultimately the result of increase in no. of bolls per plant, average boll weight and seed cotton yield. Similar finding was also reported by Seilsepour & Rashidi (2011) [35] that N application significantly increased the boll number, boll weight, seed cotton yield and lint yield.

**Table 1:** Effect of different fertilizer levels on plant biometric parameters and seed cotton yield (pooled over three years)

| Treatments | Plant height (cm) | | No. of sympodia | | Boll weight (g) | No. of bolls/plant | | | Seed cotton yield (kg/ha) | | Lint yield (kg/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N levels** | | | | | | | | | | | | |
| $N_1$: 180 kg/ha | 126.1 | | 23.9 | | 3.41 | 31.0 | | | 1921 | | 625 | |
| $N_2$: 240 kg/ha | 127.6 | | 25.2 | | 3.57 | 36.6 | | | 2302 | | 761 | |
| $N_3$: 300kg/ha | 128.3 | | 26.0 | | 3.60 | 36.4 | | | 2339 | | 766 | |
| S.Em ± | 0.82 | | 0.32 | | 0.027 | 0.56 | | | 34.57 | | 12.2 | |
| CD (0.05) | 2.3 | | 0.91 | | 0.08 | 1.6 | | | 97 | | 34.3 | |
| P levels | | | | | | | | | | | | |
| $P_1$: 0 kg/ha | 128.44 | | 24.8 | | 3.50 | 34.2 | | | 2134 | | 699 | |
| $P_2$: 40 kg/ha | 129.65 | | 25.3 | | 3.56 | 35.1 | | | 2241 | | 736 | |
| S.Em ± | 0.67 | | 0.26 | | 0.023 | 0.46 | | | 28.23 | | 10.0 | |
| CD (0.05) | NS | | NS | | NS | NS | | | 79 | | 28.0 | |
| K levels | | | | | | | | | | | | |
| $K_1$: 0 kg/ha | 128.1 | | 25.2 | | 3.51 | 34.0 | | | 2125 | | 695 | |
| $K_2$: 30 kg/ha | 129.1 | | 24.5 | | 3.53 | 34.6 | | | 2195 | | 725 | |
| $K_3$: 60kg/ha | 129.9 | | 25.5 | | 3.56 | 35.4 | | | 2242 | | 733 | |
| S.Em ± | 0.82 | | 0.32 | | 0.027 | 0.56 | | | 34.57 | | 12.2 | |
| CD (0.05) | NS | | NS | | NS | NS | | | NS | | NS | |
| Mean | 129.0 | | 25.0 | | 3.53 | 34.7 | | | 2187 | | 717 | |
| Source | Y | YxP | -- | Y | Y | Y | YxN | YxNxK | Y | YxN | Y | YxN |
| S.Em± | 0.82 | 1.16 | 0.56 | 0.32 | 0.059 | 0.56 | 0.98 | 1.69 | 34.57 | 59.88 | 12.24 | 21.21 |
| CD (0.05) | 2.3 | 3.24 | 1.57 | 0.9 | NS | 1.6 | 2.7 | 4.7 | 97 | 168 | 34 | 29 |
| Interactions | -- | | NxK | | -- | -- | | | -- | | -- | |
| CV (%) | 4.6 | | 7.3 | | 5.5 | 11.9 | | | 11.6 | | | |

**N, P and K content (%) in cotton seed and stalk**

The pooled results on content of N, P and K in seed and stalk of cotton are given in table 2. Nitrogen content in seed was significantly by N levels. Significant higher N content was recorded in $N_3$ (2.07%) as compared to $N_1$ (1.93%), but was found at par with $N_2$ (2.04%). Egelkraut *et al*. (2004) [9] reported that the N concentration in the cottonseed increased linearly with increasing N fertilizer rates and maximum yields were obtained at less than maximum seed N concentration. Further, they reported that critical N concentration of 35 g/kg exists for cottonseeds, above which no yield response to N fertilizer is likely. In our case the optimum concentration of N in cotton seed was 20.4 g/kg seed. This difference in N concentration in cottonseed could be due to numerous factors *viz.*, split application, timing and quantity of fertilizer application, variety, and availability of water (Elmore *et al*., 1979; Guinn and Mauney, 1984; Hunt *et al*., 1998) [10, 14, 15].

Stalk N content was found non-significant due to N levels. P and K levels did not exert any significant difference on N content both in seed and stalk of cotton. Phosphorus levels significantly affected the P content in seed, where $P_2$ recorded significant higher content of 0.65% as compared to $P_1$ (0.61%). Similar was the case for P content in cotton stalk with $P_2$ recording significant higher content (0.16%) as compared to $P_1$ (0.15%). Phosphorus plays a key role in cell division and has stimulating effect increasing flower buds and bolls per plant (Russell, 1973) [28]. Deshpande and Lakhdive (1994) [7] reported that P application increased P content and uptake by leaf, stem and cotton seed.

In case of K content, P levels significantly influenced its content in seed. Significant higher K content was recorded in $P_1$ (0.83%) as compared to $P_2$ (0.80%). Increasing P levels might have contributed to higher biomass which might have favored the nutrients and photosynthates translocation toward the reproductive organs rather than vegetative parts (Stewart *et al.*, 2005; Iqbal *et al.*, 2020) [38, 16].

**Total uptake of N, P and K by cotton plant**

The data with respect to total N, P and K uptake by cotton crop is given in table 2. Total uptake of N was significantly influenced by N, P and K levels. Nitrogen level $N_3$ recorded significant higher total N uptake (76.2 kg/ha) as compared to both $N_1$ (58.0 kg/ha) as well as $N_2$ (71.1 kg/ha). However, the rate of increase of total N uptake decreased with increasing rate N application. Increase in N uptake with increasing doses of N levels was also reported by Malik *et al.* (2021) [22]. Among P levels, $P_2$ recorded significant higher total N uptake of 70.6 kg/ha as compared to $P_1$ (66.2 kg/ha). Phosphorus significantly increases the nitrogen uptake, chlorophyll content and dry matter (Sawan *et al.*, 2008) [33].

**Table 2:** Effect of different fertilizer levels on N, P & K content (%) in cotton seed and stalk and total uptake (kg/ha) by cotton crop (pooled over 3 years)

| Treatments | N content (%) | | P content (%) | | K content (%) | | Total uptake (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Seed | Stalk | Seed | Stalk | Seed | Stalk | N | P | K |
| **N levels** | | | | | | | | | |
| $N_1$: 180 kg/ha | 1.93 | 0.46 | 0.64 | 0.16 | 0.82 | 0.50 | 58.0 | 19.4 | 38.1 |
| $N_2$: 240 kg/ha | 2.04 | 0.46 | 0.63 | 0.16 | 0.81 | 0.49 | 71.1 | 22.5 | 43.9 |
| $N_3$: 300kg/ha | 2.07 | 0.47 | 0.62 | 0.15 | 0.81 | 0.50 | 76.2 | 23.6 | 47.8 |
| S.Em ± | 0.02 | 0.005 | 0.01 | 0.002 | 0.01 | 0.004 | 1.09 | 0.37 | 0.66 |
| CD (0.05) | 0.05 | NS | NS | 0.01 | NS | NS | 3.0 | 1.0 | 1.9 |
| P levels | | | | | | | | | |
| $P_1$: 0 kg/ha | 1.99 | 0.46 | 0.61 | 0.15 | 0.83 | 0.49 | 66.2 | 20.9 | 42.7 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $P_2$: 40 kg/ha | 2.04 | 0.47 | 0.65 | 0.16 | 0.80 | 0.49 | 70.6 | 22.9 | 43.9 |
| S.Em ± | 0.02 | 0.004 | 0.01 | 0.001 | 0.01 | 0.004 | 0.89 | 0.30 | 0.54 |
| CD (0.05) | 0.04 | NS | 0.02 | 0.004 | 0.02 | NS | 2.5 | 0.8 | NS |
| K levels | | | | | | | | | |
| $K_1$: 0 kg/ha | 2.00 | 0.47 | 0.63 | 0.15 | 0.82 | 0.50 | 66.4 | 20.9 | 42.2 |
| $K_2$: 30 kg/ha | 1.99 | 0.47 | 0.64 | 0.16 | 0.82 | 0.49 | 68.2 | 22.2 | 43.4 |
| $K_3$: 60kg/ha | 2.04 | 0.46 | 0.62 | 0.16 | 0.81 | 0.49 | 70.6 | 22.5 | 44.3 |
| S.Em ± | 0.02 | 0.005 | 0.01 | 0.002 | 0.01 | 0.004 | 1.09 | 0.37 | 0.66 |
| CD (0.05) | NS | NS | NS | NS | NS | NS | 3.05 | 1.03 | NS |
| Mean | 2.01 | 0.47 | 0.63 | 0.16 | 0.81 | 0.49 | 68.4 | 21.9 | 43.3 |
| Interactions | PxK, YxN | YxN | -- | -- | -- | -- | YxN | YxP | -- |
| Year effect | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| S.Em ± | 0.02 | 0.005 | 0.007 | 0.002 | 0.01 | 0.004 | 1.09 | 0.37 | 0.66 |
| CD (0.05) | NS | 0.01 | 0.02 | 0.01 | 0.02 | 0.012 | 3.05 | NS | 1.9 |
| CV (%) | 7.10 | 7.68 | 8.51 | 8.60 | 6.05 | 6.60 | 11.7 | 12.3 | 11.2 |

Increasing K levels showed corresponding increase in total N uptake by cotton crop. Significant higher total N uptake was recorded in $K_3$ (70.6 kg/ha) as compared to $K_1$ (66.4 kg/ha), but was found statistically at par with $K_2$ (68.2 kg/ha). Similar finding was reported by Khalifa *et al.* (2012) [19] that N accumulation increased as a result of the addition of different rates of K fertilizer.

The results of total P uptake by cotton crop indicated similar trend to that of total N uptake. Among N levels, significant higher total P uptake was recorded in $N_3$ (23.6 kg/ha) as compared to $N_1$ (19.4 kg/ha) and $N_2$ (22.5 kg/ha), while among P levels, $P_2$ recorded significant higher total P uptake (22.9 kg/ha) as compared to $P_1$ (20.9 kg/ha). Increase in biomass production due to increasing levels of N fertilizer might have favored higher uptake of P by the cotton crop. Synergistic interaction effect N and P was recorded by Raghuvanshi *et al*. (1989) [26] in cotton. Higher uptake of P due to application of P fertilizer in cotton was also reported by Iqbal *et al*. (2020) [16], where the reason they ascribed was that increase the available P contents in the soil, led to well-established transport of water and nutrients towards the areal parts of the plant.

In case of effect of K levels on total P uptake, $K_3$ and $K_2$ being at par with each other both recorded significant higher values of 22.5 and 22.2 kg/ha as compared to $K_1$ (20.9 kg/ha).

Total K uptake by cotton crop was significantly affected by N levels only. Significant higher K uptake was recorded in $N_3$ (47.8 kg/ha) as compared to $N_2$ (43.9 kg/ha) as well as $N_1$ (38.1 kg/ha). Increase in levels of N application increased K uptake by cotton crop indicating the positive role of N in absorption of K by cotton crop. Similar finding was also reported by Khalifa *et al.* (2012) [19], indicating that the greater level of N fertilizer improved KUE within each K treatment.

**Available N, $P_2O_5$ and $K_2O$ content (kg/ha) in soil**

Soil analysis (0-30 cm depth) for available nutrients *viz*., N, $P_2O_5$ and $K_2O$ was done after harvest of the crop (Table 3). The results indicated that, increase in nitrogen fertilizer levels significantly the available N content in soil. During 2017-18, significant higher available N content was recorded in $N_3$ (245.4 kg/ha) as compared to $N_1$ (228.1 kg/ha), but was found at par with $N_2$ (239.4 kg/ha). Similar was the case during 2018-19 and 2019-20, where $N_3$ recorded significant higher available N content in soil as compared to $N_1$ but was found at par with $N_2$. The effect of P and K fertilizer levels did not produce any significant differences on available N content in soil. Increase in N doses improved soil N status in soil.

Available $P_2O_5$ content in soil was significantly affected by P levels during 2017-18 and 2018-19. During both the years significant higher available $P_2O_5$ content was recorded in $P_2$ (31.7 and 29.9 kg/ha, respectively) as compared to $P_1$ (28.9 and 27.0 kg/ha, respectively). No significant difference on $P_2O_5$ in soil was observed due to N and K application during all three years of the experiment. Significant increase in available phosphorus status ($P_2O_5$ kg/ha) in soils with increasing levels of phosphorus as compared to control of mono-cropped cotton was observed by Rao *et al.* (2017) [27].

In case of available soil $K_2O$ content, none of the fertilizer levels affected significantly. Interaction of N, P and K fertilizer levels did not produce any significant difference on available N, $P_2O_5$ and $K_2O$ content in soil.

**Table 3:** Effect of N, P and K levels on available soil N, $P_2O_5$ and $K_2O$ content (kg/ha)

| Treatment | Avail. N (kg/ha) | | | Avail. $P_2O_5$ (kg/ha) | | | Avail. $K_2O$ (kg/ha | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2017-18 | 2018-19 | 2019-20 | 2017-18 | 2018-19 | 2019-20 | 2017-18 | 2018-19 | 2019-20 |
| ***Nitrogen levels*** | | | | | | | | | |
| N1 (180 kg/ha) | 228.1 | 221.3 | 230.3 | 32.5 | 31.6 | 30.1 | 360.4 | 402.2 | 472.8 |
| N2 (240 kg/ha) | 239.4 | 230.3 | 240.7 | 28.7 | 29.6 | 27.6 | 377.5 | 388.9 | 487.1 |
| N3 (300 kg/ha) | 245.4 | 235.5 | 251.0 | 30.8 | 29.8 | 28.0 | 362.2 | 387.3 | 504.9 |
| S.Em± | 4.58 | 3.64 | 4.32 | 1.3 | 1.0 | 1.1 | 12.8 | 7.5 | 9.4 |
| CD (0.05) | 13.2 | 10.5 | 12.4 | NS | NS | NS | NS | NS | NS |
| *Phosphorus levels* | | | | | | | | | |
| P1 (0 kg/ha) | 233.3 | 229.9 | 243.4 | 29.3 | 28.9 | 27.3 | 370.1 | 397.8 | 483.9 |
| P2 (40 kg/ha) | 242.0 | 228.1 | 237.9 | 32.1 | 31.7 | 29.9 | 363.4 | 387.8 | 492.7 |
| S.Em± | 3.74 | 2.97 | 3.52 | 1.1 | 0.9 | 0.9 | 10.4 | 6.2 | 7.7 |
| CD (0.05) | NS | NS | NS | NS | 2.4 | 2.6 | NS | NS | NS |
| *Potassium levels* | | | | | | | | | |
| K1 (0 kg/ha) | 234.6 | 227.2 | 240.7 | 29.4 | 30.3 | 28.5 | 360.6 | 381.0 | 476.0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| K2 (30 kg/ha) | 240.7 | 229.6 | 234.6 | 32.3 | 30.5 | 29.0 | 361.1 | 395.2 | 491.7 |
| K3 (60 kg/ha) | 237.6 | 230.3 | 246.7 | 30.3 | 30.2 | 28.3 | 378.4 | 402.2 | 497.2 |
| S.Em± | 4.58 | 3.64 | 4.32 | 1.3 | 1.0 | 1.1 | 12.8 | 7.5 | 9.4 |
| CD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| Mean | 237.6 | 229.0 | 240.7 | 30.7 | 30.3 | 28.6 | 366.7 | 392.8 | 488.3 |
| Interactions | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| CV (%) | 8.2 | 6.7 | 7.6 | 18.1 | 14.6 | 16.3 | 14.8 | 8.1 | 8.2 |
| Initial | 226.74 | 209.63 | 233.48 | 26.57 | 29.21 | 25.98 | 354.6 | 390.5 | 474.0 |

**Table 4:** Economics of different treatments (Pooled over 3 years)

| Treatments | Seed cotton yield (kg/ha) | Cost of cultivation (Rs./ha) | Gross income (Rs./ha) | Net income (Rs./ha) | B:C Ratio |
|---|---|---|---|---|---|
| N levels | | | | | |
| $N_1$: 180 kg/ha | 1921 | 51403 | 105654 | 54251 | 1.06 |
| $N_2$: 240 kg/ha | 2302 | 55354 | 126620 | 71267 | 1.29 |
| $N_3$: 300kg/ha | 2339 | 56346 | 128622 | 72276 | 1.28 |
| P levels | | | | | |
| $P_1$: 0 kg/ha | 2134 | 52454 | 117364 | 64910 | 1.24 |
| $P_2$: 40 kg/ha | 2241 | 55984 | 123234 | 67250 | 1.20 |
| K levels | | | | | |
| $K_1$: 0 kg/ha | 2125 | 52703 | 116899 | 64196 | 1.22 |
| $K_2$: 30 kg/ha | 2195 | 54709 | 120705 | 65997 | 1.21 |
| $K_3$ : 60kg/ha | 2242 | 54801 | 123292 | 68491 | 1.25 |

Selling price of seed cotton @ Rs.55/kg

## Cost economics

The economics of seed cotton yield (average of three years) is given in table 4. Since the interaction of different fertilizer levels were found non-significant on seed cotton yield, the economics was calculated on individual treatment basis. The cost of cultivation among N levels was Rs.51403/ha in $N_1$, Rs.55354/ha in $N_2$ and Rs.56346/ha in $N_3$. Higher gross and net income was realized from $N_2$ (Rs.128622/ha and R0s.72276/ha) closely followed by $N_2$ (Rs.126620/ha and Rs.71267/ha). The higher B:C ratio was achieved in $N_2$ (1.29) closely followed by $N_3$ (1.28), while the lowest B:C ratio was found in $N_1$ (1.06). Among P levels, the cost of cultivation was worked in $P_1$ and $P_2$ was Rs.52454/ha and Rs.55984/ha, respectively. Higher gross income (Rs.123234/ha) and net income (Rs.67250/ha) was realized from $P_2$ as compared to $P_1$ (Rs.117364 and Rs.64910/ha). However, the B:C ratio computed was higher in $P_1$ (1.24) as compared to $P_2$ (1.20).

In case of K levels, its application on seed cotton yield was found non-significant on seed cotton yield. The cost of cultivation, gross and net income realization increased with doses of K levels. The net income realized in $K_1$, $K_2$ and $K_3$ was Rs.64196/ha, Rs.65997/ha and Rs.68491/ha, respectively. The corresponding B:C ratio worked out was 1.22, 1.21 and 1.25.

## Conclusions

Based on the results of the three years experiment, fertilizer levels *viz*., nitrogen and phosphorus were significantly found to increase the yield of Bt. cotton hybrid (G.Cot. Hy. 10, BG-II). Nitrogen level $N_3$ (@ 300 N kg/ha) being at par with $N_2$ (@ 240 kg N/ha) both increased seed cotton yield as well as lint yield of Bt. Hybrid as compared to $N_1$ (@180 kg N/ha). Among phosphorus levels, $P_2$ (@ 40 kg $P_2O_5$/ha) gave higher seed cotton as compared to no application of phosphorus fertilizer. Application of nitrogen @ 240 kg N/ha applied in 5 equal splits at 30, 60, 75, 90 and 105 DAS with basal application of phosphorus (@ 40 kg/ha) was found to have pronounced effect for getting seed cotton yield as well as in realizing higher income. Application of above recommended fertilizer also improved the nutrient status in the soil.

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