Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(2): 16-21

Received: 04-01-2017
Accepted: 05-02-2017

S Anusha
Part of M.Sc (Ag) thesis submitted by the senior author to Acharya N G Ranga Agricultural University, Hyderabad, Telangana, India

GMV Prasada Rao
Principle Scientist, RARS, Lam, Guntur, Andhra Pradesh, India

DV Sai Ram Kumar
Associate Professor, Department of Entomology, Agricultural College, Bapatla, Andhra Pradesh, India

Correspondence
S Anusha
Part of M.Sc (Ag) thesis submitted by the senior author to Acharya N G Ranga Agricultural University, Hyderabad, Telangana, India

Influence of different nitrogen levels on the management of Bt cotton sucking pests

S Anusha, GMV Prasada Rao and DV Sai Ram Kumar

Abstract
An experiment was conducted in order to manage different sucking pests in plots under different increasing nitrogen doses 0, 120, 150, 180, 225, 280, 350, 440 kg ha^{-1} in Jaadu BG-II cotton hybrid plants. The sucking pest incidence was low till 38 DAS and from thereafter the leafhopper population crossed ETL at 48 DAS i.e. 6.73 to 17.83 leafhoppers per three leaves and at 97 DAS aphids i.e. 32.93 to 160 aphids per three leaves and leafhopper population i.e. 3.9 to 8.6 leafhoppers per three leaves, crossed ETL from 0 to 440 kg N ha^{-1} respectively. The plot was sprayed with fipronil 5% SC @ 50 g a.i. ha^{-1} at 48 DAS and second with acephate 75% SP @ 750 g a.i. ha^{-1} at 97 DAS.

Keywords: Bt cotton sucking pests, nitrogen levels, ETL, pest management

1. Introduction
Commercialization of *Bt* transgenic genotypes in 2002, provided an effective method for lepidopteran pest control and also served for the increase in area and production of cotton in India. Adoption of *Bt* cotton has not only changed the cultivation profile, but also the pest scenario. While there is a decline in the pest status of bollworms; the sap feeders, *viz*. aphids, jassids, mirids and mealy bugs are emerging as serious pests [1]. Thus, insect pests remain a main determinant factor in sustainable cotton production. Fertilizer application plays an important role in raising cotton production. Nitrogen is utilized in cotton plant to greater extent and is generally considered the most important nutrient for maximizing the cotton yield. In recent years there has been tendency among cotton growers to increase maximum yield potentials by applying higher amount than that recommended nitrogen rates. *Bt* cotton at higher nitrogen levels (25% more than recommended dose of N) produced significantly higher yields [2].
Bt cotton plants supplied with higher nitrogen levels provide congenial substratum for growth and development of sucking pests throughout the crop growth period. In plant-herbivore interactions, Nitrogen availability can alter quality of the plant [3]. The heavy application of nitrogen fertilizer alter morphological, biochemical and physiological characters of host plants and improve nutritional conditions for herbivores [4] and also increases herbivore feeding preference, food consumption, survival, growth, reproduction, and population density [5]. Such conditions need more insecticidal application against sucking pests compared to Non-*Bt* era. Hence, knowledge on pest management along with their defenders influenced by fertilizer levels especially nitrogen will help in understanding and devising suitable management strategies for sucking pests in *Bt*-cotton. Keeping this in view, field study was conducted at RARS, Lam to evaluate the effect of nitrogen on management of insect pests in *Bt* cotton.

2. Materials and Methods
2.1 Lay out: Field experiment was conducted at Regional Agricultural Research Station, Lam, Guntur during *Kharif* 2013 in a randomised block design.

2.2 Treatments: seven treatments of different nitrogen levels *i.e.* 120, 150, 180, 225, 280, 350 and 440 kg N ha^{-1}. They were 3 replicates of each treatment and a control consisting in 0 kg ha^{-1} N.

2.3 Spacing: The crop was sown in the month of August and distance between rows and plants was 105 cm and 45 cm respectively; crop received nitrogen in three splits at 30 DAS, 60 DAS and 90 DAS.

The crop was maintained under protected conditions. In protected condition the crop was protected against insect pests by seed treatment and by giving insecticidal sprays as per the ANGRAU recommendations. The insecticides were sprayed on crop whenever the insect population reached ETL (Economic Threshold Limit).

2.4 Observations: Sucking insect pest incidence was recorded from top, middle and bottom leaves, for natural enemies *viz*., spiders and coccinellids recorded from whole plant on five randomly selected plants in each plot at weekly interval starting from three weeks after sowing.

2.5 Statistical analysis: The average of all the five observations was calculated and expressed as mean population. The data pertaining to the population of pests and natural enemies was subjected to square root transformation from respective treatments. Analysis of variance was done with the transformed data by using AGRISTAT statistical package.

3. Results and Discussion

An experiment was conducted to manage different sucking pests in plots which received different nitrogen doses. In this experiment two sprayings; one with fipronil 5% SC @ 40 g a.i. ha^{-1} at 48 DAS and second with acephate 75% SP @ 750 g a.i. ha^{-1} at 97 DAS were imposed to manage the sucking pests particularly, leafhoppers and aphids with different nitrogen doses. The objective was to ascertain the influence of different nitrogen levels on management of sucking insect pests. The data on sucking pests such as aphid *Aphis gossypii*, leafhopper *Amrasca biguttula biguttula*, thrips *Thrips tabaci* and whitefly *Bemisia tabaci* was documented along with natural enemies *viz*., spiders and coccinellid beetles, regularly on weekly interval from 31 DAS in a field adopting randomised block design with eight nitrogen levels as treatments replicated three times during *Kharif* 2013.

The sucking pest incidence was very low till 38 DAS and from thereafter the population levels increased (Table 1). The low population at early stages of crop growth period may be because of popular test hybrid used which is tolerant to leafhoppers and use of pre-treated seed with imidacloprid 70 WS @ 5 g / kg. Research studies says that seed treatment with imidacloprid 70 WS @ 5 g kg^{-1} was found effective till 40 DAS, afterwards leafhopper incidence increased above ETL level [6]. Likewise, imidacloprid at 7.5 g a.i. / kg seed exhibited remarkable effects on incidence of early sucking pests in cotton and recorded low population density of whitefly *B. tabaci*, aphids *A. gossypii* and thrips, *T. tabaci* upto 45 days [7].

The first spraying with fipronil 5% SC @ 40 g a.i. ha^{-1} was imposed at 48 DAS to manage the leafhopper population. At this stage highest leafhopper population of 14.83 per three leaves were recorded at 440 kg N ha^{-1} and lowest population of 6.73 per three leaves were recorded at 0 kg N ha^{-1}. Perusal of the data collected after spray (60 DAS) indicated that population reached below ETL in all the treatments and ranged from 1.00 to 3.13 leafhoppers per three leaves. The lowest population of 1.00 per three leaves were recorded in without nitrogen treatment (0 kg ha^{-1}) and highest population of 3.13 per three leaves were recorded in 440 kg N ha^{-1} applied treatment (Table 1). These results are in conformity with research work that, treatment with fipronil 5% SC @ 50-75 g a.i ha^{-1} was effective in lowering the population of thrips, aphids and jassids infesting cotton [8] and also with fipronil at 50 g a.i. ha^{-1} was effective in lowering the population of leafhopper infesting cotton [9].

Second spray with acephate 75% SP @ 750 g a.i. ha^{-1} was imposed at 97 DAS because the aphid and leafhopper population crossed ETL in all the treatments. The aphid population at 97 DAS ranged from 32.93 to 160.00 per three leaves (Table 2). Data documented at seven days after spray (104 DAS) indicated reduction in population to below ETL levels in all the treatments. Population ranged from 8.53 to 29.67 aphids per three leaves recorded in all the treatments (from 0 kg N ha^{-1} to 440 kg N ha^{-1}) (Table 2). This is in conformity with the results that two applications of acephate @ 1.5 g / L at 3 weeks interval was most effective against aphids, jassids and whiteflies [10].

Similarly, leafhopper population at 97 DAS ranged from 3.90 to 8.60 per three leaves (Table 1). Data documented at seven days after spray (104 DAS) indicated reduction in population to below ETL levels in all the treatments. Population ranged from 0.27 to 0.87 in all the treatments (from 0 kg N ha^{-1} to 440 kg N ha^{-1}) (Table 1).

This indicates that increase in nitrogen doses is not posing a major threat on managing the leafhoppers and aphids at 48 DAS by using fipronil 5% SC @ 40 g a.i. ha^{-1} and at 97 DAS by spraying acephate 75% SP @ 750 g a.i. ha^{-1} during *Kharif* 2013 at RARS farm, Lam, Guntur.

The incidence of other sucking insect pests *viz*., thrips and whiteflies was below ETL throughout the crop growth period (Table 3 and 4). Nitrogen had effect on population of spiders and coccinellid beetles. The mean population increased from 0.27 to 1.89 spiders per plant and 0.04 to 0.38 coccinellid beetles per plant as nitrogen dose increased from 0 kg ha^{-1} to 440 kg ha^{-1} (Table 5 and 6). Abundance of natural enemies increased with increase in nitrogen may be due to maximum population of sucking insect pests (aphids and leafhoppers). Because, dynamics of predators was prey density dependent which is confirmed by a study, saying positive correlation between populations of predators and aphid on both *Bt* and non- *Bt* cotton [11]. These results are in conformity with work that closer spacing of 90 X 45 cm and higher dose of 200 kg N ha^{-1} recorded more number of spiders and coccinellids [12].

Non significant differences were observed with reference to population of natural enemies such as spiders and coccinellid beetles before and after spray of insecticides in different nitrogen treatments (Table 5 and 6).

It is clearly evidenced from the results obtained in this study that enhanced activity of insect pests and natural enemies was evident at higher N levels. This may be due to nitrogen induced changes in food quality, quantity and phenology, which alters herbivore population dynamics. Increase N leads to increase in foliar concentration of N and free amino acids thereby concentrations of base cations Ca and Mg will decrease this subsequently disrupts plant cell wall membranes which may predispose plants to insects and pathogens. This enhances the activity of insects in terms of their development and reproduction and attains pest status.

Table 1: Incidence of leafhoppers on Jaadu BG-II cotton hybrid as influenced by nitrogen levels (protected)

Mean population of leafhoppers / three leaves															
Treatment	**31***	**38**	**48****	**60**	**71**	**76**	**83**	**90**	**97*****	**104**	**111**	**117**	**132**	**138**	**Over all mean**
T_1 – 120 kg N ha^{-1} (RDF)	3.53 (2.13) ^{b}	4.83	9.00 (3.16) ^{ab}	1.87	2.13 (1.77)^{ab}	2.40 (1.84) ^{ab}	3.67	4.47 (2.34) ^{b}	6.00	0.40	3.73	2.40	3.80	3.67	3.48 (2.12) ^{b}
T_2 – 150 kg N ha^{-1}	3.73 (2.18) ^{bc}	4.87	10.67 (3.42) ^{bc}	2.13	2.50 (1.87) ^{bc}	2.53 (1.88) ^{ab}	3.87	4.53 (2.35) ^{b}	6.07	0.53	3.87	2.60	3.87	3.80	3.73 (2.17) ^{bc}
T_3 – 180 kg N ha^{-1}	3.93 (2.22) ^{bc}	4.97	12.40 (3.66) ^{cd}	2.13	2.77 (1.94) ^{bc}	3.00 (2.00) ^{abc}	4.13	4.77 (2.40) ^{b}	6.47	0.60	4.20	2.67	3.93	3.53	3.98 (2.23) ^{bcd}
T_4 – 225 kg N ha^{-1}	3.93 (2.22) ^{bc}	5.03	12.50 (3.67) ^{cd}	2.33	2.87 (1.97) ^{bcd}	3.07 (2.02) ^{abc}	4.47	5.27 (2.50) ^{b}	7.60	0.60	4.53	2.80	4.07	3.73	4.21 (2.28) ^{bcde}
T_5 – 280 kg N ha^{-1}	4.47 (2.34) ^{bc}	5.27	12.87 (3.72) ^{cd}	2.40	3.17 (2.04) ^{bcd}	3.53 (2.13) ^{bc}	5.00	5.53 (2.56) ^{b}	8.07	0.73	4.60	2.80	4.20	4.13	4.48 (2.34) ^{cde}
T_6 - 350 kg N ha^{-1}	4.60 (2.37) ^{bc}	5.33	13.30 (3.78) ^{cd}	2.93	3.57 (2.14) ^{cd}	4.27 (2.29) ^{c}	5.27	5.80 (2.61) ^{b}	8.13	0.80	4.87	2.87	4.93	4.13	4.74 (2.40) ^{de}
T_7 – 440 kg N ha^{-1}	4.73 (2.39) ^{c}	5.50	14.83 (3.98) ^{d}	3.13	3.97 (2.23) ^{d}	4.67 (2.38) ^{c}	5.40	5.93 (2.63) ^{b}	8.60	0.87	4.87	2.93	4.93	4.33	4.99 (2.45) ^{e}
T_8 – 0 kg N ha^{-1}	2.27 (1.81) ^{a}	3.60	6.73 (2.78) ^{a}	1.00	1.33 (1.53) ^{a}	1.73 (1.65) ^{a}	2.13	2.30 (1.82) ^{a}	3.90	0.27	2.70	2.33	3.73	3.13	2.51 (1.87) ^{a}
CD (P=0.05)	0.24	NS	0.43	NS	0.28	0.38	NS	0.32	NS	NS	NS	NS	NS	NS	0.20
CV%	6.31	7.57	6.97	13.64	8.37	10.65	13.45	7.72	12.64	14.16	8.18	9.06	7.94	6.07	5.19

Figures in parentheses are $\sqrt{x+1}$ values
NS : Non significant
RDF : Recommended Dose of Fertilizer
Numbers with same superscript are not statistically different
*Days After Sowing
** Fipronil 5SC @ 40 g a.i./ha was sprayed
*** Acephate 75 SP @ 750 g a.i./ha was sprayed

Table 2: Incidence of aphids on Jaadu BG-II cotton hybrid as influenced by nitrogen levels (protected)

Mean population of aphids / three leaves															
Treatment	**31***	**38**	**48****	**60**	**71**	**76**	**83**	**90**	**97*****	**104**	**111**	**117**	**132**	**138**	**Over all mean**
T_1 – 120 kg N ha^{-1} (RDF)	2.87 (1.97) ^{ab}	1.60 (1.61) ^{ab}	4.47 (2.34) ^{b}	0.80 (1.34) ^{ab}	5.00 (2.45) ^{b}	5.60 (2.57) ^{b}	5.07 (2.46) ^{ab}	15.00 (4.00) ^{ab}	53.53 (7.38) ^{b}	12.87 (3.72) ^{ab}	22.27 (4.82) ^{b}	22.40 (4.84) ^{ab}	25.33 (5.13) ^{b}	24.23 (5.02) ^{ab}	13.47 (3.80) ^{b}
T_2 – 150 kg N ha^{-1}	3.80 (2.19) ^{b}	1.87 (1.69) ^{ab}	4.73 (2.39) ^{b}	1.07 (1.44) ^{abc}	6.20 (2.68) ^{c}	5.67 (2.58) ^{b}	7.07 (2.84) ^{bc}	18.67 (4.43) ^{bc}	65.83 (8.18) ^{bc}	14.80 (3.97) ^{abc}	23.67 (4.97) ^{bc}	24.67 (5.07) ^{bc}	25.67 (5.16) ^{b}	24.67 (5.07) ^{ab}	15.25 (4.03)^{b}
T_3 – 180 kg N ha^{-1}	3.87 (2.21) ^{b}	2.07 (1.75) ^{bc}	4.73 (2.39) ^{b}	1.40 (1.55) ^{bc}	6.67 (2.77) ^{cd}	6.00 (2.65) ^{b}	7.30 (2.88) ^{c}	19.00 (4.47) ^{bc}	67.17 (8.26) ^{bc}	15.07 (4.01) ^{abc}	24.27 (5.03) ^{bcd}	24.93 (5.09) ^{bc}	26.00 (5.20) ^{b}	27.00 (5.29) ^{bc}	15.71 (4.09)^{b}
T_4 – 225 kg N ha^{-1}	4.33 (2.31) ^{bc}	2.33 (1.83) ^{bc}	4.87 (2.42) ^{b}	1.67 (1.63) ^{cd}	7.47 (2.91) ^{de}	7.03 (2.83) ^{b}	7.47 (2.91) ^{c}	21.67 (4.76) ^{bc}	73.83 (8.65)^{c}	20.07 (4.59)^{bc}	25.60 (5.16) ^{bcd}	26.00 (5.20) b^{c}	26.89 (5.28) ^{b}	25.67 (5.16) ^{abc}	17.04 (4.25)^{bc}
T_5 – 280 kg N ha^{-1}	4.47 (2.34) ^{bc}	3.00 (2.00) ^{c}	5.00 (2.45) ^{b}	2.60 (1.90) ^{de}	7.93 (2.99) ^{def}	9.27 (3.20) ^{c}	8.13 (3.02) ^{cd}	25.33 (5.13) ^{cd}	112.67 (10.66) ^{d}	22.07 (4.80) ^{c}	26.33 (5.23) ^{cd}	26.67 (5.26) ^{bc}	27.07 (5.30) ^{b}	27.50 (5.34) ^{bc}	20.62 (4.65)^{cd}
T_6 - 350 kg N ha^{-1}	4.53 (2.35) ^{bc}	4.33 (2.31) ^{d}	5.33 (2.52) ^{b}	2.70 (1.92) ^{e}	8.00 (3.00) ^{ef}	9.57 (3.25) ^{c}	10.43 (3.38) ^{de}	27.00 (5.29) ^{cd}	116.67 (10.85) ^{d}	28.47 (6.64) ^{d}	26.73 (5.27) ^{cd}	26.80 (5.27) ^{bc}	28.20 (5.40) ^{b}	29.16 (5.49) ^{c}	21.92 (4.79)^{d}
T_7 – 440 kg N ha^{-1}	6.40 (2.72) ^{c}	4.47 (2.34) ^{d}	5.80 (2.61) ^{b}	3.00 (2.00) ^{e}	9.00 (3.16) ^{f}	10.33 (3.37) ^{c}	12.67 (3.70) ^{e}	35.47 (6.04) ^{d}	160.00 (12.69) ^{e}	29.67 (7.22) ^{d}	28.00 (5.39) ^{d}	28.50 (5.43) ^{c}	29.00 (5.48) ^{b}	29.67 (5.54)^{e}	26.20 (5.22)^{e}
T_8 – 0 kg N ha^{-1}	1.67 (1.63) ^{a}	1.07 (1.44) ^{a}	3.00 (2.00) ^{a}	0.60 (1.26) ^{a}	3.67 (2.16) ^{a}	3.87 (2.21) ^{a}	3.93 (2.22) ^{a}	8.03 (3.01) ^{a}	32.93 (5.83) ^{a}	8.53 (3.09) ^{a}	17.17 (4.26) ^{a}	19.03 (4.48) ^{a}	19.00 (4.47) ^{a}	22.00 (4.80) ^{a}	9.67 (3.27)^{a}
CD (P=0.05)	0.48	0.26	0.31	0.28	0.22	0.27	0.38	1.10	1.22	0.94	0.38	0.47	0.53	0.38	0.48
CV%	12.55	7.86	7.38	9.8	4.65	5.37	7.43	13.67	7.73	12.35	4.29	5.28	5.82	4.12	6.40

Figures in parentheses are $\sqrt{x+1}$ values.
NS : Non significant
RDF : Recommended Dose of Fertilizer
Numbers with same superscript are not statistically different.
*Days After Sowing
** Fipronil 5SC @ 40 g a.i./ha was sprayed
*** Acephate 75 SP @ 750 g a.i./ha was sprayed

Table 3: Incidence of thrips on Jaadu BG-II cotton hybrid as influenced by nitrogen levels (protected)

Mean population of thrips / three leaves															
Treatment	**31***	**38**	**48****	**60**	**71**	**76**	**83**	**90**	**97*****	**104**	**111**	**117**	**132**	**138**	**Over all mean**
T_1 – 120 kg N ha^{-1} (RDF)	1.27 (1.51) ^{ab}	2.33 (1.83) ^{b}	2.90 (1.97) ^{ab}	0.13	0.50	0.00	0.10	0.10	1.23	0.00	0.33	0.00	0.00	0.00	0.64 (1.28) ^{ab}
T_2 – 150 kg N ha^{-1}	1.47 (1.57) ^{abc}	2.53 (1.88) ^{b}	3.33 (2.08) ^{bc}	0.13	0.53	0.00	0.13	0.13	1.27	0.00	0.37	0.00	0.00	0.00	0.71 (1.31) ^{abc}
T_3 – 180 kg N ha^{-1}	1.93 (1.71) ^{bcd}	2.67 (1.91) ^{b}	3.40 (2.10) ^{bcd}	0.20	0.76	0.00	0.13	0.13	1.37	0.00	0.40	0.00	0.00	0.00	0.77 (1.33) ^{bc}
T_4 – 225 kg N ha^{-1}	2.00 (1.73) ^{bcd}	3.13 (2.03) ^{b}	4.33 (2.31) ^{cde}	0.33	0.60	0.10	0.17	0.20	1.40	0.00	0.43	0.00	0.00	0.00	0.91 (1.38) ^{bcd}
T_5 – 280 kg N ha^{-1}	2.13 (1.77) ^{cd}	3.23 (2.06) ^{bc}	4.43 (2.33) ^{de}	0.37	0.67	0.13	0.20	0.23	1.47	0.00	0.47	0.00	0.00	0.00	0.95 (1.40) ^{bcd}
T_6 - 350 kg N ha^{-1}	2.67 (1.91) ^{de}	3.53 (2.13) ^{bc}	4.77 (2.40)^{e}	0.40	0.70	0.17	0.27	0.30	1.53	0.00	0.50	0.00	0.00	0.00	1.06 (1.44) ^{cd}
T_7 – 440 kg N ha^{-1}	3.27 (2.07) ^{e}	4.50 (2.35) ^{c}	4.80 (2.41) ^{e}	0.43	0.73	0.27	0.27	0.33	1.53	0.00	0.53	0.00	0.00	0.00	1.19 (1.48) ^{d}
T_8 – 0 kg N ha^{-1}	0.87 (1.37) ^{a}	1.27 (1.51) ^{a}	2.07 (1.75) ^{a}	0.10	0.13	0.00	0.00	0.00	1.00	0.00	0.10	0.00	0.00	0.00	0.40 (1.18) ^{a}
CD (P=0.05)	0.25	0.31	0.24	NS	NS	NS	NS	NS	NS	-	NS	-	-	-	0.13
CV%	8.36	9.17	6.34	11.62	13.56	4.87	9.83	9.42	10.40	-	13.83	-	-	-	5.41

Figures in parentheses are $\sqrt{x+1}$ values.
Numbers with same superscript are not statistically different.
** Fipronil 5SC @ 40 g a.i./ha was sprayed

NS : Non significant
*Days After Sowing
*** Acephate 75 SP @ 750 g a.i./ha was sprayed

RDF : Recommended Dose of Fertilizer

Table 4: Incidence of whitefly on Jaadu BG-II cotton hybrid as influenced by nitrogen levels (protected)

Mean population of whitefly / three leaves															
Treatment	**31***	**38**	**48****	**60**	**71**	**76**	**83**	**90**	**97*****	**104**	**111**	**117**	**132**	**138**	**Over all mean**
T_1 – 120 kg N ha^{-1} (RDF)	0.13	0.00	0.33 (1.15) ^{a}	0.20	1.00	1.03	1.47	1.93 (1.71) ^{ab}	2.50 (1.87) ^{b}	2.07 (1.75) ^{a}	2.53	2.53 (1.88) ^{ab}	0.87	1.60 (1.61) ^{ab}	1.21 (1.49) ^{ab}
T_2 – 150 kg N ha^{-1}	0.13	0.07	0.43 (1.20) ^{ab}	0.20	1.07	1.10	1.60	2.00 (1.73) ^{b}	2.57 (1.89) ^{bc}	2.10 (1.76) ^{a}	2.73	2.87 (1.97) ^{bc}	0.93	1.87 (1.69) ^{b}	1.31 (1.52) ^{ab}
T_3 – 180 kg N ha^{-1}	0.17	0.07	0.50 (1.22) ^{ab}	0.27	1.13	1.27	1.73	2.07(1.75) ^{bc}	2.87 (1.97) ^{cd}	2.27 (1.81) ^{a}	2.77	3.00 (2.00) ^{bc}	0.93	2.07 (1.75) ^{bc}	1. 41 (1.55) ^{bc}
T_4 – 225 kg N ha^{-1}	0.17	0.07	0.53 (1.24) ^{ab}	0.30	1.33	1.40	1.80	2.10 (1.76) ^{bc}	2.93 (1.98) ^{cd}	2.43 (1.85) ^{ab}	2.80	3.13 (2.03) ^{bc}	1.13	2.27 (1.81) ^{bc}	1.49 (1.58) ^{bcd}
T_5 – 280 kg N ha^{-1}	0.20	0.00	0.97 (1.40) ^{bc}	0.33	1.60	1.80	1.93	2.13 (1.77) ^{bc}	3.00 (2.00) ^{d}	3.13 (2.03) ^{bc}	3.07	3.80 (2.19) ^{c}	1.13	2.40 (1.84) ^{bc}	1.70 (1.64) ^{bcd}
T_6 - 350 kg N ha^{-1}	0.20	0.07	1.00 (1.41) ^{bc}	0.33	1.67	1.83	2.03	2.60 (1.90) ^{bc}	3.40 (2.10) ^{e}	3.17 (2.04) ^{bc}	3.33	3.93 (2.22) ^{c}	1.33	2.87 (1.97) ^{c}	1.85 (1.69) ^{cd}
T_7 – 440 kg N ha^{-1}	0.27	0.00	1.17 (1.47) ^{c}	0.47	1.73	1.93	2.07	2.93 (1.98) ^{c}	3.40 (2.10) ^{e}	3.40 (2.10) ^{c}	3.60	3.93 (2.22) ^{c}	1.67	2.93 (1.98) ^{c}	1.97 (1.72) ^{d}
T_8 – 0 kg N ha^{-1}	0.07	0.00	0.13 (1.06) ^{a}	0.00	0.53	0.57	0.73	1.20 (1.48) ^{a}	2.07 (1.75) ^{a}	1.93 (1.71) ^{a}	2.20	1.87 (1.69) ^{a}	0.73	1.00 (1.41) ^{a}	0.87 (1.37) ^{a}
CD (P=0.05)	NS	NS	0.22	NS	NS	NS	NS	0.23	0.09	0.19	NS	0.27	NS	0.23	0.15
CV%	6.01	2.90	9.95	8.56	13.77	10.88	9.95	7.43	2.76	5.70	13.11	7.61	10.09	7.38	5.63

Figures in parentheses are $\sqrt{x+1}$ values.
Numbers with same superscript are not statistically different.
** Fipronil 5SC @ 40 g a.i./ha was sprayed

NS : Non significant
*Days After Sowing
*** Acephate 75 SP @ 750 g a.i./ha was sprayed

RDF : Recommended Dose of Fertilizer

Table 5: Incidence of spiders on Jaadu BG-II cotton hybrid as influenced by nitrogen levels (protected)

Mean population of spiders / plant															
Treatment	**31***	**38**	**48****	**60**	**71**	**76**	**83**	**90**	**97*****	**104**	**111**	**117**	**132**	**138**	**Over all mean**
T_1 – 120 kg N ha^{-1} (RDF)	0.27	0.43	0.60	0.30	0.47	0.67	0.47	0.53	0.93	0.00	0.10	0.13	0.12	0.18	0.37 (1.17) ^{ab}
T_2 – 150 kg N ha^{-1}	0.33	0.63	0.70	0.37	0.63	0.87	0.80	0.83	1.00	0.00	0.14	0.15	0.13	0.20	0.45 (1.21) ^{abc}
T_3 – 180 kg N ha^{-1}	0.33	0.67	0.77	0.43	0.70	0.87	0.83	0.87	1.00	0.00	0.17	0.23	0.17	0.27	0.49 (1.22) ^{abc}
T_4 – 225 kg N ha^{-1}	0.33	0.77	0.77	0.47	0.73	0.87	0.73	0.77	1.00	0.33	0.20	0.23	0.20	0.30	0.51 (1.23) ^{abc}
T_5 – 280 kg N ha^{-1}	0.67	0.83	0.83	0.50	0.83	0.93	0.87	0.90	1.33	0.33	0.25	0.28	0.22	0.32	0.61 (1.27) ^{bcd}
T_6 - 350 kg N ha^{-1}	0.67	0.87	1.33	0.67	0.93	0.93	0.93	1.00	2.33	0.43	0.26	0.30	0.25	0.33	0.77 (1.33) ^{cd}
T_7 – 440 kg N ha^{-1}	1.00	1.17	1.67	0.93	1.03	0.97	1.00	1.07	2.67	0.50	0.38	0.35	0.28	0.40	0.89 (1.38) ^{d}
T_8 – 0 kg N ha^{-1}	0.00	0.33	0.47	0.20	0.37	0.47	0.43	0.47	0.90	0.00	0.07	0.10	0.10	0.13	0.27 (1.13) ^{a}
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.13
CV%	12.34	13.96	15.00	18.28	7.68	5.40	9.88	11.39	16.59	14.43	5.97	6.11	5.61	6.04	6.18

Figures in parentheses are $\sqrt{x+1}$ values.
Numbers with same superscript are not statistically different.
** Fipronil 5SC @ 40 g a.i./ha was sprayed
NS : Non significant
*Days After Sowing
*** Acephate 75 SP @ 750 g a.i./ha was sprayed
RDF : Recommended Dose of Fertilizer

Table 6: Incidence of coccinellids on Jaadu BG-II cotton hybrid as influenced by nitrogen levels (protected)

Mean population of coccinellids / plant															
Treatment	**31***	**38**	**48****	**60**	**71**	**76**	**83**	**90**	**97****	**104**	**111**	**117**	**132**	**138**	**Over all mean**
T_1 – 120 kg N ha^{-1} (RDF)	0.00	0.00	0.30	0.00	0.00	0.00	0.00 (1.00) ^{a}	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.11 (1.05) ^{ab}
T_2 – 150 kg N ha^{-1}	0.00	0.33	0.33	0.33	0.00	0.00	0.00 (1.00) ^{a}	0.67	0.33	0.00	0.00	0.00	0.00	0.00	0.13 (1.06) ^{ab}
T_3 – 180 kg N ha^{-1}	0.00	0.33	0.40	0.00	0.00	0.00	0.00 (1.00) ^{a}	0.67	0.67	0.00	0.00	0.00	0.00	0.00	0.14 (1.07) ^{ab}
T_4 – 225 kg N ha^{-1}	0.00	0.00	0.43	0.00	0.00	0.00	0.67 (1.29) ^{b}	0.67	1.00	0.33	0.00	0.00	0.00	0.00	0.23 (1.11) ^{bc}
T_5 – 280 kg N ha^{-1}	0.00	0.00	0.43	0.00	0.00	0.00	0.00 (1.00) ^{a}	0.70	1.00	0.00	0.00	0.00	0.00	0.00	0.16 (1.08) ^{ab}
T_6 - 350 kg N ha^{-1}	0.00	0.00	0.50	0.00	0.00	0.00	0.00 (1.00) ^{a}	0.73	1.17	0.33	0.00	0.00	0.00	0.00	0.20 (1.10) ^{abc}
T_7 – 440 kg N ha^{-1}	0.00	0.67	0.67	0.00	0.00	0.00	1.67 (1.63) ^{c}	1.03	1.67	0.00	0.00	0.00	0.00	0.00	0.38 (1.17) ^{c}
T_8 – 0 kg N ha^{-1}	0.00	0.00	0.27	0.00	0.00	0.00	0.33 (1.15) ^{ab}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04 (1.02) ^{a}
CD (P=0.05)	-	NS	NS	NS	-	-	0.22	NS	NS	NS	-	-	-	-	0.05
CV%	-	14.90	16.36	8.31	-	-	10.90	13.73	15.58	11.96	-	-	-	-	4.24

Figures in parentheses are $\sqrt{x+1}$ values.
Numbers with same superscript are not statistically different.
** Fipronil 5SC @ 40 g a.i./ha was sprayed
NS : Non significant
*Days After Sowing
*** Acephate 75 SP @ 750 g a.i./ha was sprayed
RDF : Recommended Dose of Fertilizer

4. Conclusion

The increased insect populations (particularly aphids and leaf hoppers) were effectively managed with seed treatment and two insecticide sprays during crop growth period even at high nitrogen treatments than recommended dose.

5. References

1. Vennila S. Pest management for cotton ecosystems or ecosystem management for cotton production? Current Science. 2008; 94:1351-1352.
2. Bharathi S, Prasada Rao GMV, Kumari RS, Chengareddy V. Influence of plant geometry and nitrogen levels on performance of cotton hybrids under rainfed conditions in vertisols of Andhra Pradesh. Journal of Cotton Research and Development. 2012; 26:204-206.
3. Chen Y, Olson DM, Ruberson JR. Effects of nitrogen fertilization on tritrophic interactions. Arthropod-Plant Interactions. 2010; 4:81-94.
4. Simpson SJ, Simpson CL. The mechanisms of nutritional compensation by phytophagous insects. *In*: Bernayas, E. A. Insect-plant interactions, New York: CPC Press, Inc. 1990; 2:111-160.
5. Lu ZX, Yu XP, Heong KL, Hu C. Effect of nitrogen fertilizer on herbivores and its stimulation to major insect pests in rice. Rice Science. 2007; 14:56-66.
6. Kannan M, Uthamasamy S, Mohan S. Impact of insecticides on sucking pests and natural enemy complex of transgenic cotton. Current Science. 2004; 86:726-729.
7. Vijaykumar K, Ravi H, Patil NKB, Vyakarnhal BS. Storage of seeds coated with polymer fungicide, insecticide and its effects on incidence of early sucking pests in cotton. Karnataka Journal of Agricultural Sciences. 2007; 20:381-383.
8. Wadnerkar DW, Kawthekar BR, Zanwar PR. Evaluation of fipronil 5% SC against cotton insect pests. Pestology. 2003; 27:15-18.
9. Neelima S, Prasada Rao GMV, Chalam MSV, Grace ADG. Bioefficacy of ecofriendly products against cotton leafhopper, *Amrasca devastans*. Annals of Plant Protection Sciences. 2011; 19:15-19.
10. Sinha SR, Sharma RK. Effect of insecticides on insect pests of brinjal. Annals of Plant Protection Sciences. 2010; 18: 82-85.
11. Udikeri SS, Patil BV, Khadi BM. Population dynamics of cotton aphid and its predators on *Bt* cotton and its impact of *Bt* cotton fed aphids on biology of *Chyrsoperla carnea* Steph. Journal of Cotton Research and Development. 2013; 27:286-290.
12. Kalaichelvi K. Effect of plant spacing and fertilizer levels on insect pests in *Bt* cotton hybrids. Indian Journal of Entomology. 2008; 70(4):356-359.