



Assessing the Damage Potential of *Spodoptera litura* on Bg II Cotton

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ABSTRACT

The damage potential assessing of *Spodoptera litura* on BG II cotton were conducted in the experimental field at Regional Agricultural Research Station, Lam, Guntur district, A.P. during *kharif* 2014-2015. Four times larvae was infested to cotton crop at phenological development of the crop to assess the damage potential. The leaf, square and boll damage was less at 50 and 80 DAS larvae released crop compared to 110 and 140 DAS larvae released crop. This may be due to expression of Cry2Ab toxin in leaves which was effective against *S. litura* damage compare to later stages of the crop.

Key words : Cotton, Damage, *S. litura*.

Cotton, *Gossypium* spp. (L.) is the most important fibre crop of India and it has been reported that about 162 insect pests attack on cotton in India (Lingappa,2001) but only few of them are key production constraints which cause losses to the tune of 30-80%. Tobacco caterpillar (*Spodoptera litura*) is one of the key pests on cotton damaging the crop and causes serious losses. To assess the damage potential causing caused by *S. litura* the present study was conducted.

MATERIAL AND METHODS

The damage of *S. litura* was assessed based on the economic losses in yield resulting from insect pest with eight treatments replicated thrice using the popular *Bt* cotton hybrid Mallika BG II.

Treatments

- T₁ - Complete protection
- T₂ - Releasing 3 larvae/plant
- T₃ - Releasing 6 larvae/plant
- T₄ - Releasing 9 larvae/plant
- T₅ - Releasing 12 larvae/plant
- T₆ - Releasing 15 larvae/plant
- T₇ - Releasing 18 larvae/plant
- T₈ - Releasing 21 larvae/plant

For each treatment, three replications were maintained with a plant under caged condition, as it was covered with fine nylon mesh to prevent infestation from outside. The cages were designed in such a way that they did not interrupt ventilation

and aeration to the growing plants inside and they did not allow free passage of larvae. The bottom edges of the cages were inserted into the soil on all the sides to check the escape or entry of larvae. Nylon net cages were erected on bamboo sticks fixed in four corners. Third instar larvae of *S. litura* from laboratory culture were released four times on cotton plants at 50, 80, 110 and 140 days after sowing. Different blocks were maintained for releasing the larvae at different intervals after sowing to assess the damage potential. The leaf damage area (Graphic method) and number of squares and bolls damage in each caged plant were recorded at 3, 7, 11 days after release of larvae. The yield at harvest was collected from two pickings and total weight of seed cotton yield from all the blocks was recorded. The data was subjected to Square root transformation and subjected to statistical analysis in Randomized Block Design (RBD).

RESULTS AND DISCUSSIONS

The leaf area consumption of *S. litura* larvae on BG II cotton hybrid at different days after sowing was recorded
Fifty days after sowing

The total leaf area consumption after 11 DAS was 25.97 cm² for 3 larvae released per plant followed by 48, 69.12, 96.10, 115.67, 144.80 and 171.63cm² for the plant received 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively. From this

Table 1. Leaf area consumption of *S. litura* larvae on BG II *Bt* cotton.

Treatments No. of Larvae released/ plant	Leaf Area Consumption (Cm ²) (Mean of Three Replications)															
	50 DAS				80 DAS				110 DAS				140 DAS			
	3DAR	7DAR	11DAR	Total	3DAR	7DAR	11DAR	Total	3DAR	7DAR	11DAR	Total	3DAR	7DAR	11DAR	Total
Control	0.00 (1.00) ^e	0.00 (1.00) ^f	0.00 (1.00) ^g	0.00	0.00 (1.00) ^e	0.00 (1.00) ^f	0.00 (1.00) ^g	0.00	0.00 (1.00) ^e	0.00 (1.00) ^f	0.00 (1.00) ^g	0.00	0.00 (1.00) ^e	0.00 (1.00) ^f	0.00 (1.00) ^g	0.00
3	7.05 (2.80) ^d	9.40 (3.15) ^e	9.52 (3.24) ^f	25.97	8.47 (3.06) ^d	10.37 (3.31) ^e	10.27 (3.28) ^e	29.11	9.83 (3.24) ^f	12.47 (3.66) ^d	10.90 (3.43) ^f	33.20	14.37 (3.88) ^f	16.53 (4.14) ^e	15.50 (4.03) ^e	46.40
6	14.03 (3.85) ^c	16.33 (4.16) ^{de}	17.64 (4.31) ^{ef}	48.00	14.67 (3.87) ^d	19.94 (4.45) ^{de}	18.42 (4.34) ^{de}	53.03	15.45 (4.05) ^{ef}	23.93 (4.96) ^{cd}	17.60 (4.28) ^{ef}	56.99	22.13 (4.77) ^{ef}	23.63 (4.86) ^e	22.37 (4.81) ^{de}	68.13
9	18.25 (4.32) ^c	25.57 (5.12) ^{cd}	25.30 (5.11) ^{de}	69.12	25.37 (5.07) ^c	29.03 (5.45) ^{cd}	25.47 (5.08) ^{cd}	79.87	23.20 (4.90) ^{de}	31.87 (5.72) ^{bc}	24.20 (4.95) ^{de}	79.27	30.90 (5.64) ^{de}	38.57 (6.28) ^d	33.40 (5.79) ^{cd}	102.87
12	30.07 (5.53) ^b	35.30 (6.01) ^{bc}	30.73 (5.60) ^{cd}	96.10	32.43 (5.77) ^{bc}	40.60 (6.42) ^{bc}	35.73 (6.03) ^{bc}	108.76	34.03 (5.89) ^{cd}	45.87 (6.84) ^{ab}	32.27 (5.74) ^{cd}	112.17	39.70 (6.35) ^{cd}	45.90 (6.84) ^{cd}	41.83 (6.45) ^{bcd}	127.43
15	34.40 (5.91) ^b	40.80 (6.41) ^b	40.47 (6.35) ^{bc}	115.67	40.67 (6.43) ^{ab}	47.00 (6.89) ^{ab}	45.40 (6.75) ^{ab}	133.07	39.03 (6.29) ^{bc}	53.93 (7.40) ^a	41.07 (6.43) ^{bc}	134.03	50.57 (7.16) ^{bc}	55.27 (7.49) ^{bc}	53.43 (7.33) ^{abc}	159.27
18	48.87 (7.05) ^a	50.63 (7.12) ^{ab}	45.30 (6.73) ^{ab}	144.80	45.39 (6.77) ^{ab}	55.63 (7.50) ^{ab}	55.50 (7.47) ^{ab}	156.53	50.50 (7.12) ^{ab}	57.07 (7.61) ^a	53.13 (7.32) ^{ab}	160.70	59.07 (7.66) ^{ab}	65.03 (8.11) ^{ab}	63.23 (7.94) ^{ab}	187.33
21	55.77 (7.53) ^a	60.07 (7.76) ^a	55.80 (7.50) ^a	171.63	55.13 (7.45) ^a	65.53 (8.12) ^a	60.80 (7.80) ^a	181.47	58.67 (7.69) ^a	67.17 (8.06) ^a	63.93 (8.04) ^a	189.77	70.40 (8.44) ^a	73.77 (8.63) ^a	74.97 (8.70) ^a	219.13
F-test	Sig	Sig	Sig		Sig	Sig	Sig		Sig	Sig	Sig		Sig	Sig	Sig	
SEm±	0.28	0.40	0.37		0.35	0.45	0.52		0.39	0.45	0.39		0.38	0.33	0.56	
CD (P=0.05)	0.85	1.23	1.13		1.05	1.37	1.52		1.19	1.37	1.19		1.16	1.00	1.70	

Figures in parentheses are square root transformed values
Numbers followed by same superscript are not statistically different

Table 2. Comparison of per cent leaf damage at 50, 110 and 140 DAS.

Treatments No. of Larvae released/plant	Leaf damage (cm ²)			% Leaf damage increase over 50 DAS larvae released crop	
	50 DAS	110 DAS	140 DAS	110 DAS	140 DAS
Control	0.00	0.00	0.00	0.00	0.00
3	25.97	33.20	46.40	21.77	44.02
6	48.00	56.99	68.13	15.77	29.55
9	69.12	79.27	102.87	12.80	32.81
12	96.10	112.17	127.43	14.32	24.59
15	115.67	134.03	159.27	13.70	27.38
18	144.80	160.70	187.33	9.89	22.70
21	171.63	189.77	219.13	9.56	21.68

results the leaf area consumption was statically similar in treatment received 6 & 9 larvae/plant, 12 & 15 larvae/plant and the higher number of larvae of 18 and 21/plant.

Eighty days after sowing

Similarly the total leaf area consumption after 11 DAR was 29.11 cm² followed by 53.03, 79.87, 108.76, 133.07, 156.53 and 181.47cm² which received 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively. The treatments which received 15, 18 & 21 larvae per plant were statically similar in influencing the leaf damage. (Table 1).

One hundred and ten days after sowing

The total cumulative leaf area consumption was 33.20 cm² followed by 56.99, 79.27, 112.17, 134.03, 160.70 and 189.77 cm² which received 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively at 11 DAR. The leaf area consumption was increased by 21.77% for 3 larvae released/plant, 15.77 % for 6 larvae released/plant, 12.80% for 9 larvae released/plant, 14.32% for 12 larvae released/plant, 13.70% for 15 larvae released/plant, 9.89% for 18 larvae released/plant and 9.56% for 21 larvae released/plant compared to 50 DAS larvae released crop (Table 2).

One hundred and forty days after sowing

The leaf damage area was more at 140 DAS compare to earlier crop stages. The total cumulative leaf damage varied from 46.40 cm² followed by 68.13, 102.87, 127.43, 159.27, 187.33

and 219 cm² which received 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively. The leaf area consumption was increased by 44.02% for 3 larvae released/plant, 29.55 % for 6 larvae released/plant, 32.81% for 9 larvae released/plant, 24.59% for 12 larvae released/plant, 27.38% for 15 larvae released/plant, 22.70% for 18 larvae released/plant and 21.68% for 21 larvae released/plant compared to 50 DAS larvae released crop. This results indicated that the per cent leaf consumption was increased nearly double at 140 DAS when compare to 110 DAS (Table2).

Squares damage by *S. litura* larvae on BG II cotton hybrid at different days after sowing

Fifty days after sowing

The total square damage after 11 DAR was 3.33 followed by 3.67, 4.67, 6.67, 8.33, 9.67 and 12.00 squares damaged by 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively. (Table 3).

Eighty days after sowing

The total cumulative squares damage after 11 DAR was 3.33 followed by 5, 7, 8, 9.67, 12 and 13 squares which received 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively. The treatments which received 6, 9, 12, 15 and 18 larvae per plant were on par with each other.

One hundred and ten days after sowing

The total cumulative square damage after 11 DAR was 4.33 followed by 5.33, 9.67, 11.33, 13.00, 15.33 and 17 squares per plant which

Table 3. Damage of squares by larvae of *S. litura* on BG II *Bt* cotton.

Treatments No. of Larvae released/ plant	Number of squares damaged/plant (Mean of Three Replications)															
	50 DAS				80 DAS				110 DAS				140 DAS			
	3DAR	7DAR	11DAR	Total	3DAR	7DAR	11DAR	Total	3DAR	7DAR	11DAR	Total	3DAR	7DAR	11DAR	Total
Control	0.00 (1.00) ^d	0.00 (1.00) ^d	0.00 (1.00) ^d	0.00	0.00 (1.00) ^e	0.00 (1.00) ^e	0.00 (1.00) ^e	0.00	0.00 (1.00) ^d	0.00 (1.00) ^d	0.00 (1.00) ^c	0.00	0.00 (1.00) ^e	0.00 (1.00) ^e	0.00 (1.00) ^e	0.00
3	1.00 (1.38) ^{cd}	1.33 (1.52) ^c	1.00 (1.41) ^{cd}	3.33	1.00 (1.38) ^{cd}	1.33 (1.52) ^d	1.00 (1.38) ^{de}	3.33	1.33 (1.52) ^c	1.67 (1.57) ^c	1.33 (1.52) ^b	4.33	1.67 (1.62) ^d	1.33 (1.52) ^d	1.33 (1.47) ^{de}	4.33
6	1.00 (1.38) ^{cd}	1.67 (1.62) ^{bc}	1.00 (1.41) ^{cd}	3.67	1.67 (1.63) ^{bc}	1.67 (1.62) ^{cd}	1.67 (1.60) ^{cd}	5.00	1.67 (1.57) ^c	2.00 (1.71) ^{bc}	1.67 (1.57) ^b	5.33	2.67 (1.91) ^{cd}	2.67 (1.91) ^{cd}	2.33 (1.82) ^{cd}	7.67
9	1.33 (1.52) ^{bc}	2.00 (1.65) ^{bc}	1.33 (1.48) ^c	4.67	2.33 (1.82) ^{abc}	2.67 (1.91) ^{bc}	2.00 (1.71) ^{bcd}	7.00	3.00 (1.98) ^{bc}	3.67 (2.15) ^{ab}	3.00 (1.98) ^{ab}	9.67	3.67 (2.14) ^{bc}	4.00 (2.22) ^{bc}	3.00 (1.98) ^{bc}	10.67
12	2.33 (1.82) ^{abc}	2.67 (1.91) ^{abc}	1.67 (1.60) ^{bc}	6.67	2.67 (1.91) ^{ab}	3.00 (2.00) ^{abc}	2.33 (1.79) ^{abcd}	8.00	3.33 (2.07) ^b	4.00 (2.22) ^{ab}	4.00 (2.22) ^a	11.33	4.67 (2.36) ^{ab}	5.00 (2.44) ^{ab}	4.00 (2.22) ^{abc}	13.67
15	2.67 (1.90) ^{ab}	3.33 (2.07) ^{ab}	2.33 (1.80) ^{abc}	8.33	3.00 (1.99) ^{ab}	3.67 (2.13) ^{ab}	3.00 (1.98) ^{abc}	9.67	4.00 (2.21) ^{ab}	4.67 (2.36) ^a	4.33 (2.30) ^a	13.00	5.00 (2.42) ^{ab}	6.00 (2.64) ^{ab}	5.00 (2.44) ^{ab}	16.00
18	2.67 (1.91) ^{ab}	4.00 (2.22) ^a	3.00 (1.98) ^{ab}	9.67	3.67 (2.15) ^a	4.33 (2.29) ^{ab}	4.00 (2.20) ^{ab}	12.00	5.00 (2.40) ^{ab}	5.67 (2.58) ^a	4.67 (2.36) ^a	15.33	6.00 (2.64) ^a	6.67 (2.76) ^a	6.00 (2.64) ^a	18.67
21	3.67 (2.14) ^a	4.33 (2.30) ^a	4.00 (2.22) ^a	12.00	4.00 (2.20) ^a	4.67 (2.36) ^a	4.33 (2.30) ^a	13.00	5.67 (2.57) ^a	6.00 (2.60) ^a	5.33 (2.49) ^a	17.00	6.33 (2.68) ^a	7.00 (2.79) ^a	6.33 (2.69) ^a	19.67
F-test	Sig	Sig	Sig		Sig	Sig	Sig		Sig	Sig	Sig		Sig	Sig	Sig	
SEm±	0.15	0.15	0.15		0.15	0.13	0.18		0.16	0.14	0.17		0.14	0.15	0.16	
CD (P=0.05)	0.47	0.47	0.45		0.45	0.39	0.55		0.48	0.42	0.50		0.43	0.45	0.47	

Figures in parentheses are square root transformed values
Numbers followed by same superscript are not statistically different

received 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively. The treatments which received 6, 9 and 12 larvae per plant were on par with each.

One hundred and forty days after sowing

The total square damage after 11 DAR was 4.33 followed by 7.67, 10.67, 13.67, 16.00, 18.67 and 19.67 squares which received 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively.

Boll damage by *S. litura* larvae on BG II cotton hybrid at different days after sowing

Fifty days after sowing

There was no boll formation at 50 DAS, hence boll damage could not be recorded (Table 4)

Eighty days after sowing

The total bolls damaged were 2, 3, 3.67, 4.67, 6, 7.33 and 9 bolls per plant, received 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively at 11 DAR.

One hundred and ten days after sowing

The total bolls damaged was 1.33 followed by 2.67, 4.67, 6.33, 8.00, 9.00 and 11.33 bolls per plant which received 3, 6, 9, 12, 15, 18 and 21 larvae per plant respectively.

One hundred and forty days after sowing

The total number of damaged bolls per plant was 1.00 followed by 4.00, 5.33, 6.33, 9.00, 10.33 and 12.00 bolls which received 3, 6, 9, 12, 15, 18 and 21 larvae per treatment respectively.

Seed cotton yield and percent yield reduction over control

Larvae were released fifty days after sowing

The yield was more in this block due to less damage due to *S. litura*. In control the yield recorded was 293.33 g/plant without any damage to leaf, squares and bolls (Table 5). In the treatment which received 3 larvae per plant the yield was 276 g/plant because of 25.97 cm² leaf damage and 3.33 square damage due to this the percent yield reduction over control was 5.91 %. When 6 larvae were released per plant the yield was 271 g/plant, and the yield reduction over control was 7.38 % because of 48.00cm² leaf damage and 3.67 damaged squares per plant. The treatments which

received 9 larvae per plant, recorded 270 g/plant and yield reduction over control was 7.95 % due to 69.12 cm² leaf damage and 4.67 damaged squares. In the treatment which received 12 larvae per plant the yield recorded was 263.33g/plant and the percent yield reduction over control was 10.23 % because of 96.10 cm² leaf damage and 6.67 damaged squares by *S. litura*. The treatments which received 15 larvae per plant recorded 253.33g/plant and the percent yield reduction over control was 13.64% due to 115.67 cm² leaf damage and 8.33 damages squares. The treatments which received 18 larvae per plant, recorded 246.67g/plant and the percent yield reduction over control was 15.91 % because of 144.80cm² leaf and 9.67 squares damage. Treatments which received 21 larvae per plant, recorded 230g/plant and the percent yield reduction over control was 21.59% due to 171.63cm² leaf damage and 12 squares damage.

Larvae were released eighty days after sowing

In control yield recorded was 276.67g/plant without any damage to leaf, squares and bolls. In treatment which received 3 larvae per plant the yield was 249.67 g/plant because of 29.11 cm² leaf, 3.33 damaged squares and 2 damaged bolls per plant due to this the percent yield reduction over control was 9.76 %. When 6 larvae were released per plant the yield was 235 g/plant, with yield reduction over control of 15.06 % because of 53.03cm² leaf damage and 5 damaged squares and 3 damaged bolls. The treatments which received 9 larvae per plant, recorded yield 221.67 g/plant and the yield reduction over control was 19.88 % due to 79.87 cm² leaf damage, 7 damaged square and 3.67 damaged bolls per plant. The treatment which received 12 larvae per plant recorded yield of 211.67g/plant and the percent yield reduction over control was 23.49 % because of 108.76 cm² leaf damage, 8 damaged squares and 4.67 damaged bolls by *S. litura*. The treatments which received 15 larvae per plant, recorded 202.67g/plant and the percent yield reduction over control was 26.75% due to 133.07 cm² leaf damage, 9.67 damaged squares and 6 damaged bolls per plant. The treatments which received 18 larvae per plant, record of 178.33g/plant and the percent yield reduction over control was 35.54 % because of

Table 4. Damage of bolls by larvae of *S. litura* on BG II *Bt* cotton.

Treatments No. of Larvae released/ plant	Number of bolls damaged/plant (Mean of Three Replications)											
	50 DAS			80 DAS			110 DAS			140 DAS		
	3DAR	7DAR	11DAR	Total	3DAR	7DAR	11DAR	Total	3DAR	7DAR	11DAR	Total
Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	(1.00) ^d	(1.00) ^e	(1.00) ^d	2.00	(1.00) ^e	(1.00) ^e	(1.00) ^d	0.00
6	0.00	0.00	0.00	0.00	(1.27) ^{cd}	(1.41) ^d	(1.13) ^{cd}	3.00	(1.13) ^{de}	(1.27) ^{de}	(1.13) ^{cd}	1.33
9	0.00	0.00	0.00	0.00	(1.38) ^{bc}	(1.52) ^{cd}	(1.27) ^{bcd}	3.67	(1.41) ^{cd}	(1.38) ^{bcde}	(1.27) ^{bcd}	2.67
12	0.00	0.00	0.00	0.00	(1.41) ^{bc}	(1.62) ^{bcd}	(1.38) ^{abcd}	4.67	(1.52) ^{cd}	(1.60) ^{bcd}	(1.62) ^{abc}	4.67
15	0.00	0.00	0.00	0.00	(1.52) ^{bc}	(1.73) ^{bcd}	(1.52) ^{abc}	6.00	(1.71) ^{bc}	(1.80) ^{bc}	(1.71) ^{ab}	6.33
18	0.00	0.00	0.00	0.00	(1.71) ^{ab}	(1.82) ^{bc}	(1.62) ^{abc}	7.33	(1.91) ^{ab}	(1.95) ^{abc}	(1.80) ^a	8.00
21	0.00	0.00	0.00	0.00	(1.91) ^a	(1.88) ^{ab}	(1.71) ^{abc}	9.00	(1.97) ^{ab}	(2.07) ^{abc}	(1.86) ^a	9.00
F-test					Sig	Sig	Sig		Sig	Sig	Sig	
SEm±	0	0	0	0	0.12	0.11	0.15		0.13	0.16	0.17	
CD(P=0.05)	0	0	0	0	0.37	0.32	0.46		0.38	0.48	0.52	
					Sig	Sig	Sig		Sig	Sig	Sig	
					(2.00) ^a	(2.15) ^a	(1.80) ^a		(2.22) ^a	(2.29) ^a	(1.98) ^a	
					4.33	4.67	3.00	11.33	4.33	4.67	3.00	12.00
					(2.29) ^a	(2.36) ^a	(1.98) ^a		(2.29) ^a	(2.36) ^a	(1.98) ^a	
					0.19	0.13	0.18		0.19	0.13	0.18	
					0.56	0.39	0.55		0.56	0.39	0.55	

Figures in parentheses are square root transformed values
Numbers followed by same superscript are not statistically different

Table 5. Seed cotton yield and percent yield reduction over control

Treatment No. of Larvae released/plant	Seed cotton yield (g/plant)				Per cent reduction over control			
	Released larvae at 50 DAS	Released larvae at 80 DAS	Released larvae at 110 DAS	Released larvae at 140 DAS	50 DAS	80 DAS	110 DAS	140 DAS
Control	293.33	276.67	275.00	270.33	0.00	0.00	0.00	0.00
3	276.00	249.67	245.33	245.33	5.91	9.76	10.79	9.25
6	271.67	235.00	233.33	212.67	7.38	15.06	15.15	21.33
9	270.00	221.67	202.67	194.33	7.95	19.88	26.30	28.11
12	263.33	211.67	187.67	170.33	10.23	23.49	31.76	36.99
15	253.33	202.67	168.00	145.00	13.64	26.75	38.91	46.36
18	246.67	178.33	154.33	126.33	15.91	35.54	43.88	53.27
21	230.00	166.67	135.00	119.33	21.59	39.76	50.91	55.86
SEm±	18.87	17.37	15.21	15.33				
CD (P=0.05)	57.25	52.68	46.14	47.12				
CV %	12.43	13.81	13.16	14.51				

Table6. Comparison of per cent seed cotton yield at 50, 110 and 140 DAS.

Treatment No. of Larvae released/plant	Yield (g/plant)			% Reduction of yield over 50 DAS	
	50 DAS	110 DAS	140 DAS	110 DAS	140 DAS
Control	293.33	275.00	270.33	6.25	7.84
3	276.00	245.33	245.33	11.11	11.11
6	271.67	233.33	212.67	14.11	21.72
9	270.00	202.67	194.33	24.94	28.03
12	263.33	187.67	170.33	28.73	35.32
15	253.33	168.00	145.00	33.68	42.76
18	246.67	154.33	126.33	37.43	48.79
21	230.00	135	119.33	41.30	48.12

156.53cm² leaf damage, 12 damaged squares and 7.33 damaged bolls per plant. Treatments which received 21 larvae per plant, recorded lowest yield of 166.67g/plant and percent yield reduction over control was 39.76% due to 181.47cm² leaf, 13 damaged squares and 9 damaged bolls per plant (Table 5).

Larvae were released one hundred and ten days after sowing

Gradual decrease in yield was observed with increase in crop age. In control the yield recorded was 275g/plant without any damage to leaf, squares and bolls. When the treatment received 3 larvae

per plant the yield recorded was 245.33 g/plant because of 33.20 cm² leaf damage, 4.33 damaged squares and 1.33 damaged bolls per plant due to this the percent yield reduction over control was 10.79 %. When 6 larvae were released per plant the yield was 233.33 g/plant and the yield reduction over control was 15.15% because of 56.99cm² leaf damage and 5.33 damaged squares and 2.67 damaged bolls. The treatments which received 9 larvae per plant recorded 202.67 g/plant with yield reduction over control of 26.30 % due to 79.27 cm² leaf damage, 9.67 damaged squares and 4.67 damaged bolls per plant. When the treatment received 12 larvae per plant the yield recorded was

187.67g/plant and the percent yield reduction over control was 31.76 % because of 112.17 cm² leaf, 11.33 damaged squares and 6.33 damaged bolls by *S. litura*. In treatments which received 15 larvae per plant the yield was 168g/plant and the percent yield reduction over control was 38.91% due to 134.03 cm² leaf damage, 13 damaged squares and 8 damaged bolls per plant. The treatments which received 18 larvae per plant, recorded 154.33 g/plant and the percent yield reduction over control was 43.88 % because of 160.70cm² leaf damage, 15.33 damaged squares and 9 damaged bolls per plant. Treatments which received 21 larvae per plant, recorded yield of 135g/plant and percent yield reduction over control was 50.91% due to 189.77cm² leaf, 15.33 damaged squares and 11.33 damaged bolls per plant. The per cent yield reduction was increased at 110 and 140 DAS compare to 50 DAS larvae released crop. At 110 DAS larvae released block, the per cent yield reduction was increased by 11.11 for 3 larvae released/plant, 14.11 % for 6 larvae/plant, 24.94% for 9 larvae released/plant, 28.73% for 12 larvae released/plant, 33.68% for 15 larvae released/plant, 37.43% for 18 larvae released/plant and 41.30% for 21 larvae/plant compared to 50 DAS larvae released crop. (Table 5).

Larvae were released one hundred and forty days after sowing block

In control yield recorded was 270.33g/plant without any damage to leaf, squares and bolls. When the treatment received 3 larvae per plant, yield was 245.33 g/plant because of 46.40 cm² leaf damage, 4.33 damaged squares and 1.00 damaged bolls per plant due to this the percent yield reduction over control was 9.25 %. When 6 larvae were released per plant the yield recorded was 212.67 g/plant with the yield reduction over control was 21.33% because of 68.13cm² leaf damage, 7.67 damaged squares and 4 damaged bolls per plant. The treatments which received 9 larvae per plant recorded yield of 194.33 g/plant with yield reduction over control of 28.11 % due to 102.87 cm² leaf damage, 10.67 damaged squares and 5.33 damaged bolls per plant. When the treatment received 12 larvae per plant the yield recorded was 170.33g/

plant and the percent yield reduction over control was 36.99 % because of 127.43 cm² leaf, 13.67 damaged squares and 6.33 damaged bolls by *S. litura*. In treatment which received 15 larvae per plant the yield recorded was 145g/plant and the percent yield reduction over control was 46.36% due to 159.27 cm² leaf, 16 damaged squares and 9 damaged bolls per plant. The treatments which received 18 larvae per plant the yield recorded was 126.33 g/plant and the percent yield reduction over control was 53.27 % because of 187.33cm² leaf, 18.67 damaged squares and 10.33 damaged bolls per plant. Treatments which received 21 larvae per plant recorded yield of 119.33g/plant and the percent yield reduction over control was 55.86% due to 219.13cm² leaf, 19.67 damaged squares and 12.00 damaged bolls. At 140 DAS larvae released block, the per cent yield reduction was increased by 11.11 for 3 larvae released/plant, 21.72% for 6 larvae/plant, 28.03% for 9 larvae released/plant, 35.32% for 12 larvae released/plant, 42.76% for 15 larvae released/plant, 48.79% for 18 larvae released/plant and 48.12% for 21 larvae/plant when compared to 50 DAS larvae released block. (Table 6)

From this results, it can be summarized that there was a significant difference of leaf , square and boll damage in BG II cotton hybrid at different days of release of *S. litura*. The leaf damage area was less at 50 and 80 DAS larvae released crop compared to 110 and 140 DAS larvae released crop this may due to expression of Cry2Ab toxin in leaves which was effective against *S. litura* damage. At 110 and 140 DAS crop leaf damage was more may be due to decrease in protein expression of Cry2Ab. The present findings derive support from Li *et al.* (2006), Bheemanna *et al.* (2008) and Pradeep (2011) who reported that the percentage of feeding damage on BG II cotton was less. El-Sherif *et al.* (1992) reported that the losses of 1 or 50% leaf area at the vegetative growth, budding, flowering, initial fruiting and full fruiting stages decreased the cotton yield. Dhir *et al.* (1992) reported that at seedling stage of ground nut, one larva per plant consumed about 54.7% leaf area and reduced pod yield by 25.8%. As the density of larvae increased, more damage was observed and this was confirmed by (Luttrell *et al.* 1999), Santos *et al.* (2010) and Katayama *et al* (1989).

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