Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(6): 890-894

Received: 16-09-2019
Accepted: 18-10-2019

Sarode AD
Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Zanwar PR
Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Matre YB
Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
Sarode AD
Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Bio-efficacy of newer insecticide against bollworm complex in cotton

Sarode AD, Zanwar PR and Matre YB

Abstract
The Bio-efficacy of newer insecticide against bollworm complex in cotton were studied during *kharif* 2018-2019 was conducted on the farm of Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The results revealed that application of Chlorantraniliprole 18.5% SC proved effective in recording minimum green fruiting bodies damage as well as per cent shed material, which was at par with emamectin benzoate 5% SG, spinosad 45% SC and thiodicarb 75% WP.

Keywords: Cotton, bollworm complex, insecticide, pectinophora

Introduction
Cotton is a major fiber crop of global significance, cultivated in more than seventy countries in the world. Cotton crop is playing an important role in economic, political and social affairs of the world. Cotton belongs to the family "*Malvaceae*" and genus "*Gossypium*". Cotton crop as commercial commodity plays an important role in industrial activity of nation, in terms of both employment generation and foreign exchange, Hence it is popularly known as "White Gold" and "Friendly Fiber".

The area under cotton production in the world is estimated at around 34.14 million hectares and production is 121.37 million bales of 480 lb (Anonymous, 2018) [1].

In India area under cotton cultivation is more in the world but productivity is still low. Among the various causes major cause of low productivity in cotton is attack of insect pests. About 200 insect pests are reported to attack cotton crop in India Cotton is mainly attacked by Sucking pests such as jassids, *Amrasca biguttula* (Ishida); whiteflies, *Bemisia tabaci* (Genn.); aphids, *Aphis gossypii* (Glover) and thrips, *Thrips tabaci* (Linn.) (Anonymous, 1992)

The pest spectrum of cotton crop is quite complex comprising of several species of the insects. Bollworm complex *viz.*, American bollworm (*Helicoverpa armigera* Hub.), spotted bollworm (*Earias vitella* Fab.) and pink bollworm (*Pectinophora gossypiella* Saunders) account for a considerable yield loss to the extent of 36.2 per cent losses by the bollworm complex (Kranti *et al.*, 2005) [6].

A wide range of insecticides have proved as effective weapons in reducing the pest population. The cotton growers in India depend heavily on synthetic pesticides to combat pests and the crop consumes about 20 per cent of the total insecticides used in the country. However, the indiscriminate use of organophosphates, carbamates and synthetic pyrethroids has created a number of problems such as resistance and pest resurgence (Bajya *et al.*, 2010) [2]. Hence the Newer insecticides was selected for reducing the bollworm population and avoids the insecticide resistance.

In India More than 90 percent area is under Bt cotton and Bt cotton is susceptible to sucking pests. Bt cotton effectively control specific lepidopetrous species, but there is lack of resistance against sucking insect pest in Bt cotton (Sharma and Pampathy, 2006) [20]. In India sucking pests are serious problems from seedling stage to boll development stage which reduce the yield considerably in the range of 21.20 to 22.86 per cent and also vectors for a number of viral diseases in cotton crop. The pests of Bt cotton not only reduce the yield but also adversely affect the quality of lint and seed by sucking the cell sap and injects the toxic saliva inside veins during feeding at vegetative phase of the crop. Due to continuous sucking of cell sap plant leaves turned yellowish and letter on turned to reddish colouration of the margins of leaves followed by dryness.

Materials and Methods

The experiment was conducted in randomized block design with ten treatments and three replications. The plot size of each treatment was 4.8 x 2.7 m^2. NH-615 (non-*Bt*) variety was used for experiment with spacing 60 cm x 30 cm.

Effect of insecticides on infestation of bollworm in fruiting bodies

The observation of infested squares, flowers, buds, bolls from each of observation plant from seven and fourteen days after each spraying was taken. The per cent damage in fruiting bodies was worked out by using following formula.

$$\% \text{ damage in green fruiting bodies} = \frac{\text{Damaged green fruiting bodies}}{\text{Total green fruiting bodies}} \times 100$$

Effect of insecticides on infestation of bollworm in shed material

The shed squares, flowers, buds, bolls from each of observation plant were collected seven and fourteen days after each spraying. The shed fruiting bodies was collected in plastic bags and taken to the laboratory for the differentiation between damaged and undamaged bodies based on bollworm infestation. The per cent damage in shed material was worked out by using following formula.

$$\% \text{ Shed material} = \frac{\text{Shed material after insecticide treatment due to bollworms}}{\text{Total shed material (PTC)}} \times 100$$

Effect of insecticide on locule damage

At each picking number of locules from each plot was counted and sorted out into infested and healthy ones and percentage of infestation was worked out.

Effect of insecticides on yield of seed cotton

The four pickings of seed cotton were done and yield of seed from each plot was worked out in quintale per hectare basis. The picking wise yield of seed cotton was also recorded. The net plot yield was converted into kg ha-1 for analysis and comparison.

Statistical Analysis

The population count of sucking pests recorded at before treatment application and 3,7 and 10 days after application of treatment was subjected to square root (x+0.5) and square root transformations before analyzing and data subjected to analysis of variance in randomised block design.

Results and Discussion

Effect of insecticides on infestation of bollworm in fruiting bodies

The observations recorded 7 Days and 14 Days after each spraying i.e., first spray, second spray and third spray showed significant treatment differences in per cent fruiting body damage due to bollworm damage.

The mean data (Table 1) indicated that all treatments are significantly effective than control in reducing per cent fruiting body. The treatment chlorantraniliprole 18.5% SC recorded minimum per cent fruiting body damage(3.50%) and which was at par with emamectin benzoate 5% SG (5.10%), spinosad 45% SC (5.64%) and thiodicarb 75% WP (6.05%). The next best treatments observed are cypermethrin 25% EC (6.45%), lambda cyhalothin 5% EC (6.90%), profenofos 50% EC (7.10%), indoxacarb 14.5% SC (7.86%) and flubendiamide 20% WG (11.20%) were also found effective in lowering fruiting body damage.

The present findings prove that they are more parallel to the Bajya *et al.* (2015) [2] reported that the Ampligo 150 ZC (combination of chlorantranilipole 9.3% + lambdacyhalothrin 4.6% ZC) in cotton gave significant reduction of per cent damage on bolls due to bollworm during *Kharif* 2011 and 2013 when compared to standard check Ampligo 150 ZC (30 g a.i./ha), chlorantranilipole 18.5 SC @ 30g a.i./ha, qunalphos 25 EC @ 500 g a.i./ha, deltamethrin 2.8 EC @ 12.5 g a.i./ha and lambdacyhalothrin 4.9 CS @ 25 g a.i./ha similar results to the Bajya and its coworkers.

Effect of insecticides on infestation of bollworm in shed material

The observations recorded 7 Days and 14 Days after each spraying that is first spray, second spray and third spray showed significant treatment differences in per cent shed material due to bollworm damage.

The overall mean of three sprays (Table 2) revealed that the per cent shed material was ranged between 3.15 to 11.36 indicated that all treatments are significantly effective than control in reducing per cent shed material due to bollworm damage.

Table 1: Effect of different insecticides against fruiting body damage due to bollworm complex

T. No	Treatment	Dose a.i/ha	Conc. %	First Spray			Second Spray		Third Spray		Mean
				PTC	7 DAS	14 DAS	7 DAS	14 DAS	7 DAS	14 DAS	
1	Chlorantraniliprole 18.5% SC	30 g	0.005%	11.30 (19.61)	3.06 (9.98)	4.09 (11.60)	3.08 (10.01)	4.03 (11.52)	3.00 (9.97)	3.76 (11.16)	3.50 (10.77)
2	Emamectin benzoate 5% SG	9.5 g	0.0019%	11.76 (20.03)	3.40 (10.57)	4.82 (12.64)	5.30 (13.25)	6.32 (14.55)	4.67 (12.41)	6.10 (14.16)	5.10 (13.02)
3	Spinosad 45% SC	75 g	0.014%	11.18 (19.50)	4.85 (12.56)	6.70 (14.83)	4.80 (12.59)	6.37 (14.61)	4.90 (12.75)	6.22 (14.29)	5.64 (13.73)
4	Thiodicarb 75% WP	75 g	0.15%	11.85 (20.11)	4.06 (11.42)	6.64 (14.92)	4.93 (12.72)	6.98 (15.30)	5.90 (14.05)	7.84 (16.22)	6.05 (14.23)
5	Indoxacarb 14.5% SC	75 g	0.014%	12.20 (20.41)	6.36 (14.31)	8.84 (17.15)	7.06 (15.38)	8.94 (17.37)	7.10 (15.43)	8.86 (17.28)	7.86 (16.24)
6	Flubendiamide 20% WG	50 g	0.005%	15.36 (23.06)	10.23 (18.64)	12.44 (20.64)	10.05 (18.43)	12.10 (20.34)	10.08 (18.49)	12.30 (20.52)	11.20 (19.52)
7	Cypermethrin 25% EC	40 g	0.008%	11.40 (19.58)	5.69 (13.68)	6.73 (15.02)	5.86 (13.96)	7.36 (15.49)	5.74 (13.79)	7.34 (15.70)	6.45 (14.70)

8	Profenofos 50% EC	750 g	0.15%	11.38 (19.68)	5.92 (13.90)	7.98 (16.38)	6.13 (14.32)	8.20 (16.54)	6.32 (14.54)	8.05 (16.43)	7.10 (15.22)
9	Lambda cyhalothin 5% EC	15 g	0.0037%	11.68 (19.93)	5.97 (14.13)	7.32 (15.67)	6.68 (14.96)	8.10 (16.52)	5.88 (13.97)	7.50 (15.83)	6.90 (14.99)
10	Control (Water Spray)	-	-	12.53 (20.72)	15.40 (23.01)	21.10 (27.12)	24.37 (29.52)	29.36 (32.65)	32.44 (34.62)	40.61 (39.52)	27.21 (31.33)
	SE ±			-	1.09	1.31	0.93	1.30	1.02	1.24	1.19
	CD @ 5%			NS	3.28	3.93	2.81	3.91	3.05	3.71	3.57
	CV%			-	13.35	13.69	10.47	12.96	11.05	11.87	12.61

Figure in parentheses are angular transformed values. PTC- Pre treatment count DAS- Days after spraying

Table 2: Effect of different insecticides on per cent shed material due to bollworm damage

				Per cent shed material							
				First Spray			Second Spray		Third Spray		
Tr. No	**Treatment**	**Dose a.i/ha**	**Conc. %**	**PTC**	**7 DAS**	**14 DAS**	**7 DAS**	**14 DAS**	**7 DAS**	**14 DAS**	**Mean**
1	Chlorantraniliprole 18.5% SC	30 g	0.005%	8.35 (16.74)	2.74 (9.49)	3.21 (10.31)	3.00 (9.97)	4.06 (11.61)	2.76 (9.55)	3.13 (10.18)	3.15 (10.21)
2	Emamectin benzoate 5% SG	9.5 g	0.0019%	9.26 (17.68)	3.91 (11.39)	4.60 (12.34)	3.20 (10.29)	5.23 (13.15)	3.16 (10.18)	5.13 (13.03)	4.20 (11.81)
3	Spinosad 45% SC	75 g	0.014%	10.44 (18.72)	4.06 (11.61)	5.63 (13.71)	4.01 (11.54)	5.36 (13.35)	4.10 (11.29)	5.40 (13.26)	4.76 (12.57)
4	Thiodicarb 75% WP	75 g	0.15%	9.65 (18.03)	4.40 (12.04)	5.85 (13.96)	4.35 (12.01)	6.15 (14.22)	4.25 (11.83)	6.32 (14.54)	5.22 (13.03)
5	Indoxacarb 14.5% SC	75 g	0.014%	8.96 (17.41)	5.92 (13.98)	7.98 (16.36)	6.35 (14.58)	8.65 (17.09)	6.23 (14.44)	8.56 (16.88)	7.28 (15.64)
6	Flubendiamide 20% WG	50 g	0.005%	10.20 (18.60)	6.89 (15.19)	8.94 (17.32)	6.83 (15.13)	8.93 (17.32)	7.47 (15.78)	8.94 (17.37)	8.00 (16.34)
7	Cypermethrin 25% EC	40 g	0.008%	9.10 (17.55)	4.75 (12.41)	6.10 (14.29)	4.85 (12.54)	6.70 (14.93)	4.93 (12.70)	6.87 (15.18)	5.70 (13.74)
8	Profenofos 50% EC	750 g	0.15%	8.73 (17.16)	5.83 (13.96)	7.10 (15.44)	6.40 (14.46)	8.15 (16.55)	5.80 (13.84)	7.70 (16.02)	6.83 (15.05)
9	Lambda cyhalothin 5% EC	15 g	0.0037%	8.36 (16.75)	5.45 (13.46)	6.72 (14.70)	5.06 (12.89)	7.12 (15.46)	5.49 (13.51)	7.06 (15.33)	6.15 (14.33)
10	Control (Water Spray)	-	-	9.86 (18.29)	10.16 (18.37)	12.44 (20.41)	10.05 (18.26)	12.06 (20.05)	10.75 (19.09)	12.70 (20.71)	11.36 (19.38)
	SE ±			-	1.03	1.20	0.92	1.03	1.07	1.16	1.10
	CD @ 5%			NS	3.08	3.61	2.75	3.08	3.22	3.48	3.30
	CV%			-	13.54	14.03	12.12	11.61	14.10	13.22	13.44

Figure in parentheses are angular transformed values. PTC- Pre treatment count DAS- Days after spraying

Table 3: Effect of newer insecticides on the locule damage, per cent bad kapas, per cent seed damage and yield qt per ha.

T. No	**Treatment**	**Dose a.i/ha**	**Conc. %**	**(%) Locule damage**	**% bad kapas**	**% Seed Damage**	**Yield qt/ha**
1	Chlorantraniliprole 18.5% SC	30 g	0.005%	20.46 (26.88)	10.19 (18.60)	10.45 (18.84)	12.46 (20.65)
2	Emamectin benzoate 5% SG	9.5 g	0.0019%	28.35 (32.09)	11.34 (19.66)	13.43 (21.37)	10.45 (18.69)
3	Spinosad 45% SC	75 g	0.014%	32.30 (34.58)	13.39 (21.45)	18.20 (25.23)	10.11 (18.51)
4	Thiodicarb 75% WP	75 g	0.15%	36.20 (36.95)	17.28 (24.48)	21.93 (27.90)	9.46 (17.87)
5	Indoxacarb 14.5% SC	75 g	0.014%	53.95 (47.24)	32.33 (34.58)	36.06 (36.88)	8.08 (16.50)
6	Flubendiamide 20% WG	50 g	0.005%	57.14 (49.08)	36.37 (37.05)	38.11 (38.08)	8.58 (17.02)
7	Cypermethrin 25% EC	40 g	0.008%	37.36 (37.66)	20.57 (26.95)	24.21 (29.40)	8.92 (17.33)
8	Profenofos 50% EC	750 g	0.15%	46.72 (43.10)	29.61 (32.90)	32.12 (34.49)	7.90 (16.30)
9	Lambda cyhalothin 5% EC	15 g	0.0037%	41.20 (39.91)	25.80 (30.49)	29.44 (32.75)	8.62 (16.98)
10	Control (Water Spray)	-	-	65.40 (55.10)	64.23 (53.54)	52.38 (46.45)	3.24 (10.33)
	SE ±			3.01	2.17	2.64	0.90
	CD @ 5%			9.03	6.50	7.91	2.71
	CV%			12.98	12.55	14.70	9.23

* values are angular transformed.

Among them, chlorantraniliprole 18.5% SC minimum per cent shed material (3.15%) and was statistically at par with emamectin benzoate 5% SG (4.20%), spinosad 45% SC (4.76%) and thiodicarb 75% WP (5.22%). The next best treatments were cypermethrin 25% EC (5.70%), lambda cyhalothin 5% EC (6.15%), profenofos 50% EC (6.83%), indoxacarb 14.5% SC (7.28%) and flubendiamide 20% WG (8.00%) were also found effective in lowering per cent shed material.

The infestation of pink bollworm in early sowing was the present findings are more or less parallel to Dhawan *et al.* (2009) [4] he reported that chlorantranilipole 30 g a.i./ha had significantly lowest infestation of bollworm complex with minimum damage to floral shedding, boll damage, loculi damage as compared to the standard check insecticides namly the *i. e* deltamethrin, quinalpohs, chlorpyriphos and

indoxacarb.

The data displayed in Table 3 indicated that all the treatments are significantly superior over control in lowering the per cent locale damage. Among them minimum locule damage (20.46%) is observed in the plot sprayed with chlorantraniliprole 18.5% SC and this treatment and was statistically at par with emamectin benzoate 5% SG (28.35%) and spinosad 45% SC (32.30%). The next best treatments were thiodicarb 75% WP (36.20%), cypermethrin 25% EC (37.36%), lambda cyhalothin 5% EC (41.20%), profenofos 50% EC (46.72%), indoxacarb 14.5% SC (53.95%) and flubendiamide 20% WG (57.14%) were also found effective in lowering per cent locule damage. Gaikwad (2003) [5] conducted experiment and reported that, treatment with spinosad 50 g. a.i/ha and beta cyfluthrin @ 12.5 g. a.i/ha recorded minimum per cent damage. the treatment with spinosad 45 SC @ 50 g. a.i/ha recorded minimum damage in green fruiting bodies, at 7 and 14 days after treatment, which was at par with beta cyfluthrin 2.5 EC @ 12.5 g. a.i/ha and indoxacarb 14.5 SC @ 75 g. a.i/ha also Minimum locule damage, at harvest due to PBW was observed with betacyfluthrin 2.5 EC @ 12.5 g. a.i/ha followed by spinosad 45 SC @ 50 g. a.i/ha and Indoxcarb 14.5 SC @ 75 g. a.i/ha.

It is evident from Table 3 that all the treatments are significantly effective as compared to control in reducing per cent bad kapas and per cent seed damage due to bollworm. The treatment with chlorantraniliprole 18.5% SC showed minimum per cent of bad kapas (10.19%) and which was statistically at par with emamectin benzoate 5% SG (11.34%), spinosad 45% SC (13.39%) and thiodicarb 75% WP (17.28%). In other treatments viz., cypermethrin 25% EC (20.57%), lambda cyhalothin 5% EC (25.80%), profenofos 50% EC (29.61%), indoxacarb 14.5% SC (32.33%) and flubendiamide 20% WG (36.37%) were also found effective in lowering per cent bad kapas. The treatment with chlorantraniliprole 18.5% SC showed minimum per cent seed damage (10.45%) and which was statistically at par with emamectin benzoate 5% SG (13.43%) and spinosad 45% SC (18.20%). In other treatments viz., thiodicarb 75% WP (21.93%), cypermethrin 25% EC (24.21%), lambda cyhalothin 5% EC (29.44%), profenofos 50% EC (32.12%), indoxacarb 14.5% SC (36.06%) and flubendiamide 20% WG (38.11%) also found effective in lowering per cent seed damage.

The present findings are more or less parallel to Bhujade *et al*. (2018) [3] reported that all the treatments are significantly effective as compared to control in reducing per cent bad kapas and per cent seed damage due to bollworm. The treatment with chlorantraniliprole 8.8% + thiamethoxam 17.5% SC showed minimum per cent of bad kapas and per cent seed damage (7.8% and 6.66%) which was statistically at par with indoxacarb 14.5% + acetamiprid 7.7% SC (9.83% and 13.33%).In other treatments viz., chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (16.3% and 16.33%), flubendiamide 19.92% + thiacloprid 19.92%SC (18.44% and 23.33%), spinatorum 10% + sulfoxaflor 30% (20.88% and 26.66%), thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC (25.53% and 30.0%), novaluron 5.25% + indoxacarb 4.5% SC (27.67% and 36.66%),profenophos 40% + cypermethrin 4% EC (30.06% and 46.66%) and cypermethrin 3% + quinalphos 20% EC (39.94% and 56.66%) recorded minimum per cent bad kapas than untreated control.

The data on yield of seed cotton was recorded and presented in Table 3 reported that all the insecticides were found to be significantly superior in recording higher seed cotton yield over untreated control.

The significantly highest yield of seed cotton yield (12.46 q/ha) was recorded in the treatment with chlorantraniliprole 18.5% SC. The next best treatments were emamectin benzoate 5% SG (10.45 q/ha), spinosad 45% SC (10.11 q/ha), thiodicarb 75% WP (9.46 q/ha), cypermethrin 25% EC (8.92 q/ha), lambda cyhalothin 5% EC (8.62 q/ha), profenofos 50% EC (7.90 q/ha), indoxacarb 14.5% SC (8.08 q/ha) and flubendiamide 20% WG (8.58 q/ha). However, in untreated control plot, the lowest seed cotton yield (3.24 q/ha) was recorded. Bajya *et al.* (2015) [2] who reported that Ampligo 150 ZC (combination of chlorantranilipole 9.3% + lambdacyhalothrin 4.6% ZC) in cotton gave significant reduction of per cent damage on squares, bolls and loculi as well as high yield during *Kharif* 2011 and 2013 when compared to standard check Ampligo 150 ZC (30 g a.i./ha), chlorantranilipole 18.5 SC @ 30g a.i./ha, qunalphos 25 EC @ 500 g a.i./ha, and lambda cyhalothrin 4.9 CS @ 25 g. a.i./ha.

Conclusion

Significantly minimum per cent fruiting body damage observed in all the treatments over the control. The plot treated with chlorantraniliprole 18.5% SC recorded minimum per cent fruiting body damage (3.50%) and which was at par with emamectin benzoate 5% SG (5.10%), spinosad 45% SC (5.64%) and thiodicarb 75% WP (6.05%).

Significantly lowest per cent infestation in shed material was observed due to bollworms in all the treatments over control. The treatment of chlorantraniliprole 18.5% SC recorded minimum per cent shed material (3.15%) and was statistically at par with emamectin benzoate 5% SG (4.20%), spinosad 45% SC (4.76%) and thiodicarb 75% WP (5.22%). The next best treatments were cypermethrin 25% EC (5.70%), lambda cyhalothin 5% EC (6.15%), profenofos 50% EC (6.83%), indoxacarb 14.5% SC (7.28%) and flubendiamide 20% WG (8.00%) were also found effective in lowering per cent shed material.

Lowest percentage of locule damage was observed in all the treatments over the control. Minimum locule damage (20.46%) is observed in the treatment with chlorantraniliprole 18.5% SC and this treatment was statistically at par with emamectin benzoate 5% SG (28.35%) and spinosad 45% SC (32.30%).

All the treatments were significantly effective as compared to control in reducing per cent bad kapas due to bollworms. The Treatment with chlorantraniliprole 18.5% SC showed minimum per cent of bad kapas (10.19%) and was statistically at par with emamectin benzoate 5% SG (11.34%), spinosad 45% SC (13.39%) and thiodicarb 75% WP (17.28%).

All the treatments were significantly effective as compared to control in reducing per cent seed damage due to bollworms. The Treatment with chlorantraniliprole 18.5% SC showed minimum per cent seed damage (10.45%) and was statistically at par with emamectin benzoate 5% SG (13.43%) and spinosad 45% SC (18.20%).

All the insecticides were observed to be significantly superior in recording higher seed cotton yield over untreated control. The highest yield of seed cotton yield (12.46 q/ha) was recorded in the treatment with chlorantraniliprole 18.5% SC.

The highest ICBR (1:14.51) was observed in the treatment cypermethrin 25% EC followed by chlorantraniliprole 18.5% SC (1:12.31) and lambda cyhalothin 5% EC (1:12.07).

References

1. Anonymous. Annual report of cotton corporation of India, 2018, 10-32.
2. Bajya DR, Baheti HS, Raza SK. Field efficacy of newer insecticide formulation Ampligo 150 ZC against bollworm complex in cotton. Journal of Cotton Research and Development. 2015; 29(1):94-98.
3. Bhujade DR, Zanwar PR, Bokan SC. Evaluation of newer insecticide combinations against bollworm complex in cotton. International Journal of Current Microbiology and Applied Science. 2018; 7(7):3619-3626.
4. Dhawan AK, Singh R, Singh K, Sharma M. Efficacy of chlorantraniliprole against bollworm complex on cotton. Journal of Insect Science. 2009; 22(3):248-253.
5. Gaikwad SD. Efficacy of newer insecticide against cotton bollworms. MSc. (Agri.) unpublished thesis Dr. P.D K.V, Akola, 2003.
6. Kranthi KR, Naidu S, Dhawad CS, Tatwawadi A, Mate K, Patil *et al*. Temporal and intra-plant variability of Cry1Ac expression in Bt-cotton and its influence (Hubner) (Noctuidae: Lepidoptera). Current science. 2005, 291-298.