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Efficacy of insecticidal combinations on cotton square and boll shedding due to bollworm complex

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Abstract
A field experiment was undertaken to study the efficacy of newer insecticidal combinations (acetamiprid + cypermethrin, acetamiprid + quinalphos and acetamiprid + chlorpyrifos) along with their sole counterparts against the bollworm complex of cotton, their effect on yield and phytotoxicity at Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra. An experiment comprised of fourteen treatments was laid out in randomized block design with three replications. Effectiveness of insecticides was judged on the basis of infestation of different bollworms in shed material (square and boll) on randomly selected plants. The per cent damage was worked out at 7th and 14th days after application of insecticides. During both the years, results were quite promising and the mean results revealed that combination treatments acetamiprid + quinalphos (40+2000) g, acetamiprid + chlorpyrifos (40+2000) g and acetamiprid + cypermethrin (40+200) g a.i./ha were significantly superior in reducing bollworm infestation in shed material (squares and bolls) and increasing the seed cotton yield per hectare. The combination product, acetamiprid + quinalphos (40+2000) g a.i./ha significantly reduced infestation of *Helicoverpa armigera* (2.64 %) and *Earias vittella* (1.08 %) in shed squares and bollworm infestation (4.02 %) in shed bolls at 14 days after second spray. Among the treatments, acetamiprid + quinalphos (40+2000) g a.i./ha evidenced significantly highest seed cotton yield (14.79 q/ha). The overall result concludes that all the combinations performed better over their individual counterparts. The result on phytotoxicity symptoms showed that only leaf injury was observed up to 3 days after spraying in higher concentration of combi products, whereas, other phytotoxic symptoms like wilting, vein clearing, necrosis, epinasty and hyponasty did not observed in any of the treatments.

Keywords: Insecticidal combinations, bollworm complex, phytotoxicity, *Helicoverpa armigera*, *Earias vittella*, cotton square and boll shedding

Introduction
Cotton is most important commercial crop known as “king of natural fiber” and world over commonly referred as “white gold” which belongs to family Malvaceae and genus *Gossypium.* Cotton plays an important role in strengthening economy of 82 countries across the world. In India, apart from providing 60 per cent of the fiber used in textile industries, the crop is also a source for 11.5 lakh tonnes of oil, 90 lakh tonnes of animal feed and about 200 lakh tonnes of cotton stalk that is used for fuel and value addition as particle boards (1). About 60 million people including 4.5 million farmers in India depend on cotton for their livelihood (2). Cotton was cultivated in about 35.7 M hectares area across the world and in about 12.2 M hectares area in India (3). During 2014-15, the total cotton production in India was 400.00 lakh bales of 170 kg/bale with average productivity of 537 kg/ha (4). In Maharashtra cotton was grown in about 41.92 lakh ha area with the production of 85 lakh bales of 170 kg/bale and average productivity of 345 kg/ha during 2014-15 (4). At national level Maharashtra ranked first in area, second in production and eleventh in productivity (4).
Cotton is cultivated in India best with profuse problems of which, the insect pests remain most serious constraints in achieving regular yields. Cotton hybrids and high yielding varieties are more susceptible to insect-pests like bollworms and sucking pests. Cotton crop is subjected to damage by 162 species right from emergence till the final picking (5). In Maharashtra about 25 pests are reported to cause damage to cotton crop at different growth stages (6). The use of insecticides has played a major role in increasing cotton productivity for the last three decades. However, the indiscriminate and injudicious use of insecticides has led to many problems including the resurgence of sucking insect-pests, development of insecticidal resistance in some insects and residues in food stuff, consequence is that the chemical control has become less effective. Application of combination of insecticides / mixed formulations has been reported to be an effective approach to delay the development of resistance in insects, to avoid the resurgence problem and to achieve effective control over different insect-pests attacking

cotton simultaneously (7). Therefore, an attempt was made to study the efficacy of newer insecticidal combinations (acetamiprid + cypermethrin, acetamiprid + quinalphos and acetamiprid + chlorpyrifos) along with their sole counterparts against the bollworm complex of cotton, their effect on yield and phytotoxicity.

Materials and method

The present investigation was carried out at Department of Agril. Entomology, VNMKV, Parbhani, Maharashtra, India during *kharif* 2000-01 and 2001-02 under rainfed conditions. The design of the experiment was laid out in Randomized Block Design (RBD) replicated thrice with plot size of 4.5 x 4.2 sq. m. for both years. The popular cotton hybrid Ganga (PHH-316) was sown at a spacing of 90 x 60 cm. All recommended agronomic practices were followed during the experimentation for proper crop management except plant protection. Five plants randomly selected in each plot were tagged with label card. The treatment spray was given in the morning hours with knapsack sprayer. The plants were treated with sufficient care to cover whole of the plant surface. Due care was taken to avoid the drift during spray from one treatment plot to others.The first treatment spray was given as soon as bollworm crossed ETL i.e. 5 per cent infestation in fruiting bodies or shed material and subsequent spraying was given at 15 days interval. The observation on total number of bollworm infested fruiting bodies in the shed material was recorded before the treatment and 7th and 14th days after the treatment and the per cent infestation in shed material (squares and green bolls) was worked out. Shedding due to American and spotted bollworm was recorded separately. Seed cotton yield was recorded from each treatment separately and converted to hectare basis. The generated data was subjected for statistical analysis as per (8).

The phytotoxic symptoms like injury to leaf tip and leaf surface, wilting, vein clearing, necrosis, epinasty and hyponasty were recorded from ten randomly selected and tagged plants at 1,3,7 and 14 days after spraying on the following visual rating scale.

Phytotoxicity rating

Rating	Phytotoxicity (%)
0	No phytotoxicity
1	1 – 10
2	11 – 20
3	21 – 30
4	31 – 40
5	41 – 50
6	51 – 60
7	61 – 70
8	71 – 80
9	81 – 90
10	91 – 100

(Central Insecticide Board and Registration Committee (CIB & RC))

The total number of leaves and those showing phytotoxicity, if any were counted. The data collected were converted into percentage. The extent of phytotoxicity was recorded on 0 (no phytotoxic symptoms) to 10 score (100 % phytotoxic)

The per cent leaf injury was worked out by using the formula,

$$\text{Per cent leaf injury} = \frac{\text{Total grade points}}{\text{Max. grade x No. of leaves observed}} \times 100$$

Result and discussion

The data representing the effect of newer insecticidal combinations on square and boll shedding and yield has been presented in table 1 and 2.

1. Effect of newer insecticidal combinations on square shedding due to *Helicoverpa armigera*

The pooled data revealed that the results before the application of insecticides were non-significant. The square shedding before imposing treatments ranged from 9.53 – 11.48 per cent. All the insecticidal treatments were found significantly superior in reducing square shedding due to *H. armigera* over untreated control.

After first spraying

The analysis of pooled means indicated that the combination of acetamiprid + quinalphos (40+2000) g a.i./ha recorded significantly lowest infestation of *H. armigera* in shed squares at 7 DAS (1.51 %) and 14 DAS (3.92 %) followed by acetamiprid + chlorpyrifos (40+2000) g a.i./ha (2.14 and 4.15 % at 7 and 14 DAS) and acetamiprid + cypermethrin (40+200) g a.i./ha (2.26 and 5.36 % at 7 and 14 DAS). However among sole insecticides, the treatment quinalphos 500 g a.i./ha noticed 5.55 and 6.96 per cent infested squares in shed material due to *H. armigera* at 7 and 14 DAS, respectively.

After second spraying

The pooled data showed similar trend of results during second spray. Significantly lowest infestation of *H. armigera* was evidenced in shed squares at 7 DAS (0.83 %) and 14 DAS (2.64 %) in the combination of acetamiprid + quinalphos (40+2000) g a.i./ha followed by acetamiprid + chlorpyrifos (40+2000) g a.i./ha (1.21 and 2.89 % at 7 and 14 DAS) and acetamiprid + cypermethrin (40+200) g a.i./ha (2.01 and 3.11 % at 7 and 14 DAS). However among sole insecticides, quinalphos 500 g a.i./ha recorded significantly lowest shed squares due to *H. armigera* (4.49 and 5.52 per cent at 7 and 14 DAS).

2. Effect of newer insecticidal combinations on square shedding due to *Earias vittella*

The pooled data indicated that the results before the application of insecticides were non-significant. The square shedding before imposing treatments ranged from 2.15 – 3.17 per cent. All the insecticidal treatments were found significantly superior in reducing square shedding due to *E. vittella* over untreated control.

After first spraying

The analysis of pooled means showed that the combination of acetamiprid + quinalphos (40+2000) g a.i./ha recorded significantly lowest infestation of *E. vittella* in shed squares at 7 DAS (0.69 %) and 14 DAS (1.21 %) followed by acetamiprid + chlorpyrifos (40+2000) g a.i./ha (0.83 and 1.73 % at 7 and 14 DAS) and acetamiprid + cypermethrin (40+200) g a.i./ha (0.77 and 1.45 % at 7 and 14 DAS). However among sole insecticides, quinalphos 500 g a.i./ha noted 1.76 per cent infested squares in shed material due to *E. vittella* at 7 DAS, whereas, chlorpyrifos 500 g a.i./ha recorded 2.40 per cent infested squares due to spotted bollworm in shed material at 14 DAS.

After second spraying

The pooled means of two seasons observed significantly

lowest infestation of *E. vittella* in shed squares at 7 DAS (0.39 %) and 14 DAS (1.08 %) with the combination of acetamiprid + quinalphos (40+2000) g a.i./ha followed by acetamiprid + chlorpyrifos (40+2000) g a.i./ha (0.56 and 1.23 % at 7 and 14 DAS) and acetamiprid + cypermethrin (40+200) g a.i./ha (1.10 and 1.30 % at 7 and 14 DAS). However amongst sole insecticides, quinalphos 500 g a.i./ha recorded 2.04 per cent infested squares in shed material due to *E. vittella* at 7 DAS, whereas, chlorpyrifos 500 g a.i./ha recorded 2.10 per cent infested squares due to spotted bollworm in shed material at 14 DAS.

3. Effect of newer insecticidal combinations on boll shedding due to bollworm complex

The data indicated that the results before the application of insecticides were non-significant. The boll shedding before imposing treatments ranged from 8.32 – 9.15 per cent. The analysis of pooled means indicated that all the treatments were found significantly superior in reducing boll shedding due to bollworm complex over untreated control.

Significantly lowest boll shedding due to bollworm complex was noticed in acetamiprid + quinalphos (40+2000) g a.i./ha (1.26 and 4.02 % at 7 and 14 DAS) followed by acetamiprid + chlorpyrifos (40+2000) g a.i./ha (1.85 and 4.41 % at 7 and 14 DAS) and acetamiprid + cypermethrin (40+200) g a.i./ha (2.73 and 4.74 % at 7 and 14 DAS). However among sole insecticides, chlorpyrifos 500 g a.i./ha recorded 4.58 per cent infested bolls in shed material due to bollworm complex at 7 DAS, whereas, quinalphos 500 g a.i./ha recorded 7.32 per cent infested bolls due to bollworm complex in shed material at 14 DAS.

The results of effectiveness of insecticidal combinations on square and boll shedding due to *H. armigera* and *E. vittella* are in close conformity with the findings of (9) who found combi product Polytrin C-44 EC (profenofos + cypermethrin) at both doses (1.0 and 1.5 l/ha) superior in reducing the bollworm infestation in shed material. Similarly, (10) reported effectiveness of insecticidal combinations like profenofos + cypermethrin (Polytrin C-44), cypermethrin 5 per cent + chlorpyrifos 50 per cent (Nurelle-D) and chlorpyrifos methyl (Reldon 50 EC) in reducing bollworm infestation in shed material. While, (11) reported Chlorguardplus (chlorpyrifos 48 % + alphamethrin 2.4 %) and Spark extremely valuable tools in reducing the bollworm infestation in shed green fruiting bodies. However, according to (12) Celphos 405 a ready mix combination containing 60 g cypermethrin (5 %) and 480 g a.i./ha ethion (40 %) was significantly effective in reducing square shedding due to bollworm complex. Similarly, (13) revealed that all the doses of Lancer Gold (51.8 % SP) (imidacloprid + acephate) documented effective in reducing bollworm infestation over their individual counterparts.

4. Effect of newer insecticidal combinations on cotton yield

Pooled data on seed cotton yield of two seasons ranged between 6.83 to 14.79 q/ha among the treatments. The treatment acetamiprid + quinalphos (40+2000) g a.i./ha recorded significantly higher yield (14.79 q/ha), followed by acetamiprid + chlorpyrifos (40+2000) g a.i./ha (14.28 q/ha) and acetamiprid + cypermethrin (40+200) g a.i./ha (13.84 q/ha). However among sole insecticides, quinalphos 500 g a.i./ha recorded (10.22 q/ha). These results are in agreement with results of (13) who concluded that all the doses of ready mix formulation Lancer Gold (51.8 % SP) (imidacloprid + acephate) significantly reduced bollworm infestation over their individual counterparts and also registered higher seed cotton yield. However, in the investigation of (14) mixtures of endosulfan (35 %) and cypermethrin (5 %) EC @ 1.00, 1.25, 2.00 and 2.50 l/ha and Polytrin C-44 EC @ 0.5 l/ha recorded higher cotton yield than alone application.

5. Phytotoxicity of newer insecticidal combinations on cotton

The pooled data on phytotoxicity symptoms *viz*; leaf injury, wilting, vein clearing, necrosis, epinasty and hyponasty due to the application of various treatments in cotton revealed that acetamiprid + quinalphos (40+2000) and (20+1000) g, acetamiprid + cypermethrin (40+200) and (20+100) g and acetamiprid + chlorpyrifos (40+2000) and (20+1000) g a.i./ha inflicted leaf injury up to three days after spraying. However, rest of the treatments did not show any phytotoxic symptoms. The phytotoxicity study on 7 and 14 days after spraying did not show any phytotoxicity symptoms in cotton due to the application of various treatments. The present findings confirm the results of (15) who observed phytotoxicity symptoms in the plots treated with acetamiprid 20 SP and 20 SL @ 80, 40, 20 and 10 g a.i./ha. Similar results were reported by (16) who observed that the phytotoxicity increased with increasing rates of acetamiprid SL. However, (17) reported that plants treated with neonicotinoid insecticides inflicted phytotoxicity symptoms, characterized by burning of leaf margin.

Therefore it may be concluded that newer insecticidal combinations (acetamiprid + cypermethrin, acetamiprid + chlorpyrifos and acetamiprid + quinalphos) exhibited good efficacy against bollworm complex and also recorded higher yield. Thus, these newer insecticidal combinations could be deployed for effective management of bollworm complex of cotton under rainfed conditions.

Table 1: Effect of newer insecticidal combinations on per cent square shedding of cotton due to *Helicoverpa armigera* and *Earias vittella*

Sr.	Treatments	Dose	*H. armigera* (Pooled means of two seasons)					*E. vittella* (Pooled means of two seasons)				
			After first spray			After second spray		After first spray			After second spray	
No.		g.a.i./ha	Pre-count	7 Das	14 Das	7 Das	14 Das	Pre-count	7 Das	14 Das	7 Das	14 Das
1	Acetamiprid 0.4%+	10+50	10.17	5.75	7.93	4.48	5.49	2.96	1.70	2.44	1.88	2.09
	Cypermethrin 2% EC		(3.17)*	(2.47)	(2.88)	(2.22)	(2.43)	(1.86)	(1.45)	(1.70)	(1.52)	(1.60)
2	Acetamiprid 0.4%+	20+100	10.10	3.65	6.46	3.26	4.28	2.46	1.31	2.14	1.62	1.72
	Cypermethrin 2% EC		(3.16)	(2.00)	(2.61)	(1.92)	(2.16)	(1.69)	(1.30)	(1.60)	(1.40)	(1.49)
3	Acetamiprid 0.4%+	40+200	11.48	2.26	5.36	2.01	3.11	2.55	0.77	1.45	1.10	1.30
	Cypermethrin 2% EC		(3.37)	(1.64)	(2.40)	(1.56)	(1.87)	(1.71)	(1.09)	(1.38)	(1.26)	(1.37)
4	Acetamiprid 0.4%+	10+500	10.73	4.69	7.00	2.95	4.73	2.15	1.51	1.86	1.35	1.63
	Quinalphos 20 % EC		(3.20)	(2.25)	(2.70)	(1.81)	(2.26)	(1.62)	(1.40)	(1.52)	(1.21)	(1.45)
5	Acetamiprid 0.4%+	20+1000	10.60	3.00	5.59	2.35	4.03	2.61	1.17	1.64	1.08	1.28

	Quinalphos 20 % EC		(3.23)	(1.81)	(2.43)	(1.63)	(2.10)	(1.75)	(1.29)	(1.45)	(1.11)	(1.33)
6	Acetamiprid 0.4%+	40+2000	9.53	1.51	3.92	0.83	2.64	2.66	0.69	1.21	0.39	1.08
	Quinalphos 20 % EC		(3.04)	(1.36)	(2.07)	(1.13)	(1.76)	(1.80)	(1.04)	(1.30)	(0.85)	(1.25)
7	Acetamiprid 0.4%+	10+500	9.73	5.23	7.04	3.36	5.04	3.17	1.71	2.54	1.42	1.90
	Chlorpyrifos 20 % EC		(3.09)	(2.37)	(2.70)	(2.00)	(2.33)	(1.92)	(1.48)	(1.74)	(1.25)	(1.54)
8	Acetamiprid 0.4%+	20+1000	10.85	3.83	5.62	2.38	4.11	2.45	1.26	1.99	1.16	1.30
	Chlorpyrifos 20 % EC		(3.25)	(2.56)	(2.43)	(1.64)	(2.12)	(1.73)	(1.33)	(1.57)	(1.08)	(1.34)
9	Acetamiprid 0.4%+	40+2000	11.35	2.14	4.15	1.21	2.89	2.57	0.83	1.73	0.56	1.23
	Chlorpyrifos 20 % EC		(3.38)	(1.58)	(2.13)	(1.24)	(1.83)	(1.77)	(1.12)	(1.50)	(0.89)	(1.30)
10	Acetamiprid 20 SP	20	9.55	6.60	8.13	5.61	6.24	2.56	2.03	2.43	2.32	2.35
			(3.04)	(2.56)	(2.82)	(2.39)	(2.53)	(1.75)	(1.56)	(1.70)	(1.61)	(1.68)
11	Quinalphos 25 EC	500	9.55	5.55	6.96	4.49	5.52	2.60	1.76	2.44	2.04	2.13
			(3.07)	(2.42)	(2.65)	(2.15)	(2.41)	(1.77)	(1.48)	(1.70)	(1.51)	(1.62)
12	Chlorpyrifos 20 EC	500	10.56	5.62	7.42	4.69	5.93	2.42	2.03	2.40	2.05	2.10
			(3.17)	(2.42)	(2.74)	(2.22)	(2.47)	(1.74)	(1.59)	(1.69)	(1.46)	(1.60)
13	Cypermethrin 10 EC	75	10.40	6.89	8.52	5.06	6.56	2.74	2.06	2.49	2.19	2.33
			(3.22)	(2.69)	(2.96)	(2.28)	(2.62)	(1.81)	(1.59)	(1.72)	(1.53)	(1.67)
14	Untreated control		10.45	11.90	13.60	14.49	15.69	3.00	3.24	3.59	4.56	5.09
			(3.21)	(3.46)	(3.68)	(3.78)	(3.93)	(1.87)	(1.88)	(2.01)	(2.06)	(2.34)
	SE		0.272	0.142	0.095	0.126	0.077	0.078	0.055	0.108	0.045	0.069
	CD		N.S.	0.412	0.278	0.365	0.224	N.S.	0.160	0.315	0.134	0.202
*Figures in parentheses are Arc Sine transformed values, DAS=Days after spray												

Table 2: Effect of newer insecticidal combinations on per cent boll shedding of cotton due to bollworm complex and yield of seed cotton

Sr.	Treatments	Dose	After second spray (Pooled means of two seasons)			Seed cotton yield (q/ha) (Pooled means of two seasons)
No.		g.a.i./ha	Pre-count	7 Das	14 Das	
1	Acetamiprid 0.4%+	10+50	8.34	4.95	7.21	10.28
	Cypermethrin 2% EC		(2.95)*	(2.26)	(2.53)	
2	Acetamiprid 0.4%+	20+100	8.32	3.80	6.09	12.34
	Cypermethrin 2% EC		(2.95)	(1.97)	(2.44)	
3	Acetamiprid 0.4%+	40+200	8.75	2.73	4.74	13.84
	Cypermethrin 2% EC		(3.02)	(1.61)	(2.27)	
4	Acetamiprid 0.4%+	10+500	8.59	3.98	6.63	11.31
	Quinalphos 20 % EC		(2.99)	(1.99)	(2.39)	
5	Acetamiprid 0.4%+	20+1000	8.67	2.92	5.49	12.95
	Quinalphos 20 % EC		(3.00)	(1.72)	(2.30)	
6	Acetamiprid 0.4%+	40+2000	9.07	1.26	4.02	14.79
	Quinalphos 20 % EC		(3.08)	(1.02)	(2.14)	
7	Acetamiprid 0.4%+	10+500	9.06	4.19	7.03	10.75
	Chlorpyrifos 20 % EC		(3.08)	(2.05)	(2.48)	
8	Acetamiprid 0.4%+	20+1000	8.83	3.34	5.83	12.77
	Chlorpyrifos 20 % EC		(3.05)	(1.79)	(2.37)	
9	Acetamiprid 0.4%+	40+2000	8.68	1.85	4.41	14.28
	Chlorpyrifos 20 % EC		(3.02)	(1.17)	(2.20)	
10	Acetamiprid 20 SP	20	8.90	6.60	7.96	8.30
			(3.04)	(2.32)	(2.66)	
11	Quinalphos 25 EC	500	8.66	4.93	7.32	10.22
			(3.01)	(2.18)	(2.47)	
12	Chlorpyrifos 20 EC	500	8.68	4.58	7.66	10.14
			(2.98)	(2.09)	(2.60)	
13	Cypermethrin 10 EC	75	9.15	5.46	7.95	9.47
			(3.10)	(2.36)	(2.66)	
14	Untreated control		9.14	10.45	13.46	6.83
			(3.10)	(3.30)	(3.85)	
	SE		0.128	0.069	0.054	0.614
	CD		N.S.	0.201	0.157	1.780
*Figures in parentheses are Arc Sine transformed values, DAS=Days after spray, 1.780						

References

1. CICR. CICR Vision 2030. Published by Central Institute for Cotton Research, PB No. 2, Shankarnagar, PO, Nagpur- 440010 (www.cicr.org.in), 2015, 1-10.
2. Agarwal OP. Cotton economy in India. The World Cotton Research Conference- IV (September 10-14, 2007), Lubbock TX (USA), 2007.
3. USDA. World cotton area and production, 2014. (www.usda.org).
4. CAB. Area, production and productivity of cotton in India during last seven decades, Cotton Advisory Board, 2015. (www.cab.org).
5. Manjunath TM. *Bt* cotton in India: The technology wins as the controversy wanes, 2004. http://www.monsanto.co.uk/news/ukshowlib.html?wid=8478.
6. Thakare KR, Borle MN, Ajri DS, Raodev AK, Gawande RB, Satpute US. Twenty five years of research on cotton

pest management in Maharashtra, Directorate of Research, MPKV, Rahuri (India), 1983, 1-15.
7. Bhamare VK, Wadnerkar DW. Bio-efficacy of newer insecticidal combinations against sucking pest complex of cotton. J Cotton Res. Dev. 2013; 27(2):279-285.
8. Gomez KA, Gomez AA. Statistical procedures for Agricultural Research 2nd Edn., John Wiley and Sons, New York, 1984, 643-645.
9. Patil BV, Bheemanna M, Thulsiram K, Hugar RS. Bioefficacy of Polytrin C-44 on cotton insect pest. Pestology 1994; XVIII:16-18.
10. Chavan MR. Bioefficacy of some newer insecticides against bollworm complex of cotton. M.Sc. (Agri.) Thesis, submitted to Dept. of Entomology, M.A.U., Parbhani (M.S.) India, 1999.
11. Nimbalkar SA, Naitam NR. Evaluation of insecticidal mixtures for management of cotton bollworms. *Pestology*, 1999; XXIII(11):26-27.
12. Dhawan AK, Simwat GS. Evaluation of cypermethrin in combination with ethion for the management cotton bollworms during flowering phase. J Cotton Res. Dev. 2001; 15(2):176-180.
13. Das SB, Veda OP. Efficacy and dose standardization of ready mix formulation of Lancer Gold against insect pest complex infesting cotton and its impact on potent predators. In International Symposium on, Strategies for Sustainable Cotton Production A Global Vision 3. Crop Protection, 23-25 Nov., 2004, UAS, Dharwad (KN) India. 2004, 180-185.
14. Borad PK, Patel HM, Sisodiya DB, Vaghela NM, Patel JR. Bioefficacy of endosulfan 35 % EC and cypermethrin 5 % EC mixture against insect pests of cotton H-6. Indian J Ent. 2003; 65(3):416-421.
15. Charalwad MS. Bioefficacy of acetamiprid against insect pests of chilli viz. aphids, jassids, thrips, whiteflies and mites. M.Sc. (Agri.) Thesis submitted to Dept. of Entomology, M.A.U., Parbhani (M.S.) India, 2005.
16. Yamamoto PT, Felippe MR, Naciti LAS, Montesino LH, Coelho JHC. Acetamiprid use to control the sharpshooter in citrus. *Laranja* 2003; 24(2):337-351.
17. Yamamoto PT, Felippe MR, Cactano AC, Sanches AL, Almeida EJ de, Nociti LAS. Efficacy of neonicotinoid insecticides applied on citrus trunk to control *Oncometopia focialis* (Signoret) (Hemiptera: Cicadellidae). *Laranja* 2002; 23(1):101-114.