Indian Journal of Agricultural Sciences **87** (11): 1515–8, November 2017/Article
https://doi.org/10.56093/ijas.v87i11.75735

Integrated management of litchi fruit and shoot borer (*Conomorpha sinensis*) using insect growth regulators under subtropics of Bihar

KULDEEP SRIVASTAVA[1], R K PATEL[2], AMRENDRA KUMAR[3], S D PANDEY[4], P V R REDDY[5] and VISHAL NATH[6]

ICAR-National Research Centre on Litchi, Mushahari, Muzaffarpur, Bihar 842 002

Received: 25 February 2017; Accepted: 18 July 2017

ABSTRACT

A field trial was conducted consecutively for two years at ICAR-National Research Centre on Litchi to develop Insect Growth Regulators based (IGRs) approaches for managing the litchi fruit and shoot borer (*Conopomorpha sinensis*; Lepidoptera: Gracillariidae) a major pests of litchi causing economical loss. Studies revealed that T4 - novaluron 10 EC 0.015% recorded least infestation (9.62% and 4.70%) during early and mid stage which is closely followed by T2- diflubenzuron 25 WP 0.03% (9.87% and 5.73%). However, at harvest stage, T2 recorded the lowest borer infestation (12.39%) followed by T4 (13.67%) against highest borer infestation (59.35%) in control. Further, highest reduction of borer infestation over control was noticed in T4 (53.25% and 73.56%) followed by T2 (52.04% and 73.99%) during early stage and mid stage, respectively. At harvest stage, most of the treatments showed more than 75% efficacy on reduction in borer infestation over control. The highest reduction in borer infestation was found in T2 (80.65%) followed by T4 (77.50%). The least infested fruit (2.11 kg/tree) and highest healthy fruit (16.38 kg/tree) was recorded with T2 followed by T1 (14.99 kg/tree), T5 (14.46 kg/tree) and T4 (13.99 kg/tree) against lowest (4.14 kg/tree) in control. Similarly, reduction in fruit infestation over control calculated on weight basis was also highest in T2 (78.77%) followed by T1 (75.79%), T5 (73.85%) and T4 (73.33%).

Key words: IGRs, IPM, Litchi fruit and shoot borer, Insect-pests

Litchi (*Litchi chinensis* Sonn) is an important subtropical evergreen fruit crop belonging to family Sapindaceae. It has high nutritive value and refreshing taste. Litchi fruit is consumed as fresh and processed into various value added products like canned, RTS, wine, nuts, etc. (Kumar *et al*. 2015). It is now an important commercial fruit crop in India due to its high market demand and export potential. Cultivation of litchi is widely spread in eastern India (Bihar, Jharkhand, West Bengal, and NE region) which provides livelihood opportunities to millions of people in the region. This crop is also gaining momentum in Uttarakhand, Uttar Pradesh, Himachal Pradesh, Jammu, Punjab, Odisha and non-traditional areas of southern states (Kerala, Karnataka and Maharashtra), owing to its high economic returns and ever increasing demand in the domestic markets. The litchi growers are facing serious threats of several insect-pests, *viz*. fruit and shoot borer, litchi mite, bark eating borer, leaf folder, litchi looper, litchi weevils etc, which causes severe loss to the growers as reported by various workers (Kumar *et al*. 2011, Srivastava and Nath 2015, Srivastava *et al*. 2015a). Among insect-pests, litchi fruit and shoot borer, *Conopomorpha sinensis* (Lepidoptera: Gracillariidae) is one of the major threat to litchi growers, causing severe losses to fruit as well as young shoots, to the tune of 24-48% and 7-70%, respectively (Srivastava *et al*. 2016a). The insects (larvae) damage the newly emerged shoot during September- October resulting in failure of shoot to bloom. Further, it punctures the peduncle of fruits (both developing as well as mature) during April-May resulting to severe loss through early fruit drop and appearance of excreta/larvae, when fruit is cut/opened after ripening (Kumar *et al*. 2014, Srivastava *et al*. 2016a). Like other crops, insecticides particularly organophosphates and carbamates are most powerful and widely accepted tool for the control of pests in litchi but, however, excessive reliance on insecticides has posed several adverse effects such as buildup of pest resistance to insecticide, outbreak of secondary pests, harmful to non target organisms, health hazards and problems related to environmental pollution. Hence, judicious use of insecticides and use of insecticides with selective action are recommended in insect management practices. Insect growth regulators (IGRs) are very well fit in integrated pest management programme, due to selective action, less hazardous and does not contaminate to the food chain in the environment (Kuldeep and Shri Ram 2004, Kuldeep *et al*.

[1]Senior Scientist (kuldeep.ipm@gmail.com), [2]Senior Scientist (rkpatelicar@gmail.com), [3]Principal Scientist (amrendra14d@gmail.com), [4]Principal Scientist (pandeynrcb@yahoo.com), [6]Director (nrclitchi@yahoo.co.in). [5]Principal Scientist (pvreddy@iihr.ernet.in), ICAR-IIHR, Bengaluru.

2004). Therefore, keeping in view the importance of litchi fruit and shoot borer, a field trial was conducted to evaluate the different IGRs against this key pest.

MATERIALS AND METHODS

Present study was conducted at experimental farm of ICAR-National Research Center on Litchi, Muzaffarpur, Bihar (latitude and longitude of 26º5'87''N and 85º26'64'' E, respectively at altitude of 210m asl) during 2014-2015. Experiment was laid out in RBD with 6 treatments viz., T1- lufenuron 5.4EC (0.006%); T2- diflubenzuron 25 WP (0.03); T3- buprofezin 25 EC (0.03%); T4- novaluron 10 EC (0.015%); T5- emamectin benzoate 5 SG (0.002%), T6- control (without pruning and spray) replicated 4 times to evaluate the efficacy of various IGRs against litchi fruit & shoot borer in cv. Shahi. Good agronomical practices were followed as per recommended package of practices (Kumar *et al*. 2014). One foliar spray of neem based formulations was given at the time of panicle emergence before flowering to avoid egg laying by the moth. Three sprays of all the chemicals were applied at different interval during April-May. First spray was given at clove size fruit, second spray at cardamom size fruit (after fifteen days of first spray) while third spray was given at 10 days after second spray (about 15 days before harvest). Spraying was done on outer as well as inner canopy in all the direction on the tree with the help of power sprayer having hollow cone nozzles. Observations were recorded on the basis of damaged fruit at early stage, mid stage and harvesting stage. To observe the borer infestation at early stage (clove size fruit) and mid stage (cardamom size fruit), the fallen fruits were collected from each treatments and cut/open with the help of sharp knife. At fruit maturity, 100 fruits from each treatment were plucked randomly for recording observation. The peduncle of harvested fruit was removed and presence of larva or their excreta was considered as infested fruits. The damage was assessed based on the weight of total number of fruits and damaged fruits in the different treatments and the percent damage was worked out. The yield of litchi fruits was recorded from each plant on weight basis. Statistical analysis was carried out using SPSS software programme.

RESULTS AND DISCUSSION

All the treatments significantly reduced the fruit borer infestation in comparison to control during the period of experimentation. During 2014, least borer infestation (8.57%) was observed in treatment with novaluron 0.015% which was closely followed by diflubenzuron 0.03% (8.75%) at early stage (Table 1). At mid stage also, same treatment registered least infestation 2.23% and 3.38%, respectively. While at harvest stage, minimum infestation (5.77%) was observed in diflubenzuron 0.03% treated plants followed by lufenuron 0.006% (8.50%) against 45.8% in control. During 2015, heavy infestation of litchi fruit and shoot borer was noticed in all the stages of observations as compared with previous year but similar trends of efficacy of IGRs against borer infestation was observed in 2015 too. The lowest borer infestation at early, mid and harvest stage was recorded in novaluron 0.015% (10.68, 7.18 and 18.33%, respectively) closely followed by diflubenzuron 0.03% (11.00, 8.08 and 19.00%, respectively) and lufenuron 0.006% (13.74, 8.96 and 19.33%, respectively). Pooled data of both the years revealed that novaluron 0.015% recorded least infestation (9.62% and 4.70%) during early stage and mid stage which was closely followed by diflubenzuron 0.03% (9.87% and 5.73%). However at harvest stage, diflubenzuron 0.03% recorded the lowest borer infestation (12.39%) followed by novaluron 0.015% (13.67%) and lufenuron 0.006% (13.92%) against highest borer infestation (59.35%) noticed in control (Table 1).

Effect of different IGRs on reduction of fruit borer

Table 1 Efficacy of different IGRs on litchi fruit borer infestation (%)

Treatment	Conc.	Early stage			Mid stage			Harvest stage		
		2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
T1-Lufenuron 5 EC	0.006%	10.96 (3.31)	13.74 (3.71)	12.35 (4.97)	5.00 (2.23)	8.96 (2.99)	6.98 (3.73)	8.50 (2.91)	19.33 (4.40)	13.92 (5.27)
T2-Diflubenzuron 25 WP	0.03%	8.75 (2.95)	11.00 (3.31)	9.87 (4.44)	3.38 (1.84)	8.08 (2.84)	5.73 (3.38)	5.77 (2.40)	19.00 (4.36)	12.39 (4.98)
T3-Buprofezin 25 SC	0.03%	14.31 (3.78)	17.65 (4.20)	15.98 (5.65)	12.55 (3.54)	14.76 (3.84)	13.66 (5.23)	13.43 (3.66)	34.67 (5.89)	24.05 (6.93)
T4-Novaluron 10 EC	0.015%	8.57 (2.92)	10.68 (3.27)	9.62 (4.39)	2.23 (1.49)	7.18 (2.68)	4.70 (3.07)	9.00 (3.00)	18.33 (4.28)	13.67 (5.23)
T5-Emamectin benzoate 5% SG	0.002%	9.93 (3.15)	12.20 (3.49)	11.07 (4.70)	7.64 (2.76)	9.23 (3.04)	8.43 (4.11)	7.14 (2.67)	24.00 (4.90)	15.57 (5.58)
T6-Control		19.10 (4.37)	22.07 (4.69)	20.59 (6.42)	16.90 (4.11)	27.14 (5.21)	22.02 (6.63)	45.80 (7.76)	72.90 (8.54)	59.35 (10.89)
SEm (±)		0.069	0.069	0.078	0.043	0.061	0.059	0.088	0.049	0.067
CD (P=0.05)		0.207	0.210	0.234	0.129	0.183	0.177	0.264	0.148	0.203

*Values in parenthesis are angular transformed (sqroot)

Table 2 Efficacy of different IGRs on reduction of litchi fruit borer infestation over control (%)

Treatment	Conc.	Early stage			Mid stage			Harvest stage		
		2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
T1-Lufenuron 5 EC	0.006%	42.27	37.31	40.01	70.37	66.88	68.31	81.34	73.48	77.41
T2-Diflubenzuron 25 WP	0.03%	54.22	50.15	52.04	80.00	70.25	73.99	87.36	73.93	80.65
T3-Buprofezin 25 SC	0.03%	25.08	20.01	22.36	25.74	45.62	37.99	70.63	52.37	61.50
T4-Novaluron 10 EC	0.015%	55.16	51.60	53.25	86.83	73.56	78.66	80.20	74.81	77.50
T5-Emamectin benzoate 5% SG	0.002%	48.00	44.72	46.24	54.79	66.00	61.70	84.27	67.03	75.65
T6-Control		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

infestation over control on litchi ecosystem are presented in Table 2. Data revealed that combined application of IGRs with neem oil were found most effective and at par with application of emamectin benzoate except buprofezin. During 2014, the highest reduction per cent over control (55.16) of litchi fruit borer was recorded in novaluron followed by diflubenzuron (54.22) at early stage. Similar trend was also observed at mid stage. However at harvest stage, diflubenzuron gave the maximum reduction over control (87.36%) followed by emamectin benzoate (84.27%) and lufenuron (81.34%). During 2015, the highest reduction per cent over control (51.60) of litchi fruit borer was observed in novaluron followed by diflubenzuron (50.15) and emamectin benzoate (44.72) at early stage. Similar trend was also observed at mid stage. The maximum reduction of borer over control (74.81%) was noticed in novaluron followed by diflubenzuron (73.93%) and lufenuron (73.48%) at harvest stage. Pooled data revealed that highest reduction of borer infestation over control was noticed in novaluron (53.25% and 73.56%) followed by diflubenzuron (52.04% and 73.99%) during early stage and mid stage, respectively. However at harvest stage, most of the treatments showed more than 75% efficacy on reduction in borer infestation over control. The highest reduction in borer infestation was found in diflubenzuron (80.65%) followed by novaluron (77.50%), lufenuron (77.41%) and emamectin benzoate (75.65%).

IGRs significantly influenced the borer infestation and fruit yield of litchi (Table 3). Weight of infested litchi fruits showed that application of IGRs reduced the damage of litchi fruits done by borer that contributed towards more marketable fruit yield as compared to control. The highest healthy fruit (16.38 kg/tree) was recorded with diflubenzuron followed by lufenuron (14.99 kg/tree), emamectin benzoate (14.46 kg/tree) and novaluron (13.99 kg/tree) against lowest (4.14 kg/tree) in control. Similarly, reduction in fruit infestation over control calculated on weight basis was also highest in diflubenzuron (78.77%) followed by lufenuron (75.79%), emamectin benzoate (73.85%) and novaluron (73.33%).

Highest reduction of litchi fruit borer infestation with IGRs might be due to selective action of IGRs as well as

Table 3 Efficacy of IGRs on fruit borer infestation and their impact on fruit yield of litchi

Treatment	Conc.	Weight of infested fruits (kg)/tree			Weight of healthy fruits (kg)/tree			% reduction on fruit infestation weight basis		
		2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
T1-Lufenuron 5 EC	0.006%	1.66	3.15	2.41	15.37 (23.09)	14.61 (22.46)	14.99 (22.78)	77.36	74.85	75.79
T2-Diflubenzuron 25 WP	0.03%	1.13	3.10	2.11	17.13 (24.47)	15.63 (23.31)	16.38 (23.89)	84.58	75.31	78.77
T3-Buprofezin 25 SC	0.03%	2.41	6.45	4.43	12.87 (20.99)	10.10 (18.68)	11.48 (19.83)	67.14	48.59	55.55
T4-Novaluron 10 EC	0.015%	1.75	3.57	2.66	15.28 (23.03)	12.70 (20.85)	13.99 (21.94)	76.30	71.53	73.33
T5-Emamectin benzoate 5% SG	0.002%	1.31	3.91	2.61	16.04 (23.59)	12.87 (21.02)	14.46 (22.31)	82.16	68.91	73.85
T6-Control		7.41	12.57	9.99	4.26 (11.86)	4.02 (11.55)	4.14 (11.70)	0.00	0.00	0.00
SEm (±)		0.166	0.190	0.148	0.25	0.36	0.18	-	-	-
CD (0.05)		0.450	0.574	0.446	0.75	0.78	0.55	-	-	-

*Values in parenthesis are angular transformed (sqroot) ovicidal action of these chemicals. The IGRs inhibit the chitin synthesis of the insects by which it causes abnormal endocuticular deposition and abortive moulting (Mulder and Gijswijt 1973). IGRs include compounds such as chitin synthesis inhibitors (CSIs) analogues of juvenile, moulting and brain hormones and their antagonists. There are two sub-structural types of CSIs: the benzoylphenyl ureas (acylureas) and thiadiazole (buprofezin) (Ishaaya and Horowitz 1998). Benzoylphenyl ureas based IGRs which includes diflubenzuron, lufenuron and novaluron are powerful suppressor of lepidopteran larvae (Srivastava *et al*. 2016).

From the study, it can be concluded that IGRs like diflubenzuron, novaluron and lufenuron are most effective against litchi borer and shoot borer. More infestation of litchi fruit and shoot borer noticed during 2015 as compared to 2014 was perhaps due to occurrence of intermittent rains during fruit growth and development, which might have created the congenial environment for borer survival. Kuldeep *et al*. (2005) also reported that growth and development of lepidopteran larvae, viz. *Spodoptera litura* and *Spilarctia obliqua* was drastically suppressed by diflubenzuron. No larvae of *Spodoptera* litura could reach up to pupation in case of 0-24 hr old larvae at 125 and 250 ppm and 6 day old larvae at 250 ppm of diflubenzuron. Similarly, Srivastava *et al*. (2007a) also observed lufenuron is highly toxic against lepidopteran larvae. The results are also in line with the findings of Patil *et al*. (2007) who reported that the minimum larval incidence of *Helicoverpa armigera* (1.68 larvae/mrl) was recorded in novaluron 10 EC@ 100 g /ha, at three days after sowing of chickpea.

Field efficacy of IGRs also revealed that diflubenzuron (600 g/h) and lufenuron (600 ml/h) are quite effective in regulating lepidopteran pests (Srivastava *et al*. 2007b, Srivastava *et al*. 2007c). The present findings are also in agreement with Saini *et al*. (2013) who reported that that novaluron @ 18.75 g ai/ha proved superior to the standard check, quinalphos in reducing larval population of *H. armigera*. These IGRs are similarly effective to so many lepidopteran larvae (Srivastava *et al*. 2015b, Srivastava *et al*. 2016b). The finding of present investigation holds a good promise in litchi fruit borer management and it showed that effectively controlled litchi fruit and shoot borer. However, further studies on effect of these combinations on natural enemies need to be undertaken so that such combination can be more effectively utilized in future.

ACKNOWLEDGEMENT

The authors are thankful to Director, ICAR-NRC Litchi, Muzaffarpur, and PI, CRP-Borers (IIHR) for extending the help in present investigation.

REFERENCES

Ishaaya I and Horowitz A R. 1998. Insecticides with novel mode of action. An overview. (*In*) *Insecticides with Novel Mode of Action: Mechanism and Application*, pp 1-24. Ishaaya I and Degheela D (Ed.). Narosa Publishing House:, *New Delhi*.

Kuldeep and Ram S. 2004. Toxicity of diflubenzuron against *Spodoptera litura* Fab. and *Spilarctia obliqua* Walk. *Indian Journal of Entomology* **66**(4): 354–6.

Kuldeep, Rahman S k Md A and Ram S. 2004. Effect of sublethal doses of lufenuron against *Spodoptera* litura Fab. and *Spilarctia obliqua* Walk. *Indian Journal of Entomology* **66**(4): 287–92.

Kuldeep, Rahman S k Md A and Ram S. 2005. Effect of sublethal doses of diflubenzuron against *Spodoptera litura* Fab. and *Spilarctia obliqua* Walk. *Annals of Plant Protection Sciences* **13**(1): 44–7.

Kumar A, Srivastava K, Patel R K and Nath V. 2014. Management of litchi fruit borer and litchi mite using bio-rational approaches under subtropics of Bihar. *Ecoscan Special Issue* **6**: 285–89.

Kumar A, Pandey S D, Patel R K, Singh S K, Srivastava K and Nath V. 2015. Induction of flowering by use of chemicals and cincturing in Shahi litchi. *Ecoscan Special Issue* **7**: 493–6.

Kumar V, Kumar A and Nath V. 2011. Emerging pests and diseases of litchi (*Litchi chinensis* Sonn.). *Pest Management in Horticulture Ecosystem* **17**(1): 11–3.

Mulder R and Gijswijt M J. 1973. The laboratory evaluation of two promising new insecticides which interfere with cuticle deposition. *Pesticide Science* **4**: 737–44.

Patil S K, Ingle M B and Jamadagni B M. 2007. Bio-efficacy and economics of insecticides for management of *Helicoverpa armigera* (hub.) in chickpea. *Annals of Plant Protection Sciences* **15**: 307–11.

Saini R K, Lal R, Yadav J L, Yadav S P and Sushil. 2013. Bioefficacy of novaluron against *Helicoverpa armigera* (hub.) on chickpea. *Journal of Insect Science* **26**: 148–54.

Srivastava K, Rahman Sk Md A and Ram S. 2007a. Toxicity of lufenuron against *Spodoptera* litura Fab. and *Spilarctia obliqua Walk. Annals of Plant Protection Sciences* **15** (1): 253–24.

Srivastava K, Rahman Sk Md A and Ram S. 2007b. Evaluation of insect growth regulators against soybean defoliators. *Annals of Plant Protection Sciences* **15**(2): 294–8.

Srivastava K, Rahman Sk Md A and Ram S. 2007c. Insect Growth Regulators (IGRs): a novel tool to regulate soybean defoliators. *Journal of Research SKUAST-J* **6**(2): 242–8.

Srivastava K and Nath V. 2015. Keeping emerging litchi pests under changing climate at bay. *Indian Horticulture* **60**(4): 28–30.

Srivastava K, Patel R K, Kumar A, Rai R R and Nath V. 2015a. Seasonal incidence and management of ash weevil (*Myllocerus undecimpustulatus*) population on litchi. *Ecoscan Special Issue* **8**: 161–5.

Srivastava K, Patel R K, Pandey S D, Kumar A and Nath V. 2015b. Integrated management of lepidopteran defoliators in litchi under subtropics of Bihar. *Ecoscan Special Issue* **7**: 483–7.

Srivastava K, Purbey S K, Patel R K and Nath V. 2016 a. Managing fruit-borer for having healthy litchi. *Indian Horticulture* **61**(3): 39–41.

Srivastava K, Sharma S, Sharma D, Ahmad H and Ganai S A. 2016b. Base line toxicity of fungicides and insecticides to *Spodoptera litura* (fab.). *Bangladesh Journal of Botany* **45**(1): 39–45.