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# EVALUATION OF AN INSECT GROWTH REGULATOR, CHLORFLUAZURON AGAINST *SPODOPTERA LITURA* IN VIRGINIA TOBACCO

**U. SREEDHAR**

ICAR-Central Tobacco Research Institute, Rajahmundry - 533 105

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**Tobacco caterpillar, *Spodoptera litura* (Fab.) is the key pest of tobacco in India. Studies were conducted to evaluate the efficacy of an insect growth regulator (IGR) chlorfluazuron (Atabron 5.4 EC) @ 0.0075%, 0.015% & 0.03% against the pest in a replicated experiment along with novaluron 10 EC @ 0.01%, lufenuron 5 EC @ 0.006% and emamectin benzoate 5 SG @ 0.0025% for two seasons in flue cured Virginia (FCV) tobacco (*Nicotiana tabacum*) cv. *Siri* at ICAR-Central Tobacco Research Institute farm, Rajahmundry, India. Results showed that emamectin benzoate 5 SG @ 0.0025%, was most effective in protecting tobacco from *S.litura* damage as shown by no damage at all in terms of number of leaves damaged, leaf area damaged and the damaged plants/plot. The next best treatment was chlorfluazuron (Atabron 5.4 EC) @ 0.03% as shown by number of leaves damaged (1.09 - 1.12%), leaf area damaged (2.71-4.18 %) and per cent plants damaged/plot (3.50 - 7.01%). Emamectin benzoate 5 SG @ 0.0025% treated plots recorded highest cured leaf (2485 kg/ha) as well as bright leaf yield (1163 kg/ha) and better grade index (1603) followed by chlorfluazuron @ 0.03% treated plots (2440, 1130 and 1555 kg /ha), respectively. Chlorfluazuron 5.4% EC @ 0.03% may be used to manage *S.litura* damage in rotation with emamectin benzoate.**

## INTRODUCTION

Tobacco caterpillar, *Spodoptera litura* is the major pest of tobacco in India. The caterpillars are nocturnal and feed voraciously and in case of severe infestation only veins are left on the plant resulting in heavy yield loss. The yield loss due to *S.litura* was estimated to be 33-71% (Sitaramaiah *et al.*, 1994). Application of insecticides for management of the pest is indispensable, effective and economical. The guidance residue levels (GRLs) of the recommended insecticides are revised to a lower level by CORESTA over the years (CORESTA, 2016). Repeated application of insecticides to control the pest is a common practice among tobacco growers. Adverse effects caused by indiscriminate use of insecticides were already well documented. In order to circumvent the problems, there is a need to replace the conventional insecticides with selective insecticides in tobacco. Emamectin benzoate is a semi-synthetic derivative of the avermectin family of naturally-derived products and quite effective against lepidopterous insects and is used in several crops including tobacco for management of *S.litura* (Sreedhar, 2010; Hegde and Gadad, 2017; Babu *et al.*, 2018; Ghosal *et al.*, 2018). The extensive use of emamectin benzoate against *S. litura* may provide an ideal environment for development of resistance (Ahmad *et al.*, 2008; Hong Tong *et al.*, 2013). In order to postpone the development of resistance, a resistance management strategy of decreased selection pressure could be achieved by certain methods. Using insect growth regulators (IGRs) is considered as one of the possible alternatives to synthetic insecticides and IGRs are regarded as a third generation of insecticides or bio rational pesticides as they differ in their mode of action from other insecticides and have low toxicity to non-target organisms. Among the IGRs chitin synthesis inhibitors are the compounds which inhibit the synthesis of chitin (Singh *et al.,* 2013). Chlorfluazuron (Atabron©) is a benzyl phenyl urea (BPU) chitin-synthesis inhibitor reported to be safe to certain beneficial insects also (Haga *et al.*, 1992; Matioli *et al.*, 2019) and due to its selective insecticidal activity, it is suited to integrated pest management programmes. The new molecule is expected to provide the necessary protection against tobacco cutworm, *S.litura*, in tobacco. The

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objective of this study was to evaluate the efficacy of the IGR, chlorfluazuron for management of *S.litura* in planted crop of tobacco.

**MATERIALS AND METHODS**

A replicated field experiment was conducted for two seasons (2013-15) in planted flue cured Virginia tobacco cv. *Siri* at CTRI Research Farm, Katheru, Andhra Pradesh. The experiment was laid out in randomized block design with six treatments and an untreated control in plots measuring 5.6 X 4.9 m with a row to row and plant to plant distance of 70 cm. Laboratory reared 10 day old *S.litura* larvae were used for infesting 5 plants/plot at random @ 10 larvae per plant, allowed to establish and start feeding. The treatments were imposed using the knapsack sprayer fitted with hollow cone nozzle. Foliar spray of chlorfluazuron 5.4 EC @ 0.075%, 0.015% & 0.03% was evaluated along with novaluron 10 EC @ 0.01%, lufenuron 5 EC @ 0.06% and emamectin benzoate 5 SG @ 0.0025%. Observations were recorded on mean number of leaves/plant, per cent leaf area damaged at 4, 8 and 15 days after spray (DAS) and per cent plants infested at 15 DAS. yield data on cured leaf, bright leaf were collected and grade index was computed. The data was subjected to analysis of variance.

**RESULTS AND DISCUSSION**

Emamectin benzoate @ 0.025% recorded least number of damaged leaves (1.00) followed by chlorfluazuron 0.03% (1.09 – 1.12) and remained on par with each other during both the seasons (Table 1). During 2013-14, at 4 DAS emamectin benzoate 0.025% (1.00), chlorfluazuron 0.03% (1.09), novaluron 0.01% (1.21) and lufenuron 0.006% (1.22) remained on par with each other. At 8 DAS emamectin benzoate, chlorfluazuron 0.03% and novaluron 0.01% remained on par with each other while chlorfluazuron 0.03% and novaluron remained on par with lufenuron (1.36). At 15 DAS emamectin benzoate and chlorfluazuron 0.03% while remaining on par with each other, recorded significantly less number of leaves damaged than all others except novaluron which remained on par with chlorfluazuron 0.03%. Chlorfluazuron @ 0.0075 % and 0.015 % recorded significantly higher number of damaged leaves than all other treatments at all the observations. As regards to leaf area damage emamectin benzoate (0.00) followed by chlorfluazuron 0.03% (2.71-4.18%) recorded significantly less leaf area damaged than all other treatments at all the observations and also remained at par with each other (Table 2). During 2013-14, at 4 DAS among others novaluron (10.89%), lufenuron (11.51%) and with chlorfluazuron medium dose 0.015% (13.89) were on a par with each other. At 8 DAS novaluron (10.89%) and lufenuron (11.51%) were on par and was significantly superior to all other treatments in terms of per cent leaf area damaged. Similar trend was observed at 15 DAS. Data on mean per cent plant infestation showed that during 2013-14 emamectin benzoate (0.00%) and chlorfluazuron 0.03% (3.50) were at par and recorded least per cent number of plants damaged/plot and provided significantly better protection than all other treatments. Among others, novaluron (11.99%) and lufenuron (13.47%) remained on par with each other and gave significantly better protection than medium, 0.015% and lower 0.0075% doses of chlorfluazuron. Though these two treatments recorded higher plant damage among all the treatments, the damage was significantly less than control (35.23%).

During 2014-15, at 4 DAS emamectin benzoate 0.025% (1.00), chlorfluazuron 0.03% (1.09) remained on par with each other while novaluron (1.21) remained on par with lufenuron (1.23) as well as chlorfluazuron 0.03% in terms of number of leaves damaged/plant. At 8 DAS emamectin benzoate (1.00), chlorfluazuron 0.03% (1.12) and novaluron 0.01% (1.24) remained on par with each other while novaluron 0.01% remained on par with lufenuron (1.32). At 15 DAS emamectin benzoate and chlorfluazuron 0.03% while remaining on par with each other recorded less number of leaves damaged than all others. However, novaluron and lufenuron remained on par with chlorfluazuron 0.03%. Chlorfluazuron @ 0.0075 % and 0.015 % recorded significantly higher number of leaves than all other treatments. Data on leaf area damaged showed that emamectin benzoate (0.00) followed by chlorfluazuron 0.03% recorded significantly less leaf area damaged than all other treatments at all the observations except chlorfluazuron 0.03% at 4 DAS. Novaluron (9.73%) and lufenuron (10.79%) were on par with each other and remained on par with chlorfluazuron

medium dose 0.015% (13.21) at 4 DAS among others. At 8 DAS novaluron (9.73%) and lufenuron (10.79%) while remaining on par were significantly superior to the medium and lower dose of chlorfluazuron in terms of per cent leaf area damaged. Similar trend was observed at 15 DAS. Data on mean per cent plant infestation showed that emamectin benzoate (0.00%) recorded least per cent number of plants damaged/plot followed by chlorfluazuron 0.03% (7.01 %) and provided significantly better protection than all other treatments. Novaluron (13.47%) and lufenuron (11.99%) remained on a par with each other and gave significantly better protection than medium (0.05%) and lower (0.0075%) doses of chlorfluazuron. Though these two treatments recorded higher plant damage among all the treatments, the damage was significantly less than control (33.84%).

Pooled data of two seasons (2013-14 and 2014-15) showed that all the treatments recorded significantly higher cured leaf, bright leaf and better grade index than untreated control. Emamectin benzoate recorded highest (2485 kg/ha) cured leaf followed by chlorfluazuron 0.03% (2440) and remained on par with novaluron (2407) and lufenuron (2365). The cured leaf yield in the treatments of emamectin benzoate and chlorfluazuron higher dose (0.03%) was significantly higher than lower and medium doses of chlorfluazuron. Similar trend was observed for

**Table 1: Field efficacy of chlorfluazuron against *S.litura* (damaged tobacco leaves) 2013-15**

| Treatment | Mean number of leaves damaged/plant | | | | | |
|---|---|---|---|---|---|---|
| | 4 DAS | | 8 DAS | | 15 DAS | |
| | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 |
| Chlorfluazuron 5.4 EC 0.0075% | 1.66(1.77) | 1.72(1.97) | 1.86(2.46) | 1.90(2.60) | 1.95(2.80) | 1.95(2.80) |
| Chlorfluazuron 5.4 EC 0.015% | 1.48(1.20) | 1.57(1.46) | 1.60(1.57) | 1.67(1.78) | 1.69(1.86) | 1.68(1.85) |
| Chlorfluazuron 5.4 EC 0.03% | 1.09(0.19) | 1.09(0.19) | 1.09(0.19) | 1.12(0.26) | 1.09(0.19) | 1.12(0.26) |
| Novaluron 10 EC 0.01% | 1.21(0.46) | 1.21(0.46) | 1.22(0.50) | 1.24(0.53) | 1.29(0.66) | 1.24(0.53) |
| Lufenuron 5 EC 0.06% | 1.22(0.50) | 1.23(0.53) | 1.36(0.86) | 1.32(0.73) | 1.38(0.90) | 1.32(0.73) |
| Emamectin benzoate 5SG 0.0025% | 1.00(0.00) | 1.00(0.00) | 1.00(0.00) | 1.00(0.00) | 1.00(0.00) | 1.00(0.00) |
| Control (untreated) | 2.14(3.56) | 2.18(3.76) | 2.79(6.76) | 2.72(6.39) | 3.33(10.12) | 3.10(8.67) |
| S.Em± | 0.07 | 0.06 | 0.10 | 0.08 | 0.08 | 0.07 |
| CD ($p$=0.05) | 0.22 | 0.20 | 0.30 | 0.25 | 0.24 | 0.23 |

DAS= Days after spraying
Figures in parenthesis are transformed means

**Table 2 : Field efficacy of chlorfluazuron against *S. litura* (tobacco leaf area damaged)- 2013-15**

| Treatment | Mean per cent leaf area damaged/plant | | | | | | Mean % plants damaged/plot | |
|---|---|---|---|---|---|---|---|---|
| | 4 DAS | | 8 DAS | | 15 DAS | | | |
| | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 |
| Chlorfluazuron 5.4 EC 0.0075% | 16.04 (7.64) | 16.38 (7.97) | 16.70 (8.27) | 17.09 (8.64) | 17.71 (9.26) | 17.84 (9.39) | 24.90 (17.75) | 25.68 (18.79) |
| Chlorfluazuron 5.4 EC 0.015% | 13.89 (5.77) | 13.21 (5.23) | 14.18 (6.01) | 14.28 (6.09) | 16.91 (8.47) | 15.83 (7.44) | 22.19 (14.28) | 21.30 (13.21) |
| Chlorfluazuron 5.4 EC 0.03% | 2.71 (0.22) | 2.72 (0.23) | 2.71 (0.22) | 4.18 (0.53) | 2.71 (0.22) | 4.18 (0.53) | 3.50 (0.37) | 7.01 (1.49) |
| Novaluron 10 EC 0.01% | 10.89 (3.57) | 9.73 (3.51) | 10.89 (3.57) | 9.73 (2.86) | 11.31 (3.85) | 9.97 (3.00) | 11.99 (4.32) | 13.47 (5.43) |
| Lufenuron 5 EC 0.06% | 11.51 (3.99) | 10.79 (3.99) | 11.51 (3.99) | 10.79 (3.51) | 11.89 (4.25) | 11.08 (3.70) | 13.47 (5.43) | 11.99 (4.32) |
| Emamectin benzoate 5SG 0.0025% | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| Control (untreated) | 25.50 (18.54) | 23.55 (15.98) | 26.69 (25.54) | 25.25 (18.21) | 32.13 (28.30) | 30.86 (26.33) | 35.23 (33.30) | 33.84 (31.03) |
| S.Em± | 1.38 | 1.21 | 1.37 | 1.11 | 1.28 | 1.15 | 1.78 | 1.68 |
| CD ($p$=0.05) | 4.24 | 3.72 | 4.21 | 3.41 | 3.93 | 3.54 | 5.46 | 5.15 |

DAS= Days after spraying
Figures in parenthesis are transformed means

bright leaf yield and grade index. As regards to bright leaf yield, emamectin benzoate recorded highest (1163 kg/ha) followed by chlorfluazuron 0.03% (1130 kg/ha) and they remained on par with novaluron (1071 kg/ha) and lufenuron (1070 kg/ha). The data on grade index showed that emamectin benzoate recorded highest grade index (1603) followed by chlorfluazuron 0.03% (1555). Both of these remained on par with novaluron (1517) and lufenuron (1488). The lower and medium doses of chlorfluazuron recorded inferior bright leaf and grade index than all other treatments. Superior performance of emamectin benzoate against *S.litura* in tobacco as well as other crops has been reported earlier (Sreedhar, 2010; Hegde & Gadad 2017; Babu *et al.*, 2018; Ghosal *et al.*, 2018). Effectiveness of chlorfluazuron against S.litura and other lepidopterous pests was reported in previous studies (Perveen, 2000; El-Bokl ., *et al.*, 2018. Hashizume (1988) reported that higher dosages of chlorfluazuron applied to newly ecdysed fifth-instar larvae, had a devastating effect on the S. litura population by killing them during larval, pupal and adult stages. The present studies are in confirmity with the earlier reports.

The filed efficacy data based on number of leaves damaged, leaf area damaged and yield parameters, indicated that emamectin benzoate @ 0.0025% was most effective in protecting Virginia tobacco from *S.litura* followed by chlorfluazuron @ 0.03. It can be inferred that emamectin benzoate 5 SG @ 0.0025% and chlorfluazuron Atabron 5.4 EC @ 0.03 % may be used for the management of tobacco leaf eating caterpillar, *S.litura* in Virginia tobacco planted crop.

**Table 3: Evaluation of Chlorfluazuron against *S. litura*- yield parameters) 2013-15**

| Treatment | Yield parameters | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cured leaf | | | Bright leaf | | | Grade Index | | |
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| Chlorfluazuron 5.4 EC 0.0075% | 1720 | 2520 | 2120 | 760 | 1096 | 928 | 1180 | 1400 | 1290 |
| Chlorfluazuron 5.4 EC 0.015% | 1830 | 2650 | 2240 | 890 | 1160 | 1025 | 1348 | 1480 | 1414 |
| Chlorfluazuron 5.4 EC 0.03% | 1940 | 2940 | 2440 | 950 | 1276 | 1130 | 1460 | 1650 | 1555 |
| Novaluron 10 EC 0.01% | 1934 | 2880 | 2407 | 942 | 1200 | 1071 | 1454 | 1580 | 1517 |
| Lufenuron 5 EC 0.06% | 1900 | 2830 | 2365 | 910 | 1230 | 1070 | 1386 | 1590 | 1488 |
| Emamectin benzoate 5SG 0.0025% | 1980 | 2990 | 2485 | 996 | 1330 | 1163 | 1506 | 1700 | 1603 |
| Control (untreated) | 1400 | 2310 | 1855 | 640 | 956 | 798 | 986 | 1210 | 1098 |
| S.Em± | 42 | 82 | 57 | 29 | 60 | 38 | 50 | 78 | 55 |
| CD ($p$=0.05) | 131 | 251 | 168 | 91 | 185 | 111 | 156 | 240 | 160 |

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