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EVALUATION OF NOVALURON + EMAMECTIN BENZOATE AGAINST LEAF EATING CATERPILLAR, SPODOPTERA LITURA IN TOBACCO NURSERIES

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Tobacco caterpillar, *Spodoptera litura* F. is the key pest of tobacco nurseries and it is one of the major biotic dampers in successful production of healthy seedlings. Novaluron 5.25 % + emamectin benzoate 0.9 % SC @ 0.006%, 0.009 % & 0.012% was evaluated against *S.litura* in tobacco seed beds in a replicated trial in comparison with novaluron 10 EC @ 0.01%, emamectin benzoate 5 SG @ 0.0025%, chlorfenapyr 10 SC @ 0.01% and untreated control during 2015 and 2016 seasons. Results showed that emamectin benzoate 0.0025% recorded least seedling damage followed by novaluron 5.25 % + emamectin benzoate 0.9 % SC @ 0.012% & 0.009%. The seedling damage in the treatments of emamectin benzoate 0.025%, novaluron 5.25 % + emamectin benzoate 0.9 % SC @ 0.009% & 0.012% and chlorfenapyr 10 SC @ 0.01% were on á par with each other. The studies on persistent residual toxicity of the test insecticides showed that more than 90 per cent mortality was recorded in novaluron + emamectin benzoate up to 8 DAS. The period of persistency was 16 days in novaluron + emamectin benzoate 6.15 SC @ 0.012%. The mean persistent toxicity and persistent toxicity index were 69.13 & 1106.08 for novaluron 5.25 % + emamectin benzoate 0.9% SC @ 0.012%.

INTRODUCTION

Tobacco caterpillar, *Spodoptera litura* is the key pest of tobacco nurseries in India. The damage due to this pest in unprotected nurseries was as high as 80 -100 per cent in the years of severe incidence (Chari, 1987). The guidance residue levels (GRLs) of the recommended insecticides have been revised to a lower level by CORESTA (CORESTA, 2016). Repeated application of insecticides to control the pest is a common practice among nursery growers. Adverse effects of indiscriminate use of insecticides were already well documented. In order to overcome the problems, there is a need to replace the conventional insecticides with selective insecticides effective at low dose in tobacco. Search for safer alternatives for pest control, which are less aggressive for the environment has brought a significant development in identification and deployment of new insecticides, with possibilities of use in pest management and contributing to a safer and more efficient way of pest management. 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. Because of their desirable characteristics, such as low toxicity, less environmental pollution, high selectivity, and low impact on natural enemies and people, IGRs are used to control various insects. Novaluron is a benzoylphenyl urea IGR with good activity against lepidopetrous pests with low mammalian toxicity (Ishaaya *et al* ., 2002). Novaluron has been reported to be effective against *S.litura* on various crops (Dhawan *et al.*, 2008; Krishna *et al.*, 2008;

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Bhushan *et al.*, 2010; Panwar and Ghugali, 2015). As development of newer pesticide molecules is scanty pesticide mixtures have promising option that has the potential to increase the commercial lives of pesticides through their use in combinations, lowering their selection pressure and broadening the spectrum of activity. Hence, experiments were conducted with the objective of evaluating the bio-efficacy of a ready to use insecticide mixture formulation, novaluron 5.25 % + emamectin benzoate 0.9% SC (Barazide) against *S.litura* in tobacco seed beds.

MATERIALS AND METHODS

Tobacco nursery was raised with *Nicotiana tabacum* cv. Siri and the 400 seedlings were reset on m^2 beds. When the seedlings were six weeks old, 30 laboratory reared third instar (10 days old) *S.litura* larvae were released per bed. Spraying with the respective treatments was carried out with a high volume knapsack sprayer. Novaluron 5.25 % + emamectin benzoate 0.9 SC @ @ 0.006%, 0.009% & 0.012% was evaluated along with novaluron 10 EC @ 0.01%, emamectin benzoate 5 SG @ 0.0025%, chlorfenapyr 10 SC @ 0.01% and compared with untreated control in a replicated experiment. Observations on per cent seedlings damaged were recorded at 2, 4 and 8 days after spraying (DAS). The data were subjected to analysis of variance after transforming the values.

Persistence studies: An experiment was conducted to know the persistent residual toxicity of novaluron (5.25 %) + emamectin benzoate (0.9 % SC) on tobacco in comparison with emamectin benzoate 5 SG @ 0.0025%, novaluron 10 EC @ 0.01% and chlorfenapyr 10 SC @ 0.01%. Leaves from the treated nursery beds were offered daily to 10 days old *S.litura* larvae in plastic jars till the mortality dropped to zero. Persistent toxicity index was calculated following Pradhan (1967).

RESULTS AND DISCUSSION

All the treatments were significantly superior to control during 2015 as shown by less seedlings damaged at 2, 4 and 8 DAS (Table 1). At 2 DAS emamectin benzoate 5 SG @ 0.0025% recorded least (2.61%) seedling damage followed by novaluron + emamectin benzoate 6.15 SC @ 0.012% (3.96) and novaluron+ emamectin benzoate 6.15 SC @ 0.009% (5.71). The seedling damage in the treatments of emamectin benzoate 5 SG @ 0.025% and novaluron + emamectin benzoate 6.15 SC @ 0.012% was on a par with each other. At 4 DAS the treatments of emamectin benzoate 5 SG @ 0.0025%, novaluron+ emamectin benzoate 6.15 % SC @ 0.009% & 0.012% and chlorfenapyr 10 SC @ 0.01% were found to be at par with each other. Similar trend was observed at 8 DAS. Among all the treatments highest damage was recorded in the treatment of novaluron 10 EC @ 0.01% at all the observations though it was significantly less than untreated control.

During 2016 emamectin benzoate 5 SG @ 0.0025% recorded least (3.01%) seedling damage followed by novaluron + emamectin benzoate 6.15 SC @ 0.012% (4.36) and chlorfenapyr 10 SC @ 0.01% (4.52) which was on a par with each other at 2 DAS. At 4 DAS similar trend was observed except that novaluron+ emamectin benzoate 6.15 SC @ 0.009% was also found to be on a par with these treatments. At 8 DAS similar trend was observed. During 2016 also highest damage was recorded in the treatment of novaluron 10 EC @ 0.01% at all the observations though it was significantly less than untreated control.

Pooled data of two seasons showed that emamectin benzoate 5 SG @ 0.0025% and novaluron + emamectin benzoate 6.15 SC @ 0.012% at 2 DAS was on a par with each other while novaluron+ emamectin benzoate 6.15 SC @ 0.012% was found to be on a par with chlorfenapyr 10 SC @ 0.01% and lower dose (0.009%) of novaluron+ emamectin benzoate 6.15 SC. At 4 & 8 DAS similar trend was observed. Effectiveness of emamectin benzoate against *S.litura* is well established (Sreedhar, 2010; Hegde & Gadad 2017; Babu *et al.*, 2018; Ghosal *et al.*, 2018). Novaluron was reported to be effective against *S.litura* on various crop viz., cotton (Dhawan *et al.*, 2008), groundnut (Krishna *et al.*, 2008), potato (Bhushan *et al.*, 2010) and soybean (Panwar and Ghugali, 2015). Similarly effectiveness of novaluron 5.25 % + emamectin benzoate against *S.litura* on cabbage and chilli without any phytotoxic symptoms was reported (Ghosal and Chatterjee, 2017; Ruth *et al.*, 2017) and the present studies are in conformity with those reports.

Table 1: Bio-Efficacy of Novaluron + emamectin benzoate against *S.litura* in tobacco seedbeds during 2015 & 2016

Treatments	Per cent seedlings damaged								
	2015	2016 2DAS	Pooled	2015	2016 4DAS	Pooled	2015	2016 8DAS	Pooled
Novaluron+ Emamectin benzoate 6.15 SC 0.006%	9.21 (2.56)	9.35 (2.64)	9.28	9.51 (2.73)	9.51 (2.73)	9.51	10.60 (3.39)	10.46 (3.30)	10.53
Novaluron+ Emamectin benzoate 6.15 SC 0.009%	5.71 (0.99)	5.93 (1.07)	5.82	5.70 (0.98)	5.17 (0.81)	5.43	6.81 (1.41)	6.62 (1.33)	6.71
Novaluron+ Emamectin benzoate 6.15 SC 0.012%	3.96 (0.48)	4.36 (0.58)	4.16	4.05 (0.50)	3.01 (0.27)	3.53	5.40 (0.89)	5.17 (0.81)	5.28
Novaluron 10 EC 0.01%	9.39 (2.66)	9.21 (2.56)	9.30	7.40 (1.66)	7.01 (1.49)	7.20	8.59 (2.23)	8.42 (2.15)	8.50
Emamectin benzoate SG 0.0025%	2.61 (0.21)	3.01 (0.27)	2.81	3.66 (0.41)	2.70 (0.22)	3.18	5.17 (0.81)	4.52 (0.62)	4.84
Chlorfenapyr 10 SC @ 0.01%	6.10 (1.13)	4.52 (0.62)	5.31	5.40 (0.89)	5.17 (0.81)	5.28	6.50 (1.28)	5.40 (0.89)	5.95
Untreated control	26.50 (26.45)	33.60 (30.64)	30.05	33.16 (29.94)	34.49 (32.08)	33.82	33.97 (29.64)	34.66 (32.36)	34.31
S.Em±	0.82	0.85	0.63	0.74	0.85	0.59	0.67	0.74	0.52
CD at 5%	2.52	2.62	1.86	2.59	2.61	1.72	2.05	2.26	1.52
CV %	14.68	14.53	14.46	12.95	15.13	14.06	10.63	11.86	11.40

Figures in parentheses are retransformed means

Persistent Residual Toxicity:

The data (Table 2) show that emamectin benzoate 5 SG @ 0.0025% and chlorfenapyr 10 SC @ 0.01% were the most persistent insecticides, which gave cent per cent mortality of *S.litura* till 6 DAS. Among others, cent per cent mortality was observed up to 4 days in novaluron + emamectin benzoate 6.15 SC @ 0.012% and novaluron 10 EC @ 0.01%. More than 90 per cent mortality was recorded in novaluron + emamectin benzoate 6.15 SC @ 0.012% up to 8 DAS and 6 DAS in novaluron 10 EC @ 0.01%. The period of persistency was longest (16 days) in case of emamectin benzoate 5 SG @ 0.0025%, chlorfenapyr 10 SC @ 0.01% and novaluron + emamectin benzoate 6.15 SC @ 0.012% where as it was 12 days for novaluron 10 EC @ 0.01%. The mean persistent toxicity was highest (75.13) in emamectin benzoate followed by chlorfenapyr (71.71) and novaluron+emamectin benzoate 6.15 SC @ 0.012% (69.13). Similarly the persistent toxicity index was also highest (1202.08) in emamectin benzoate followed by chlorfenapyr 0.01 % (1147.36) and novaluron+emamectin benzoate 0.012% (1106.08). The persistent toxicity index (PTI) was 772.08 for novaluron 0.01%. The reduction in effectiveness started from 8 DAS in emamectin benzoate (4.4%), and chlorfenapyr (9.2%); 6 DAS in novaluron+emamectin benzoate 0.012% (2%) and novaluron (9.2%). Based on the results the order of persistency was found to be emamectin benzoate 0.0025% > chlorfenapyr

Table 2: Persistent residual toxicity of Novaluron 5.25 % + emamectin benzoate 0.9 SC against *S.litura*

Treatment	Percent mortality (Days after application)												Period of persis tency (P)	Mean persis tent Toxi city (PT)	Persis tent toxi city index (PTI)
	0	2	4	6	8	10	12	14	16	18	20	22			
Novaluron+ Emamectin benzoate 6.15 SC 0.009%	100	100	98.6	82.8	68.4	50.2	32.8	6.6	0.0	-	-	-	14	67.42	943.88
Novaluron+ Emamectin benzoate 6.15 SC 0.012%	100	100	100	98.0	92.0	70.6	40.6	16.8	4.2	0.0	-	-	16	69.13	1106.08
Novaluron 10 EC 0.01%	100	100	100	90.8	40.0	14.8	5.2	0.0	-	-	-	-	12	64.40	772.8
Emamectin benzoate 5SG 0.0025%	100	100	100	100	95.6	76.8	52.2	36.8	14.8	0.0	-	-	16	75.13	1202.08
Chlorfenapyr 10 SC @ 0.01%	100	100	100	100	90.8	74.4	48.6	24.8	6.8	0.0	-	-	16	71.71	1147.08

0.01% > novaluron+emamectin benzoate 0.012% > novaluron 0.01%.

Based on the bio- efficacy data for two seasons and studies on persistent residual toxicity, it is evident that emamectin benzoate 5 SG @ 0.0025% recorded least seedling damage followed by novaluron 5.25 % + emamectin benzoate 0.9 % SC @ 0.009% & 0.012% and chlorfenapyr 10 SC @ 0.01%. It is concluded that novaluron 5.25 %+ emamectin benzoate 0.9% SC @ 0.012% and chlorfenapyr 10 SC @ 0.01% can be used along with emamectin benzoate 5 SG @ 0.0025 % for management of tobacco leaf eating caterpillar *S.litura* in tobacco nurseries.

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