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Rakesh Nayaka S
Department of Entomology, College of Agriculture, Shivamogga, Karnataka, India

Pradeep S
Department of Entomology, College of Agriculture, Shivamogga, Karnataka, India

Naveena JB
Department of Entomology, College of Agriculture, Shivamogga, Karnataka, India

Corresponding Author:
Rakesh Nayaka S
Department of Entomology, College of Agriculture, Shivamogga, Karnataka, India

Evaluation of insecticides against tobacco caterpillar, *Spodoptera litura* on cabbage during 2016

Rakesh Nayaka S, Pradeep S and Naveena JB

Abstract
The experiment was laid out at farmers field Kommanal, Shivamogga, under field condition in a Randomized Block Design (RBD) with three replications consisting of eight treatments. The overall mean of different insecticides from first and second spray indicated that chlorantraniliprole proved very effective in recording lowest larval population of 0.38 and 0.29 larva per plant being statistically on par with flubendiamide (0.47 and 0.36), emamectin benzoate (0.51 and 0.42), spinosad (0.60 and 0.47), indoxacarb(0.69 and 0.56) and dichlorvos (0.76 and 0.62). NSKE (0.84 and0.73) was least effective compared to other treatments. While untreated check registered highest number of larvae per plant (4.49 and 5.73).

Keywords: NSKE, flubendiamide, chlorantraniliprole, shivamogga

Introduction
Cabbage, *Brassica oleracea* L. var. *capitata* (Brassicaceae), is of Cyprus and Mediterranean origin. It is an economically important cruciferous vegetable. It is grown for its edible enlarged round terminal buds, which is rich source of Ca, P, Na, K, S, vitamin A, vitamin C, carbohydrates and dietary fiber. Major cabbage growing states are in the country are Uttar Pradesh, Orissa, Bihar, Assam, West Bengal, Maharashtra, Tamil Nadu (Nilgiris) and Karnataka, it is grown on area of 10,490 hectares with a production of 2.212 lakh MT (Anon., 2015) [5] and the major cabbage producing belts are Belgaum, Hassan, Mysore and Dakshin Kannada (Anon., 2015) [5]. Lepidopteron larvae are the most destructive pests of cabbage and are often controlled with insecticide. Cabbage, being a highly payable vegetable crop, intensive plant protection measures involving use of a large quantity of different insecticides is adopted. These applications are calendar-based rather than need-based. In spite of large scale and repeated applications of insecticides, the pest has been found to occur in severe form in all cabbage growing areas. Most of these applications may be unwanted or may not be timely. This practice not only results in increase in production cost but also lead to considerable complications in the ecosystem. Although several insecticides are available in market, the crop failures are very common in cabbage due to severity of the defoliator pests and the resistance developed by them especially diamondback moth. In addition to the development of resistance in pests, indiscriminate and injudicious use of pesticides has grossly poisoned almost each component of the biosphere, caused resurgence of pests and reduction in natural enemies in agro-ecosystems allowing rapid rebound of target and minor pest. Therefore, it is found necessary to evaluate new insecticides for the control of Spodoptera litura on cabbage.

Materials and Methods
The experiment was laid out at farmers field Kommanal, Shivamogga, under field condition in a Randomized Block Design (RBD) with three replications consisting of eight treatments. Cabbage seeds were sown during first week of July, 2016. When seedlings were of 25 days old, they were transplanted to main field on 27th of July, with experimental plot size of 4 × 3 m^2 and spacing of 60 × 45 cm between rows and plants, respectively. The crop was raised by following all the recommended package of practices except plant protection practices for insect control. Observation on number of larvae and pupa per plant was counted from randomly selected five plants, one day before, 3, 5 and 7 days after imposition of treatments. The statistical analysis of the data obtained from managemental trails was done using analysis of variance (ANOVA) using Web Agri Stat Package (WASP-2) developed by Indian Council of Agricultural Research, Research Complex, and Goa. Data were transformed by Arc sin transformation before subjecting to ANOVA.

Result

The result revealed that, at three days after first spray Table.1 chlorantraniliprole 18.5 SC recorded 0.53 number of larva per plant which was on par with flubendiamide 480 SC (0.60 larva per plant) and emamectin benzoate 5 SG (0.67 larva per plant). The next best treatment were spinosad 45 SC (0.80 larva per plant) followed by indoxacarb 15.8 EC, dichlorvos 76 EC and NSKE with 0.93, 1.00 and 1.07 number of larva per plant, respectively. Whereas, untreated check registered highest number of larvae per plant *i.e.,* 4.07 number of larvae per plant. At five days after spraying, a significant lower population was observed in chlorantraniliprole 18.5 SC (0.40 larva per plant) and was on par with flubendiamide 480 SC, emamectin benzoate 5 SG (both 0.53 larva per plant) and spinosad 45 SC (0.60 larva per plant). Further, indoxacarb 15.8 EC and dichlorvos 76 EC recorded the larval population of 0.67 and 0.73 larvae per plant, respectively and were on par with each other. NSKE (0.80 larva per plant) was found to be least effective compared to other treatments. However, the highest population was recorded in untreated control (4.53 larvae/ plant).Almost similar trend of results was recorded on seventh day after spraying, chlorantraniliprole 18.5 SC recorded least number of larva per plant (0.20) and it was on par with flubendiamide 480 SC, emamectin benzoate 5 SG and spinosad 45 SC (0.27, to 0.40 larva per plant). Further, indoxacarb 15.8 EC and dichlorvos 76 EC recorded larval population of 0.47 and 0.53 respectively and these were on par with each other. NSKE (0.67) was found to be least effective compared to other treatments. However, untreated control remained inferior by recording highest larval population (4.87 larvae per plant).

The overall mean number of larvae in different insecticides indicated that chlorantraniliprole proved very effective in recording lowest number of larva per plant of 0.38 was on par with flubendiamide and emamectin benzoate (0.47 and 0.51 larva per plant) followed by spinosad (0.60 larva per plant). The next best were indoxacarb (0.69) and dichlorvos (0.76 larva per plant) were on par with each other. NSKE (0.84 larva per plant) was found to be least effective compared to other treatments. While untreated check registered highest number of larvae per plant (4.49 larvae per plant).

After three days of second spray, table. 2 the results showed significant differences among all the treatments. Lowest number of larva per plant was recorded with chlorantraniliprole 18.5 SC was on par flubendiamide 480 SC, emamectin benzoate 5 SG, spinosad 45 SC and indoxacarb 15.8 EC (0.40 to 0.63 larva per plant). Dichlorvos 76 EC recorded larval population 0.73 found to be next best treatment. NSKE (0.87) was found to be least effective compared to other treatments. However, all other treatments recorded lower number of larvae per plant and superior over untreated check (5.53).

Five days after spray, the larval population varied between 0.27 to 5.73 larvae per plant. Among the treatments, a significant lower population was observed in chlorantraniliprole 18.5 SC along with flubendiamide 480 SC, emamectin benzoate 5 SG, spinosad 45 SC and indoxacarb 15.8 EC (0.20 to 0.53 larva per plant) were on par with each other. Dichlorvos 76 EC with 0.60 larva per plant, stood next best treatment. Further, NSKE (0.73) was found to be least effective compared to other treatments. However, significantly highest larval population was recorded in untreated control (5.73 larvae per plant).The observations recorded at seven days after second spray revealed that, chlorantraniliprole 18.5 SC recorded lowest population 0.20 larvae per plant which was on par with flubendiamide 480 SC, emamectin benzoate 5 SG, spinosad 45 SC and indoxacarb 15.8 EC (0.33 to 0.47 larva per plant). Followe which recorded 0.53 larva per plant found to be next best treatment. NSKE (0.60) was found to be least effective compared to other treatments. However, significantly highest larval population was recorded in untreated control (5.93 larvae per plant). The overall mean number of larvae in different insecticide at treatment indicated that chlorantraniliprole proved very effective in recording lowest number of larva per plant of 0.29 and was on par with flubendiamide, emamectin benzoate, spinosad and indoxacarb (0.36 to 0.56 larva per plant). Further, dichlorvos (0.62 larva per plant) found to be next best treatment. NSKE (0.73) was found to be least effective compared to other treatments. While untreated check registered highest number of larvae per plant (5.73).

Table 1: Evaluation of insecticides against tobacco caterpillar, *Spodoptera litura* on cabbage during 2016 (First spray)

S. No.	Treatments	Dosage	Mean number of larvae/plant				Mean
			1DBFS	3DAFS	5DAFS	7DAFS	
T1	Flubendiamide 480 SC	0.20 ml/l	3.53 (2.01)	0.60 (1.05)^{cd}	0.53 (1.02)^{cd}	0.27 (0.87)^{cd}	0.47 (0.98)^{ef}
T2	Chlorantraniliprole 18.5 SC	0.1 ml/l	3.53 (2.01)	0.53 (1.02)^{d}	0.40 (0.94)^{d}	0.20 (0.84)^{d}	0.38 (0.94)^{f}
T3	Spinosad 45 SC	0.20 ml/l	3.93 (2.10)	0.80 (1.14)^{bc}	0.60 (1.05)^{bcd}	0.40 (0.94)^{bcd}	0.60 (1.05)^{cde}
T4	Indoxacarb 15.8 EC	0.54 ml/l	3.80 (2.07)	0.93 (1.19)^{b}	0.67 (1.08)^{bc}	0.47 (0.98)^{bc}	0.69 (1.09)^{bcd}
T5	Dichlorvos 76 EC	1.70 ml/l	3.67 (2.04)	1.00 (1.22)^{b}	0.73 (1.11)^{bc}	0.53 (1.01)^{bc}	0.76 (1.12)^{bc}
T6	Emamectin benzoate 5 SG	0.40 g/l	3.93 (2.10)	0.67 (1.08)^{cd}	0.53 (1.02)^{cd}	0.33 (0.91)^{cd}	0.51 (1.01)^{def}
T7	NSKE 5%	-	3.87 (2.09)	1.07 (1.25)^{b}	0.80 (1.14)^{b}	0.67 (1.08)^{b}	0.84 (1.16)^{b}
T8	Untreated check	-	3.6 (2.02)	4.07 (2.14)^{a}	4.53 (2.24)^{a}	4.87 (2.32)^{a}	4.49 (2.23)^{a}
SEm±			0.06	0.03	0.03	0.04	0.02
CD (p=0.05)			0.20	0.10	0.11	0.12	0.08

Observations: 5 plants per plot, Figures in the parentheses are$\sqrt{}$ x+0.5 transformed values, Means followed by same letters do not differ significantly by DMRT (P=0.05), DBFS- Day Before First Spray, DAFS- Days After First Spray

Table 2: Evaluation of insecticides against tobacco caterpillar, *Spodoptera litura* on cabbage during 2016 (Second spray)

S. No.	Treatments	Dosage	Mean number of larvae/plant				Mean
			1 DBSS	3 DASS	5 DASS	7 DASS	
T1	Flubendiamide 480 SC	0.20 ml/l	3.87 (2.09)	0.47 (0.98)^{de}	0.33 (0.91)^{cd}	0.27 (0.87)^{cd}	0.36 (0.92)^{de}
T2	Chlorantraniliprole 18.5 SC	0.1 ml/l	3.60 (2.02)	0.40 (0.94)^{e}	0.27 (0.87)^{d}	0.20 (0.84)^{d}	0.29 (0.89)^{e}
T3	Spinosad 45 SC	0.20 ml/l	4.33 (2.20)	0.53 (1.01)^{cde}	0.47 (0.98)^{bcd}	0.40 (0.94)^{bcd}	0.47 (0.98)^{cde}
T4	Indoxacarb 15.8 EC	0.54 ml/l	4.47 (2.22)	0.67 (1.08)^{bcd}	0.53 (1.02)^{bcd}	0.47 (0.98)^{bcd}	0.56 (1.03)^{bcd}
T5	Dichlorvos 76 EC	1.70 ml/l	4.87 (2.31)	0.73 (1.11)^{bc}	0.60 (1.05)^{bc}	0.53 (1.02)^{bc}	0.62 (1.06)^{bc}
T6	Emamectin benzoate 5 SG	0.40 g/l	4.07 (2.14)	0.53 (1.02)^{cde}	0.40 (0.94)^{cd}	0.33 (0.91)^{bcd}	0.42 (0.96)^{cde}
T7	NSKE 5%	-	4.93 (2.33)	0.87 (1.17)^{b}	0.73 (1.11)^{b}	0.60 (1.05)^{b}	0.73 (1.11)^{b}
T8	Untreated check	-	5.33 (2.41)	5.53 (2.46)^{a}	5.73 (2.50)^{a}	5.93 (2.54)^{a}	5.73 (2.50)^{a}
Em±			0.05	0.03	0.04	0.04	0.03
CD (p=0.05)			0.17	0.11	0.14	0.13	0.09

Observations: 5 plants per plot, Figures in the parentheses are√ x+0.5 transformed values, Means followed by same letters do not differ significantly by DMRT (P=0.05), DBSS- Day Before Second Spray, DASS- Days After Second Spray

Discussion

Mean of different insecticides from first and second spray indicated that chlorantraniliprole proved very effective in recording lowest larval population of 0.38 and 0.29 larva per plant being statistically on par with flubendiamide (0.47 and 0.36), emamectin benzoate (0.51 and 0.42), spinosad (0.60 and 0.47), indoxacarb (0.69 and 0.56) and dichlorvos (0.76 and 0.62). NSKE (0.84 and 0.73) was least effective compared to other treatments. While untreated check registered highest number of larvae per plant (4.49 and 5.73). Chlorantraniliprole shown excellent control of *S. litura*on cabbage, these studies are in accordance with Deepa (2015) and Meena *et al*. (2014) [4]. Ratnasri (2012) [3] revealed that flubendiamide, emamectin benzoate, spinosad, perfomed best when they compared with other molecules. Paliwal and Oommen (2005) [1] reported that spinosad was most effective against tobacco caterpillar, *S. litura*in cauliflower. Amongst various doses tested, 60 g a.i. ha^{-1}gave maximum population reduction of *S. litura* (88.03 per cent) after seven days of first spraying, whereas, in the second spray higher reduction of 96.98 per cent was achieved in three days which increased to 100 per cent after seven days of spray and same performance continued thereafter. Similarly, Latha (2012) [2] observed that hundred per cent control was observed at seven and fifteen days after application of spinosad.

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