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EFFICACY OF INSECTICIDES AGAINST *SPODOPTERA LITURA* AND *TRICHOPLUSIA ORICHALCEA* IN CABBAGE

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ABSTRACT

A field experiment was conducted in a farmer's field near Chidambaram to evaluate some pesticides against key cabbage insect pests during kharif 2018 and summer 2019. The results revealed that emamectin benzoate 5SG, spinosad 45SC, flubendiamide 39.35SC, indoxacarb 14.5SC, chlorfenapyr 10SC and lambda cyhalothrin 5EC effectively reduced the incidence of *Spodoptera litura* (L.) and *Trichoplusia orichalcea* (F.) Maximum reduction was accomplished with flubendiamide and spinosad. Occurrence of natural enemies when evaluated did not reveal statistically significant differences. Maximum yield was obtained with flubendiamide (24.08, 25.15 t/ ha) followed by spinosad (23.41, 23.19 t/ ha).

Key words: Cabbage, *Spodoptera litura*, *Trichoplusia orichalcea*, flubendiamide 39.35%SC, spinosad 45%SC, incidence, natural enemies, *Cotesia plutella*, *Diadegma semiclaus*, *Chrysoperla carnea,* yield

Cabbage (*Brassica oleracea* var. capitata L.) is a popular cruciferous vegetable, and in India it is grown on >2.4 lakh ha, with an annual production of roughly 56.2 lakh mt (Sarma et al., 2018). Many bottlenecks affect cabbage yield including insect pests. Insect pests alone cause yield losses ranging from 57 to 97%, as it is attacked by 37 insect pests in India. Diamond back moth *Plutella xylostella* (L.), cabbage butterfly *Pieris canidia* (L.), tobacco leaf eating caterpillar *Spodoptera litura* (L), cutworm *Agrotis ipsilon* (Hfn.), cabbage borer *Hellula undalis* F., and semilooper *Trichoplusia orichalcea* (F.) are among them (Sharma et al., 2017). Insecticides are used to protect and improve crop yields by controlling various insect pests (Liu et al., 2001). Insecticides used should also be biodegradable and ecologically beneficial (Rosell et al., 2008). Pesticides have been used indiscriminately resulting in resistance to insecticides (Archunan and Pazhanisamy, 2020). This study evaluates some new pesticides with unique modes of action against cabbage insect pests.

MATERIALS AND METHODS

The field experiment was carried out in two seasons, kharif 2018 and summer 2019. Each treatment consisted of two sprays applied using a high-volume hand-operated knapsack sprayer with 1250 l/ ha. The experiments were laid out in randomized block design (RBD) comprising seven treatments and three replications. First spray was applied at 40 days after transplanting and repeated after 15 days of first spray. The treatments included emamectin benzoate 5SG (0.5 g/ l), spinosad 45SC (0.5 ml/ l), flubendiamide 39.35SC (0.5 ml/ l), indoxacarb 14.5SC (2.0 ml/ l), chlorfenapyr 10SC (1.5 ml/ l) and lambda cyhalothrin 5EC (2.0 ml/ l), and untreated control. When ETL of 2 larvae/ plant was observed sprays were given. Observations were made from five plants selected and tagged/ plot- *S. litura* and *T. orichalcea* were counted one day prior to treatment (pretreatment) and at 3, 7, 10 and 15 days after each spray. Natural enemies such as *Cotesia plutella* Kurdjumov, *Diadegma semiclaus* Horstmann and *Chrysoperla carnea* Steinmann occurring in the field were counted likewise, one day before treatment and on the 15th day after each spray. The marketable cabbage heads were weighed and converted to t/ ha. After appropriate transformation the data were subjected to ANOVA with means separated using CD (p=0.05) using OPSTAT software.

RESULTS AND DISCUSSION

The results revealed the least counts of *S. litura* with flubendiamide at 3, 7, 10, and 15 days after spray (DAS) during kharif 2018 and summer 2019. Meena et al. (2013) also found that flubendiamide 39.35% SC was effective against the chilli defoliator *S. litura*. Selvam et al. (2020) observed the least larval counts of *Maruca vitrata* Geyer when flubendiamide was used. Flubendiamide treated larvae get affected by paralysis and death (Cordova et al., 2006; Sharma et al., 2019; Anon, 2021). Second best was spinosad

Table 1. Efficacy of insecticides against *S. litura* and *T. orichalcea* on cabbage (kharif 2018, summer 2019)

	Dose (g or ml /l)	Kharif 2018										Summer 2019									
		PTC	No. of *S. litura* larvae / 5 plants								% ROC	PTC	No. of *S. litura* larvae / 5 plants								% ROC
			1st Spray				2nd Spray						1st Spray				2nd Spray				
			3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS			3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	
Emamectin Benzoate 5% SG	0.5	7.01 (2.83)	1.54 (1.59)	1.05 (1.43)	2.29 (1.81)	2.99 (1.99)	0.00 (1.00)	0.00 (1.00)	0.52 (1.23)	1.27 (1.49)	87.81	5.18 (2.48)	1.57 (1.60)	1.08 (1.44)	1.33 (1.53)	1.46 (1.57)	0.00 (1.00)	0.41 (1.18)	0.45 (1.20)	1.13 (1.46)	88.95
Spinosad 45% SC	0.5	7.28 (2.88)	1.24 (1.50)	0.57 (1.24)	1.23 (1.49)	1.83 (1.68)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.80 (1.34)	92.84	5.78 (2.60)	1.14 (1.46)	0.74 (1.32)	1.05 (1.43)	1.16 (1.47)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.68 (1.29)	92.92
Flubendiamide 39.35% SC	0.5	7.70 (2.95)	0.69 (1.30)	0.06 (1.03)	0.42 (1.19)	1.14 (1.46)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.33 (1.15)	96.68	6.53 (2.74)	0.86 (1.36)	0.49 (1.22)	0.75 (1.32)	0.80 (1.34)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.33 (1.15)	95.20
Indoxacarb 14.5% SC	2.0	7.01 (2.83)	3.34 (2.08)	3.17 (2.04)	4.59 (2.35)	7.67 (2.94)	1.90 (1.70)	2.48 (1.86)	3.29 (2.07)	4.46 (2.33)	60.98	5.64 (2.57)	3.27 (2.06)	2.82 (1.95)	3.84 (2.19)	4.81 (2.41)	2.56 (1.88)	2.43 (1.85)	3.43 (2.10)	3.79 (2.19)	59.96
Chlorfenapyr 10% SC	1.5	7.96 (2.99)	3.65 (2.16)	3.29 (2.06)	6.50 (2.74)	9.25 (3.20)	3.33 (2.08)	3.46 (2.11)	5.45 (2.54)	7.59 (2.92)	46.31	6.25 (2.69)	4.28 (2.30)	4.16 (2.27)	5.42 (2.53)	6.67 (2.77)	3.88 (2.21)	3.11 (2.03)	4.19 (2.27)	4.63 (2.37)	46.01
Lambda cyhalothrin 5% EC	2.0	7.27 (2.88)	2.99 (2.00)	2.40 (1.84)	3.78 (2.19)	4.43 (2.32)	0.00 (1.00)	0.63 (1.26)	1.91 (1.69)	2.43 (1.85)	76.56	6.25 (2.69)	2.42 (1.84)	1.89 (1.70)	2.98 (1.99)	3.33 (2.08)	1.57 (1.60)	1.54 (1.59)	2.11 (1.76)	2.53 (1.88)	72.69
Untreated control	-	7.23 (2.87)	7.75 (2.95)	8.36 (3.06)	9.50 (3.24)	10.83 (3.44)	10.04 (3.32)	10.26 (3.35)	10.59 (3.4)	11.86 (3.59)	0.00	6.06 (2.66)	6.88 (2.81)	7.36 (2.89)	7.91 (2.99)	8.43 (3.07)	8.89 (3.14)	9.02 (3.17)	9.37 (3.22)	9.41 (3.22)	0.00
C.D at 5%		NS	0.24	0.29	0.33	0.31	0.17	0.28	0.26	0.25		NS	0.22	0.17	0.19	0.20	0.17	0.23	0.22	0.18	
SE(m)		0.04	0.08	0.09	0.11	0.10	0.05	0.09	0.08	0.08		0.09	0.07	0.05	0.06	0.06	0.05	0.07	0.07	0.06	

Treatments	Dose (g or ml /l)	Kharif 2018										Summer 2019									
		PTC	No. of *T. orichalcea* larvae / 5 plants								% ROC	PTC	No. of *T. orichalcea* larvae / 5 plants								% ROC
			1st Spray				2nd Spray						1st Spray				2nd Spray				
			3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS			3 DAS	7 DAS	10 DAS	15 DAS	3 DAS	7 DAS	10 DAS	15 DAS	
Emamectin Benzoate 5% SG	0.5	4.12 (2.26)	1.77 (1.66)	1.02 (1.42)	1.17 (1.47)	1.71 (1.64)	0.00 (1.00)	0.00 (1.00)	0.99 (1.41)	1.40 (1.54)	82.22	4.57 (2.36)	1.93 (1.71)	1.00 (1.41)	1.10 (1.45)	2.10 (1.74)	0.08 (1.04)	0.00 (1.00)	0.37 (1.15)	1.72 (1.65)	83.22
Spinosad 45% SC	0.5	4.33 (2.31)	0.92 (1.38)	0.31 (1.14)	0.47 (1.21)	0.97 (1.40)	0.00 (1.00)	0.00 (1.00)	0.48 (1.22)	0.83 (1.35)	91.23	4.56 (2.36)	1.41 (1.55)	0.80 (1.34)	0.67 (1.28)	1.07 (1.43)	0.00 (1.00)	0.00 (1.00)	0.17 (1.08)	0.87 (1.37)	89.83
Flubendiamide 39.35% SC	0.5	4.26 (2.29)	0.59 (1.25)	0.00 (1.00)	0.24 (1.11)	0.47 (1.21)	0.00 (1.00)	0.00 (1.00)	0.27 (1.12)	0.52 (1.23)	95.40	4.57 (2.36)	0.85 (1.34)	0.40 (1.18)	0.10 (1.05)	0.53 (1.24)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.67 (1.29)	94.79
Indoxacarb 14.5% SC	2.0	4.28 (2.30)	1.95 (1.72)	2.12 (1.76)	2.38 (1.83)	2.90 (1.97)	1.15 (1.46)	1.00 (1.41)	2.11 (1.76)	2.52 (1.87)	60.21	4.78 (2.41)*	2.61 (1.91)	2.42 (1.85)	2.87 (1.97)	5.08 (2.46)	2.02 (1.73)	2.39 (1.84)	2.50 (1.87)	4.13 (2.26)	50.97
Chlorfenapyr 10% SC	1.5	4.17 (2.27)	2.12 (1.76)	2.73 (1.93)	2.74 (1.93)	3.14 (2.03)	1.20 (1.48)	1.36 (1.54)	3.16 (2.04)	4.43 (2.33)	58.19	4.70 (2.39)	2.10 (1.91)	2.07 (1.75)	2.40 (1.84)	4.43 (2.32)	1.47 (1.57)	2.13 (1.77)	2.27 (1.81)	4.67 (2.38)	54.86
Lambda cyhalothrin 5% EC	2.0	4.23 (2.29)	2.50 (1.87)	2.45 (1.85)	3.26 (2.06)	3.55 (2.13)	1.66 (1.63)	1.83 (1.68)	4.05 (2.24)	4.99 (2.45)	46.46	4.47 (2.34)	3.77 (2.18)	4.03 (2.24)	4.43 (2.33)	5.37 (2.51)	3.67 (2.15)	3.90 (2.21)	6.07 (2.66)	7.08 (2.84)	21.75
Untreated control	-	4.59 (2.36)	5.02 (2.44)	4.90 (2.42)	5.32 (2.50)	5.83 (2.61)	5.58 (2.56)	5.72 (2.59)	6.30 (2.70)	6.68 (2.77)	0.00	4.68 (2.38)	5.02 (2.45)	5.17 (2.48)	5.08 (2.46)	5.53 (2.55)	6.01 (2.65)	6.50 (2.73)	7.40 (2.90)	8.27 (3.04)	0.00
C.D at 5%		NS	0.29	0.31	0.31	0.27	0.20	0.21	0.22	0.20		NS	NS	0.25	0.28	0.25	0.39	0.21	0.18	0.20	
SE(m)		0.05	0.09	0.10	0.10	0.09	0.06	0.07	0.07	0.07		0.09	0.05	0.08	0.09	0.08	0.13	0.07	0.06	0.07	

PTC – Pre-treatment count, DAS- Day after spraying, *Figures in the parentheses are square root transformed values

Table 2. Occurrence of natural enemies in treatments (kharif 2018, summer 2019)

Treatments	Dose (g or ml/lit)	Kharif 2018							Summer 2019						
		C. plutella		*D. semiclausm*		*C. carnea*		Yield (t/ha)	*C. plutella*		*D. semiclausm*		*C. carnea*		Yield (t/ ha)
		PTC	15 DAS	PTC	15 DAS	PTC	15 DAS		PTC	15 DAS	PTC	15 DAS	PTC	15 DAS	
Emamectin Benzoate 5% SG	0.5	1.73 (1.65)	1.85 (1.69)	1.49 (1.58)	2.22 (1.79)	1.41 (1.55)	1.50 (1.58)	12.11	1.63 (1.62)	1.80 (1.67)	1.45 (1.57)	1.89 (1.7)	1.45 (1.56)	1.57 (1.60)	12.45
Spinosad 45% SC	0.5	1.70 (1.64)	1.89 (1.7)	1.43 (1.56)	2.17 (1.78)	1.38 (1.54)	1.54 (1.59)	16.71	1.73 (1.65)	1.81 (1.68)	1.49 (1.58)	1.84 (1.69)	1.41 (1.55)	1.61 (1.62)	15.92
Flubendiamide 39.35% SC	0.5	1.73 (1.65)	1.81 (1.68)	1.45 (1.57)	2.11 (1.76)	1.39 (1.55)	1.50 (1.58)	23.41	1.71 (1.65)	1.74 (1.66)	1.46 (1.57)	1.78 (1.67)	1.42 (1.56)	1.53 (1.59)	23.19
Indoxacarb 14.5% SC	2.0	1.74 (1.66)	1.83 (1.68)	1.49 (1.58)	2.14 (1.77)	1.40 (1.55)	1.49 (1.58)	24.08	1.69 (1.64)	1.79 (1.67)	1.42 (1.56)	1.81 (1.68)	1.44 (1.56)	1.55 (1.60)	25.15
Chlorfenapyr 10% SC	1.5	1.69 (1.64)	1.76 (1.66)	1.51 (1.58)	2.07 (1.75)	1.41 (1.55)	1.45 (1.57)	19.88	1.68 (1.64)	1.71 (1.65)	1.47 (1.57)	1.74 (1.66)	1.43 (1.56)	1.48 (1.58)	19.30
Lambda cyhalothrin 5% EC	2.0	1.86 (1.69)	1.68 (1.64)	1.47 (1.57)	2.05 (1.75)	1.43 (1.56)	1.47 (1.57)	15.82	1.67 (1.63)	1.69 (1.64)	1.48 (1.58)	1.72 (1.65)	1.45 (1.56)	1.46 (1.57)	16.49
Untreated control	-	1.71 (1.65)	1.90 (1.70)	1.46 (1.57)	2.32 (1.82)	1.40 (1.55)	1.61 (1.61)	6.51	1.65 (1.63)	1.87 (1.69)	1.46 (1.57)	1.99 (1.73)	1.43 (1.56)	1.65 (1.63)	7.54
C.D.		NS	NS	NS	NS	NS	NS	2.24	NS	NS	NS	NS	NS	NS	2.68
SE(m)		0.03	0.04	0.02	0.06	0.02	0.03	0.72	0.06	0.01	0.03	0.02	0.04	0.02	0.86

PTC – Pre-treatment count, DAS- Day after spraying, *Figures in the parentheses are square root transformed values

followed by emamectin benzoate (Table 1). These results derive support from those of Pineda et al. (2007); on the fecundity and fertility of *S. littoralis* adults with different doses of spinosad. Against *T. orichalcea* also flubendiamide 39.35%SC followed by spinosad 45% SC and emamectin benzoate 5%SG after first and second sprays during kharif 2018 and summer 2019, were effective. Rao et al. (2014) revealed that spinosad 45SC @ 0.015% was highly effective against *M. vitrata* followed by emamectin benzoate in rice fallow black gram. Flubendiamide can be used in an IPM to counter insecticide resistance (Jameel and Jamal, 2017). Maximum reduction in counts of *S. litura* and *T. orichalcea* was thus observed with flubendiamide, spinosad emamectin benzoate (Table 1). The maximum yield was obtained from flubendiamide (24.08, 25.15 t/ ha) treated plots followed by spinosad (23.41, 23.19 t/ ha). Sangamithra et al. (2018) also observed that with flubendiamide 24% w/v + thiacloprid 24% SC w/v @ 84 + 84 g a.i/ha maximum yield of 47.92 t ha^{-1} was obtained in cabbage.

The natural enemies' occurrence did not reveal any statistically significant changes (Table 2). These observations are comparable to those of Priyadarshini et al. (2013), and Singh and Kumar (2011) who found that flubendiamide had no effect on natural enemies. Flubendiamide at 50, 75, and 100 ml/ ha did not have any unfavourable effect on natural enemies (Mishra, 2008; Latif et al., 2009; Ameta et al., 2011). Emamectin-benzoate and spinosad are both safe for mammals and effective against lepidopteran insect pests (Giraddi and Gundannavar, 2006; Xu, 2007; Wang et al., 2012).

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