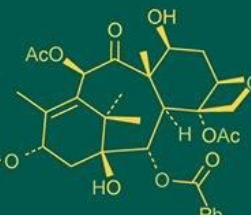
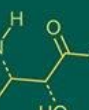
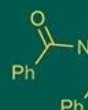


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Evaluation of selective insecticides efficacy against diamondback moth, *Plutella xylostella* (Linn.) on cabbage

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Abstract

Studies on management of diamondback moth through microbial pesticides were carried out at College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during 2015-16 and 2016-17. The field experiment was conducted during Rabi season of year 2015-16 and 2016-17 to assess the efficacy of selective insecticides against diamondback moth population. The overall mean larval population of insecticides treatment, Spinosad insecticide recorded minimum larval population with 1.09 larvae/plant followed by Chlorantraniliprole (1.33 larvae/plant) and Indoxacarb (1.48 larvae/plant). Maximum larval count (1.56 larvae/plant) was recorded in Flubendamide 39.35 SC.

Pooled analysis on the basis of three sprays and seven days observation, all treatments proved highly effective for suppression of DBM population and showed 75.96 to 83.20 percent reduction of larval population over control.

The pooled data on yield showed that maximum (174.92 q/ha) and minimum (138.25 q/ha) yield harvested from plots treated with Spinosad and Flubendamide, respectively. Effect of Spinosad (174.92 q/ha) on yield was found superior over rest of the treatments, followed by the effect of Chlorantraniliprole > Indoxacarb > Flubendamide with yield 158.41 > 151.42 > 138.25 q/ha, respectively. It was observed that more yield recorded in year 2016-17 as compare to that of year 2015-16.

Keywords: Cabbage, diamond back moth, selective insecticides, yield

Introduction

Cabbage, *Brassica oleracea* L. var. capitata (Brassicaceae), is economically important cruciferous vegetable. This crop is mooted to have cancer-preventing properties (Brooks *et al.*, 2001) [4] and rich source of Ca, P, Na, K, S, vitamin A, vitamin C, carbohydrates and dietary fibre. 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) [2]. The diamondback moth, *Plutella xylostella* (L.), is considered the most destructive pest of Brassicaceae in several regions of the world (Talekar & Shelton 1993) [3]. Lepidopteron larvae are the most destructive pests of cabbage and are often controlled with insecticide. Cabbage comprises intensive plant protection measures involving use of a large quantity of different insecticides. 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. It was subsequently established that *P. xylostella* had developed multiple resistance to carbamates, synthetic pyrethroids and organophosphates (Sereda *et al.*, 1997) [5], yet these chemicals are still on the list of recommended insecticides for use against it (Anonymous, 2007) [1]. 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

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target and minor pest. Therefore, it is found necessary to evaluate new insecticides for the control of diamond back moth of cabbage.

Materials and Methods

The field studies were conducted at the experimental area of Indira Gandhi Agricultural University, Raipur (C.G.). The experiment was conducted during *rabi* season of years, 2015-16 and 2016-17 to assess the efficacy of selective insecticides against diamondback moth population at different intervals. Total three sprays of selective insecticides were applied during both the years.

Fig. 1

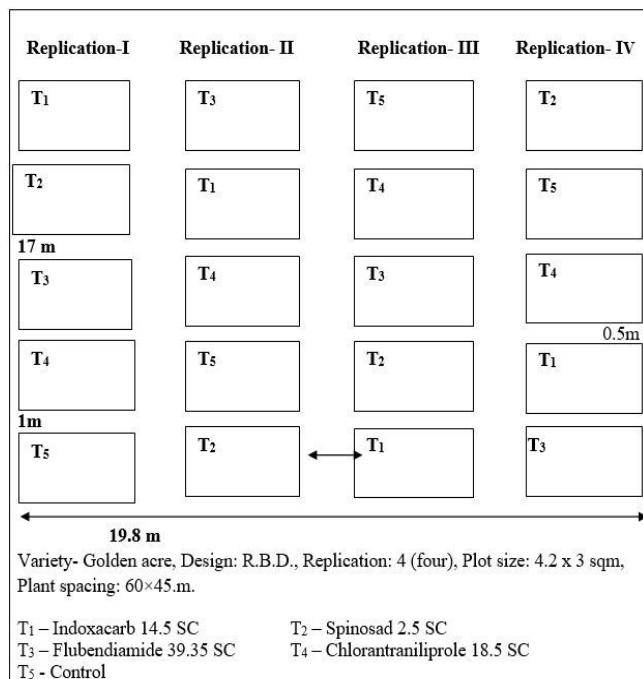


Fig 1: Layout plan for bio efficacy evaluation of microbial pesticides against DBM during *rabi* season (2015-16 and 2016-17)

Experiment details are as follows:

Variety: Golden Acre

Design: Randomized Block Design

Treatments: 5

Replication: 04 (Four)

Plant spacing: 60 X 45 cm

Spacing between plots: 0.50 m

Spacing between replications: 1.00 m

Observation on number of diamondback moth was recorded on randomly selected five plants/plot before spray and 1, 3, 5 and 7 days after each spray.

Table 1: Treatment details for selective insecticides evaluation are as follows:

S. No.	Treatment	Dose a.i g/ml/ha
1.	Indoxacarb 14.5 SC	40
2.	Spinosad 2.5 SC	17.5
3.	Flubendiamide 39.35 SC	18.24
4.	Chlorantraniliprole 18.5 SC	10
5.	Control	-

Results and Discussion

Total three sprays were applied during both the years to assess the efficacy of selective insecticides against diamondback moth population through field experiment.

First spray

On the basis of pooled evaluation of insecticides treatment during years, 2015-16 and 2016-17 after first spray, spinosad and chlorantraniliprole were found more effective and comparable. Considering least difference in efficacy, indoxacarb also have resulted as effective treatment during first spray. The order of effectiveness of selective insecticides on the basis of pooled mean reduction in diamondback moth larval population in first spray was found as spinosad (1.86 larvae/plant) > chlorantraniliprole (1.99 larvae/plant) > indoxacarb (2.18 larvae/plant) > flubendiamide (2.29 larvae/plant) (fig. 1).

Similarly, the impact of insecticides treatments on the infestation of DBM larvae was also assessed and its order of effectiveness were arranged on the basis of pooled percent reduction over control for first spray as spinosad (58.10%) > chlorantraniliprole (55.18%) > indoxacarb (50.90%) > flubendiamide (48.42%) (Table no. 2).

Second spray

The order of effectiveness of selective insecticides on the basis of pooled mean reduction in diamondback moth larval population in second spray was found as spinosad (2.01 larvae/plant) > chlorantraniliprole (2.36 larvae/plant) > indoxacarb (2.43 larvae/plant) > flubendiamide (2.62 larvae/plant) (fig. 1).

Similarly, the impact of insecticides treatments on the infestation of DBM larvae was also assessed and its order of effectiveness were arranged on the basis of pooled percent reduction over control for first spray as spinosad (63.71%) > chlorantraniliprole (57.40%) > indoxacarb (56.13%) > flubendiamide (52.70%) (Table no. 3).

Third spray

On the basis of pooled evaluation of insecticides treatment for third spray, spinosad was found best insecticide for DBM management. The order of effectiveness of selective insecticides on the basis of pooled mean reduction in diamondback moth larval population in third spray was found as spinosad (1.09 larvae/plant) > chlorantraniliprole (1.33 larvae/plant) > indoxacarb (1.48 larvae/plant) > flubendiamide (1.56 larvae/plant).

Impact of insecticides treatment on the infestation of DBM larvae on cabbage crop was also assessed and its order of effectiveness were arranged on the basis of pooled percent reduction over control for third spray was spinosad (83.20%) > chlorantraniliprole (79.50%) > indoxacarb (77.19%) > flubendiamide (75.96%) (Table no. 4).

Yield of cabbage in *rabi* season, 2015-16 and 2016-17 (pooled)

The data recorded on the yield during *Rabi* seasons of both the years were pooled together for better assessment of the performance of different treatments over untreated control and depicted in table and fig. 1. The pooled data on yield clearly demonstrated that maximum (22.04 kg/plot/174.92 q/ha) and minimum (17.42 kg/plot/138.25 q/ha) yield harvested from plots treated with spinosad and flubendiamide, respectively. This data also showed that

effect of spinosad (22.04 kg/plot) on yield was found superior over rest of the treatments and followed by the effect of chlorantraniliprole > indoxacarb > flubendamide with yield 19.96 > 19.08 > 17.42 kg/plot/158.41 > 151.42 >

138.25 q/ha, respectively. It was observed that more yield recorded in year 2016-17 as compare to that of year 2015-17 (Table no. 5).

Table 2: Effect of selective insecticides on diamondback moth, *Plutella xylostella* (Linn.) management in cabbage during both years (2015-16 and 2016-17) after first spray (pooled)

Treatment		*Mean larval population of <i>P. xylostella</i> per plant												Mean of Pooled values	Percent reduction over control
		Days after treatment													
		1		Pooled value	3		Pooled value	5		Pooled value	7		Pooled value		
		2015-16	2016-17		2015-16	2016-17		2015-16	2016-17		2015-16	2016-17			
T ₁	Flubendamide 39.35 SC	4.10 (2.25)	3.05 (2.0)	3.57 (2.13)	3.45 (2.10)	0.60 (1.26)	2.02 (1.73)	3.00 (2.0)	0.75 (1.32)	1.87 (1.69)	2.20 (1.78)	1.20 (1.48)	1.70 (1.64)	2.29 (1.79)	48.42
T ₂	Spinosad 2.5 SC	3.45 (2.10)	2.15 (1.76)	2.80 (1.94)	3.05 (2.01)	0.50 (1.22)	1.77 (1.66)	2.60 (1.89)	0.45 (1.20)	1.52 (1.58)	2.00 (1.73)	0.70 (1.30)	1.35 (1.53)	1.86 (1.67)	58.10
T ₃	Indoxacarb14.5 SC	3.80 (2.19)	2.90 (1.96)	3.35 (2.08)	3.25 (2.06)	0.60 (1.26)	1.92 (1.71)	2.90 (1.97)	0.75 (1.32)	1.82 (1.68)	2.20 (1.78)	1.05 (1.43)	1.62 (1.61)	2.18 (1.77)	50.90
T ₄	Chlorantraniliprole 18.5 SC	3.55 (2.13)	2.60 (1.88)	3.07 (2.01)	3.10 (2.02)	0.55 (1.24)	1.82 (1.68)	2.75 (1.93)	0.55 (1.24)	1.65 (1.62)	2.10 (1.76)	0.75 (1.32)	1.42 (1.55)	1.99 (1.71)	55.18
T ₅	Control	4.35 (2.31)	4.20 (2.28)	4.27 (2.29)	4.45 (2.33)	4.40 (2.32)	4.42 (2.32)	4.50 (2.34)	4.50 (2.34)	4.50 (2.34)	4.55 (2.35)	4.60 (2.36)	4.57 (2.36)	4.44 (2.32)	
	SEm±	0.03	0.09	0.04	0.02	0.05	0.02	0.02	0.04	0.02	0.04	0.03	0.02		
	CD at 5%	0.09	0.30	0.13	0.09	0.15	0.08	0.07	0.13	0.07	0.14	0.11	0.08		

* Mean of four replications, Figures in parentheses are square root transformed values

Table 3: Effect of selective insecticides on diamondback moth, *Plutella xylostella* (Linn.) management in cabbage during both years (2015-16 and 2016-17) after second spray (pooled)

Treatment		*Mean larval population of <i>P. xylostella</i> per plant												Mean of Pooled values	Percent reduction over control
		Days after treatment													
		1		Pooled value	3		Pooled value	5		Pooled value	7		Pooled value		
		2015-16	2016-17		2015-16	2016-17		2015-16	2016-17		2015-16	2016-17			
T ₁	Flubendamide 39.35 SC	3.20 (2.04)	3.30 (2.07)	3.25 (2.06)	2.15 (1.77)	3.20 (2.04)	2.67 (1.91)	1.85 (1.68)	2.95 (1.98)	2.40 (1.84)	2.00 (1.73)	2.35 (1.83)	2.17 (1.78)	2.62 (1.89)	52.70
T ₂	Spinosad 2.5 SC	2.00 (1.73)	2.75 (1.93)	2.37 (1.83)	1.80 (1.67)	2.75 (1.93)	2.27 (1.8)	1.15 (1.46)	2.55 (1.88)	1.85 (1.68)	1.00 (1.41)	2.10 (1.75)	1.55 (1.59)	2.01 (1.72)	63.71
T ₃	Indoxacarb 14.5 SC	3.20 (2.04)	2.95 (1.98)	3.07 (2.01)	2.10 (1.75)	3.10 (2.02)	2.60 (1.89)	1.80 (1.67)	2.20 (1.78)	2.00 (1.73)	1.80 (1.67)	2.30 (1.81)	2.05 (1.74)	2.43 (1.84)	56.13
T ₄	Chlorantraniliprole 18.5 SC	3.00 (1.99)	3.05 (2.01)	3.02 (2.00)	2.00 (1.72)	2.85 (1.96)	2.42 (1.84)	1.65 (1.62)	2.90 (1.97)	2.27 (1.80)	1.30 (1.51)	2.20 (1.78)	1.75 (1.65)	2.36 (1.82)	57.40
T ₅	Control	4.90 (2.42)	5.30 (2.50)	5.10 (2.47)	5.60 (2.56)	5.35 (2.52)	5.47 (2.54)	5.80 (2.60)	5.60 (2.56)	5.70 (2.58)	5.95 (2.63)	5.90 (2.62)	5.92 (2.63)	5.54 (2.55)	
	SEm±	0.02	0.04	0.02	0.03	0.02	0.02	0.03	0.02	0.01	0.03	0.06	0.02		
	CD at 5%	0.09	0.12	0.07	0.11	0.06	0.07	0.10	0.08	0.05	0.12	0.18	0.08		

* Mean of four replications, Figures in parentheses are square root transformed values

Table 4: Effect of selective insecticides on diamondback moth, *Plutella xylostella* (Linn.) management in cabbage during both years (2015-16 and 2016-17) after third spray (pooled)

Treatment		*Mean larval population of <i>P. xylostella</i> per plant												Mean of Pooled values	Percent reduction over control
		Days after treatment													
		1		Pooled value	3		Pooled value	5		Pooled value	7		Pooled value		
		2015-16	2016-17		2015-16	2016-17		2015-16	2016-17		2015-16	2016-17			
T ₁	Flubendamide 39.35 SC	2.10 (1.76)	2.20 (1.78)	2.15 (1.77)	1.90 (1.70)	1.35 (1.53)	1.62 (1.62)	1.40 (1.54)	1.20 (1.48)	1.30 (1.51)	1.25 (1.50)	1.15 (1.46)	1.20 (1.48)	1.56 (1.59)	75.96
T ₂	Spinosad 2.5 SC	1.85 (1.68)	1.60 (1.61)	1.72 (1.65)	1.40 (1.54)	1.15 (1.46)	1.27 (1.50)	1.00 (1.41)	0.90 (1.37)	0.95 (1.39)	0.25 (1.11)	0.65 (1.28)	0.45 (1.20)	1.09 (1.43)	83.20
T ₃	Indoxacarb 14.5 SC	2.05 (1.74)	2.15 (1.77)	2.10 (1.76)	1.75 (1.65)	1.25 (1.49)	1.50 (1.58)	1.30 (1.51)	1.15 (1.46)	1.22 (1.49)	1.15 (1.46)	1.10 (1.44)	1.12 (1.45)	1.48 (1.57)	77.19
T ₄	Chlorantraniliprole 18.5 SC	2.00 (1.73)	2.00 (1.73)	2.00 (1.73)	1.60 (1.61)	1.20 (1.47)	1.40 (1.54)	1.10 (1.44)	1.05 (1.43)	1.07 (1.44)	0.75 (1.32)	1.00 (1.41)	0.87 (1.36)	1.33 (1.51)	79.50
T ₅	Control	6.30 (2.70)	5.80 (2.68)	6.25 (2.69)	6.45 (2.72)	6.35 (2.71)	6.40 (2.72)	6.65 (2.76)	6.50 (2.73)	6.57 (2.75)	6.90 (2.81)	6.65 (2.76)	6.77 (2.78)	6.49 (2.73)	
	SEm±	0.03	0.03	0.01	0.02	0.04	0.02	0.03	0.02	0.02	0.03	0.03	0.02		
	CD at 5%	0.10	0.09	0.05	0.08	0.14	0.07	0.11	0.09	0.08	0.11	0.09	0.08		

* Mean of four replications, Figures in parentheses are square root transformed values

Table 5: Impact of selective insecticides treatment on cabbage yield during *rabi* season of 2015-2016 and 2016-17 (pooled)

	Treatments	Dose a.i g/ml/ha	*Mean weight of harvested heads (kg/plot)			Total yield (kg/plot)	Overall mean yield of cabbage q/ha
			1 st pick	2 nd pick	3 rd pick		
T ₁	Indoxacarb 14.5 SC	40	4.50	8.83	5.75	19.08	151.42
T ₂	Spinosad 2.5 SC	17.5	5.25	10.17	6.63	22.04	174.92
T ₃	Flubendamide 39.35 SC	18.24	4.13	7.67	5.63	17.42	138.25
T ₄	Chlorantraniliprole 18.5 SC	10	4.38	9.83	5.75	19.96	158.41
T ₅	Control	-	3.13	3.67	3.50	10.29	81.67
	S. Em.±		0.05	0.08	0.09		
	CD at 5%		0.16	0.22	0.29		

*Mean of four replications

Concussion

The field experiment evaluated the efficacy of selective insecticides against the diamondback moth (DBM) population over three sprays during the 2015-16 and 2016-17 seasons. In the first spray, spinosad and chlorantraniliprole showed comparable effectiveness, reducing larvae to 1.86 and 1.99 larvae/plant, respectively. Spinosad also led in the second and third sprays, with the highest reduction in larval population and percent control. The overall cabbage yield was highest with spinosad (22.04 kg/plot), followed by chlorantraniliprole, indoxacarb, and flubendamide, with yields of 19.96 kg/plot, 19.08 kg/plot, and 17.42 kg/plot, respectively.

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