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Bioefficacy of New Ready Mixed Insecticide Novaluron 5.25% + Emamctin 0.9% SC against Diamond Back Moth (*Plutella xylostella* L.) in Cabbage in West Bengal

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Field experiments were conducted during the rabi season of 2012 and 2013 in experimental plots of Bidhan Chandra Krishi Viswavidyalaya, West Bengal to evaluate the efficacy of ready mixed insecticide Novaluron 5.25% + Emamectin 0.9% SC @ 750, 825 and 875 ml ha^{-1} against *Plutella xylostella* in cabbage. Efficacy of different treatment schedules of novaluron 5.25% + emamectin 0.9% SC against DBM showed that all the treated plots with chemicals were significantly superior in their performance over that of control plots during both the year. Novaluron 5.25% + emamectin 0.9% SC @ 825 and 875 ml ha^{-1} gave superlative control of diamond back moth larvae up to harvesting period than the other insecticidal treatments. Novaluron 5.25% + emamectin 0.9% SC @ 875 ml ha^{-1} gave 100 per cent control from 5th day after second spray during both experimental year. The maximum yield was obtained from the plots treated with novaluron 5.25% + emamectin 0.9% SC @ 875 ml ha^{-1} closely followed by @ 825 ml ha^{-1}.

Key words: *Plutella xylostella*, Cabbage, Novaluron 5.25% +Emamectin 0.9% SC

Cabbage (*Brassica oleracea var. capitata* L.) the widely cultivated popular crucifer vegetable crop in many countries, including India. Cabbage occupies 5.4 per cent share in whole vegetable production with an area of 369 thousand ha and a production of 7949 thousand metric tons with an average productivity of 21.5 metric tons ha^{-1} during 2010-11 in India and West Bengal is the largest producer of cabbage with 27 per cent share in national cabbage production (Indian Horticulture Database, 2011) . It is grown during rabi season in different parts of West Bengal. In India wide numbers of insect pests have been reported to infest cabbage. Srivastava and Butani (1998) reported four major and 31 minor insects pests of crucifers. Diamond back moth, *Plutella xylostella* (L.) (Plutellidae:Lepidoptera) is the most destructive insect pest of cruciferous plants throughout the world and the annual cost for managing it is estimated to be US $ 1 billion (Talekar and Shelton, 1993). Among cruciferous crops cauliflower and cabbage are the most preferred hosts for DBM (Uthamasamy *et al.,* 2011). This notorious pest has developed resistance to almost all the recommended insecticides belonging to major groups in many parts of the world (Talekar and Shelton, 1993) and becoming increasingly difficult to control. In India, resistance to different insecticides was reported from several states like Punjab, Haryana, Tamilnadu, Karnataka and Andhra Pradesh (Mehrotra and Phokela, 2000). The problem is acute in areas where vegetables are grown extensively throughout the year (Joia *et al.*, 2005). Control of this pest with any single potent toxicant for a long time is quite difficult and rather impossible. The present investigation was, therefore, oriented to find out the bio-efficacy of novaluron 5.25% + emamectin 0.9% SC in controlling the DBM of cabbage in field condition.

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Materials and Methods

Field experiment was conducted to evaluate the efficacy of novaluron 5.25% + emamectin 0.9% SC against DBM in cabbage and to study the adverse effect, if any, of the chemical on important larval and pupal parasitoid found in association with cabbage at University Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal during the year 2012 and 2013. Healthy seedlings of cabbage (*var.* Green Express) were transplanted in 20 m^2 plot during September at 30 cm x 30 cm spacing with recommended fertilizer dose. The whole experiment was laid out in randomized block design with seven treatments; replicated thrice along with control. Three sprays at 10 days interval were given when pest population reached ETL level (in general one larvae plant^{-1}, Jayaratnam, 1977 reported that four or more medium sized larvae (3rd or 4th instar) could render a seedling un-transplantable and ten larvae per plant up to one month and twenty larvae per plant between one and two months after planting necessited insecticide application) with knapsack sprayer at high volume @ 500 l ha^{-1}. Observation

was recorded on before spray as well as 1, 5 and 10 days after each spray from ten randomly selected plants. To observe the effect of the insecticides used on natural enemies; ten plants were selected randomly and two leaves were again chosen at random from each of the ten plants. Each leaf was examined on 7th day after each spraying to collect pupal stages of DBM. These were kept in a growth chamber (28_0C ± 10_0C and 80% R.H.) to follow the course of development. The emergence hold and the presence of parasitoids in the glass chamber were used as an index of parasitisation. The DBM larvae were also collected from the leaves to note the rate of larval parasitisation. The data were presented in percentage and were subjected to analysis of variance after making necessary transformation.

To observe the phytotoxic effect of the used insecticides on cabbage, if any; observations on 1, 3, 7 and 10 days after spraying were recorded from five leaves per plant each from ten pre selected plants per plot regarding leaf injury on tips and leaf surface, wilting, necrosis, vein clearing, epinasty etc. and the following scale was used to assessing phytotoxicity as per the protocol of Central Insecticidal Board Registration Committee (C.I.B and R.C).

Crop response/crop injury	Grade
No Phytotoxicity	0
1-10%	1
11-20%	2
21-30%	3
31-40%	4
41-50%	5
51-60%	6
61-70%	7
71-80%	8
81-90%	9
91-100%	10

Phytotoxicity ratings were recorded based on the following visual scale. The per cent leaf injury was calculated using the formula,

$$\text{Per cent leaf injury} = \frac{\text{Total grade points}}{\text{Max. grade x no. of leaf observed}} \times 100$$

Results and Discussion

The pooled efficacy of different treatment schedules of novaluron5.25% + emamectin 0.9% SC against DBM of cabbage has been presented in Table 1 and 3. All the treated plots with chemicals were significantly superior in their performance over that of control plots. Novaluron 5.25% + emamectin 0.9% SC @ 825 and 875 ml ha^{-1} gave best control of DBM up to harvesting period, it was recorded that after 5 days after second spray and subsequently there was no DBM larvae infestation up to end of third spray. Novaluron 5.25% + emamectin 0.9% SC @ 750 ml ha^{-1} was not very effective in reducing the DBM larvae in respect of its higher dose and considered as third effective insecticidal treatment against DBM larvae (6.35 larvae ten $plants^{-1}$ on 10 days after third spray), followed by fipronil 5% SC (6.55 larvae ten $plants^{-1}$), emamectin benzoate 5% SG (6.80 larvae ten $plants^{-1}$) and novaluron 10% EC (7.15 larvae ten $plants^{-1}$). Whereas, 74.50 number DBM population was recorded in control plot at the end of the spray schedule. In respect of percent reduction of DBM population novaluron5.25% + emamectin 0.9% SC @ 825 and 875 ml ha^{-1} gave 100% protection against DBM after 5 days after second spray and onwards. The overall mean percent reduction of DBM was highest in novaluron5.25% + emamectin 0.9% SC @ 875 ml ha^{-1} (92.91%), which was at par with novaluron5.25%
+ emamectin 0.9% SC @ 825 ml ha^{-1} (91.44%), followed by emamectin benzoate 5% SG (79.98%), novaluron5.25% + emamectin 0.9% SC @ 750 ml ha^{-1} (78.55%), fipronil 5% SC (78.18%) and novaluron 10 EC (72.91%). It has also reflected in yield parameter. The maximum yield was obtained from the plots treated with novaluron5.25% + emamectin 0.9% SC @ 875 ml ha^{-1} (140.50 q ha^{-1}) closely followed by @ 825 ml ha^{-1} (138.60 q ha^{-1}), fipronil 5% SC (130.30 q ha^{-1}), whereas only 79.50 q ha^{-1} yield was obtained from untreated plot (Table-3).

During the year 2013, the effect of different treatment schedules of novaluron5.25% + emamectin 0.9% SC against DBM of cabbage has been presented in Table 2 and 3. All the treated plots with chemicals were significantly superior in their performance over that of control plots. Here also novaluron 5.25% + emamectin 0.9% SC @
875 ml ha^{-1} was considered as best treatment against DBM up to harvesting period, it was recorded that after 5 days after second spray. Fipronil 5% SC was considered as third effective insecticidal treatment against DBM larvae (3.65 larvae ten $plants^{-1}$ on 10 days after third spray), followed by emamectin benzoate 5% SG (3.80 larvae ten $plants^{-1}$), novaluron5.25% + emamectin 0.9% SC @
750 ml ha^{-1} (5.80 larvae ten $plants^{-1}$) and novaluron 10% EC (6.40 larvae ten $plants^{-1}$). Highest population of DBM was recorded in control plot (67.25 larvae ten $plants^{-1}$) at the end of the spray schedule. Similarly in respect of per cent reduction of DBM population novaluron5.25% + emamectin 0.9% SC @ 875 ml ha^{-1} gave 100 per cent protection against DBM after 5 days after second spray and onwards. The overall mean per cent reduction of DBM was highest in novaluron5.25% + emamectin 0.9% SC @ 875 ml ha^{-1} (90.45%), which was at par with novaluron5.25% + emamectin 0.9% SC @ 825 ml ha^{-1} (87.96%), followed by fipronil 5% SC (78.52%),

Table 1. Effect of treatment schedules Novaluron5.25 + Emamectin 0.9 SC on the population of DBM (*Plutella xylostella)* on Cabbage after each spray - 2012

Sl. No.	Mean No. of DBM/ ten plants before spray	Mean population of DBM at different intervals (days) after first spray			Mean population of DBM at different intervals (days) after second spray			Mean population of DBM at different intervals (days) after third spray		
		1st	5th	10th	1st	5th	10th	1st	5th	10th
T_1	66.33	24.25 (4.97)	19.30 (4.44)	19.00 (4.41)	17.15 (4.20)	11.70 (3.49)	11.00 (3.39)	10.35 (3.29)	9.20 (3.11)	6.35 (2.61)
T_2	62.67	19.45 (4.46)	16.24 (4.09)	7.30 (2.79)	5.25 (2.39)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
I_3	65.00	16.35 (4.10)	13.80 (3.78)	7.00 (2.73)	4.30 (2.19)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
T_4	63.67	36.00 (6.04)	28.25 (5.36)	22.55 (4.80)	17.25 (4.21)	14.40 (3.86)	10.50 (3.31)	9.90 (3.22)	9.20 (3.11)	7.15 (2.76)
I_5	61.67	22.25 (4.76)	16.60 (4.13)	15.35 (3.98)	13.55 (3.74)	10.40 (3.30)	9.75 (3.20)	8.35 (2.97)	8.00 (2.91)	6.80 (2.60)
I_6	59.67	26.40 (5.18)	22.20 (4.76)	20.30 (4.56)	11.90 (3.52)	9.25 (3.12)	8.35 (2.97)	7.20 (2.77)	6.95 (2.72)	6.55 (2.70)
T_7	61.67	62.00 (7.90)	64.00 (8.03)	64.40 (8.05)	64.70 (8.07)	64.20 (8.04)	62.70 (7.94)	66.00 (8.15)	70.40 (8.42)	74.50 (8.66)
	NS	0.82	0.75	0.68	0.76	0.82	1.04	1.00	1.12	1.18

Figures in parentheses are square root transformed values

emamectin benzoate 5% SG (73.00%), novaluron5.25% + emamectin 0.9% SC @ 750 ml ha^{-1} (71.57%), and novaluron 10 EC (68.99%). Like previous year maximum yield was recorded from novaluron5.25% + emamectin 0.9% SC @ 875 ml. ha^{-1} (151.00 q ha^{-1}) treated plot closely followed by @ 825 ml ha^{-1} (148.75 q ha^{-1}) and fipronil 5% SC (140.30 q ha^{-1}), whereas only 88.40 q ha^{-1} yield was obtained from untreated plot (Table 3).

Novaluron 5.25% + emamectin 0.9% SC is recently developed ready mixed formulated insecticide having two different mode of action and they are important insecticides having excellent action on insects with abnormal symptoms such as deformed moulting with feeding cessation and caused a gradual contraction of the insect body thickening and shortening without convulsions and

Table 2. Effect of treatment schedules Novaluron5.25% + Emamectin 0.9% SC on the population of DBM (*Plutella xylostella)* on Cabbage after each spray

Sl. No.	Mean No. of DBM/ ten plants before spray	Mean population of DBM at different intervals (days) after first spray			Mean population of DBM at different intervals (days) after second spray			Mean population of DBM at different intervals (days) after third spray		
		1st	5th	10th	1st	5th	10th	1st	5th	10th
I_1	43.33	22.30 (4.77)	17.20 (4.20)	16.25 (4.09)	13.50 (3.74)	9.70 (3.19)	9.70 (3.19)	8.35 (2.97)	8.10 (2.93)	5.80 (2.50)
T_2	50.00	20.25 (4.55)	14.60 (3.88)	11.00 (3.39)	6.30 (2.60)	2.00 (1.58)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
T_3	44.33	17.25 (4.21)	11.50 (3.46)	6.55 (2.65)	2.80 (1.81)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
T_4	49.00	41.20 (6.45)	21.55 (4.69)	17.60 (4.25)	14.30 (3.84)	11.00 (3.39)	11.00 (3.39)	7.25 (2.78)	6.40 (2.62)	6.40 (2.62)
T_5	43.67	24.30 (4.97)	20.50 (4.58)	17.33 (4.22)	12.85 (3.58)	9.40 (3.14)	9.40 (3.14)	4.25 (2.17)	4.00 (2.12)	3.80 (2.07)
I_6	47.33	20.50 (4.58)	18.65 (4.37)	14.25 (3.84)	9.45 (3.65)	8.00 (2.91)	8.00 (2.91)	4.85 (2.31)	4.10 (2.14)	3.65 (2.03)
T_7	44.67	44 (6.67)	43.50 (6.63)	48.75 (7.01)	49.00 (7.03)	52.25 (7.26)	59.60 (7.75)	60.00 (7.77)	60.50 (7.81)	67.25 (8.23)
	NS	1.02	1.11	0.97	0.89	0.98	1.12	0.96	1.03	1.08

Figures in parentheses are square root transformed values

the symptoms were obviously different from those of conventional insecticides. As this is newly developed insecticide and not yet launched therefore the effect of novaluron and emamectin benzoate against DBM may be correlated with the present findings. Harish *et al* . (2003) reported 90 per cent larval mortality. High efficacy of novaluron against the pest in our experiment is also in conformity with Wavare *et al* . (2008). Kumar and Devappa (2006) reported that emamectin benzoate was very effective on suppressing the larval population of the pest and increased yield of cabbage. This above report made by different worker give the conformity of the effect of this ready mixed insecticide novaluron5.25% + emamectin 0.9% SC against DBM.

Effect on some important parasitoids of DBM

The identities of larval and pupal parasitoids were established as *Cotesia (Apanteles) plutellae* and *Brachymeria* sp., respectively. The pooled data on adverse effect on novaluron 5.25% + emamectin 0.9% SC against two important parasitoids namely *Apanteles plutellae* and *Brachymeria* spp. of DBM has been presented in Table 4 which shows non significant effect among the different treatments. It may conclude that novaluron 5.25% + emamectin 0.9% SC had practically no adverse effect on the two parasitoids. At the highest dose of the product i.e. 875 ml ha^{-1}, 20.67% in larval parasitisation and 2.33% in case of pupal parasitisation was recorded. While 21.33 % larval parasitisation and 3.00% pupal parasitisation was recorded in untreated check. Similar result was recorded in next year also. Our result is in line with the findings of Nandihalli (2009). Sontakke *et al.* (2007) reported that emamectin have no phytotoxic effect on plants and no harmful effect on natural enemies. Dhanalakshmi and Mallapur (2008) reported that emamectin was safe as the untreated control to natural enemies (coccinellid larvae, spiders and *Chrysoperla* larvae). Chitin synthesis inhibitor lufenuron has no adverse effect

Table 3. Effect of different treatments of Novaluron 5.25% + Emamectin 0.9% SC on crop yield

Sl.No.	Treatments	Dose(ml/ha)	Mean Yield(q/ha)	
			2012	2013
T_1	Novaluron5.25+Emamectin 0.9 SC	750	121.40	134.50
T_2	Novaluron5.25 +Emamectin 0.9 SC	825	138.60	148.75
T_3	Novaluron5.25 +Emamectin 0.9 SC	875	140.50	151.00
T_4	Novaluron 10 EC	750	123.20	133.65
T_5	Emamectin Benzoate 5 SG	200	126.60	136.75
T_6	Fipronil 5 SC	1000	130.30	140.30
T_7	Control (Untreated)	-	79.50	88.40
	CD (0.05)	-	12.60	9.58

on *Cotesia plutellae* (Senguttuvan and Kuttalam, 2013), which can be correlated with this present findings as novaluron also a chitin synthesis inhibitor. Safety of emamectin benzoate is in line with Suganyakanna *et al.* (2005), who reported its safety to natural enemies.

Phytotoxic effects

The observations (1, 3, 7 and 10 days after spraying) clearly indicated that there was no phytotoxicity symptoms like leaf injury, wilting, epinasty and hyponasty, necrosis and vein clearing

Table 4. Effect of Novaluron 5.25% + Emamectin 0.9% SC on two important parasitoids of diamond back moth on Cabbage

Treatments	Dose (ml /ha)	% larval parasitisation by *A. plutellae*	% pupal parasitisation by *Brachymeria* sp.	% larval parasitisation by *A. plutellae*	% pupal parasitisation by *Brachymeria* sp.
		2012		2013	
Novaluron5.25+Emamectin 0.9 SC	750	21.67 (27.76)	3.00 (9.97)	15.33 (23.03)	1.67 (7.49)
Novaluron5.25 +Emamectin 0.9 SC	825	21.00 (27.27)	2.67 (9.46)	17.67 (24.88)	1.33 (6.80)
Novaluron5.25 +Emamectin 0.9 SC	875	20.67 (27.06)	2.33 (8.81)	15.67 (23.34)	1.33 (6.80)
Novaluron 10 EC	750	22.33 (28.18)	3.00 (9.97)	17.00 (24.35)	2.00 (8.13)
Emamectin Benzoate 5 SG	200	21.00 (27.27)	2.67 (9.46)	16.67 (24.12)	1.67 (7.49)
Fipronil 5 SC	1000	19.33 (26.06)	2.00 (8.13)	15.00 (22.79)	1.00 (5.74)
Control (Untreated)	-	21.33 (27.49)	3.00 (9.97)	16.67 (24.12)	2.00 (8.13)
CD (0.05)	-	NS	NS	NS	NS

Figures in parentheses are angular transformed values. N.S = Not significant.

etc., were observed in all the three doses of novaluron5.25% + emamectin 0.9% SC @ 875, 1750 and 3500 ml/ha. Therefore, it may be considered as safe to cabbage. Clarke and Fleischer (2003) reported that the lepidopteran pests of vegetables needed safer insecticides like emamectin benzoate with least phytotoxic effects with efficient control of the insect pests, which supports our experimental result. Senguttuvan and Kuttalam (2013) reported that chitin synthesis inhibitor have no phytotoxic effect on cabbage.

Conclusion

It is evident from the present investigation that novaluron5.25% + emamectin 0.9% SC was effective against DBM of cabbage @ 825 to 875 ml ha^{-1} and very safe to two most important parasitoids of diamond back moth infesting cabbage in West Bengal.

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References

Clarke, H.D. and Fleischer, S.J. 2003. Sequential sampling and biorational chemistries for management of lepidopteran pests of vegetable amaranth in the Caribbean. *J. Econ. Ent.,* **96**: 798-804.

Dhanalakshmi, D.N. and Mallapur, C.P. 2008. Evaluation of promising molecules against sucking pests of okra. *Ann. Plant Protection Sciences*, **16** : 29-32.

Harish, K., Jaglan, R.S., Rohilla, H.R. and Chauhan, R. 2003. Relative efficacy of novaluron alone and in combination with other insecticides against diamondback moth, *Plutella xylostella* (L.). *J. Entomol. Res.,* **27**: 221-231.

Jayarathnam, K. 1977. Studies on the population dynamics of the diamondback moth, *Plutella xylostella* (Linnaeus) (Lepidoptera: Yponomeutidae) and crop loss due to the pest in cabbage. Ph. D. thesis. University of Agricultural Sciences, Bangalore, p. 215.

Joia, B.S., Udeaan, A.S., Suri, K.S., Kaur, J. and Uberoi, S. K. 2005. Status of insecticide resistance in diamondback moth, *Plutella xylostella* (L.) in Punjab. *J. Insect Sci.,* **18**: 59-64.

Kumar, P. and Devappa, V. 2006. Bioefficacy of Emamectin benzoate 05 SG (Proclaim) against diamond back moth in cabbage. *Pestol.*, **32**: 32-36.

Mehrotra, K.N. and Phokela, A . 2000. Insecticide resistance

in insect pests : current status and future strategies. In : Dhaliwal, G.S. and Singh, B. (eds.), Pesticides and Environment, p. 39-85.

Nandihalli, B.S. 2009. Bioefficacy of newer insecticide molecules against chilli thrips and fruit borers. *Karnataka J. Agric. Sci.,* **22**: 591-593.

Senguttuvan, K. and Kuttalam, S. 2013. Management of Diamondback Moth (Plutella xylostella L.) in Cabbage at Tropical and Temperate Regions of Tamil Nadu with Chitin Synthesis Inhibitor. *Madras Agric. J.,* **100** : 206-209.

Srivastava, K.P. and Butani, D.K. 1998. Insect Pests of Vegetables, p. 428-430.

Suganyakanna, S., Chandrasekaran, S., Regupathy, A. and Lavanya, D. 2005. Emamectin SG (Proclaim) – A newer insecticide for diamondback moth, Plutella xylostella management in cabbage. *Pestol.,* **29** : 24-27.

Talekar, N.S. and Shelton, A.M. 1993. Biology, ecology and management of diamondback moth. *Ann. Rev. Entomol.,* **38**: 275-301.

Wavare, S.S. Patil, R.S. and Jalgaonkar, V.N. 2008. Evaluation of novaluron (Rimon 10 EC) against diamond back moth, *Plutella xylostella* (L.). *Pestol.*, **32**: 38-40.

Uthamasamy, S., Kannan, M. Senguttuvan, K. and Jayaprakash. S.A. 2011. Status, damage potential and management of diamondback moth, *Plutella xylostella* (L.) in Tamil Nadu, India. pp 270 – 279. In: Proceedings of The Sixth International Workshop on Management of the Diamondback Moth and Other Crucifer Insect Pests, AVRDC-The World Vegetable Centre, Taiwan, March 21–25, 2011.

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