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Effect of abamectin sprays on *Cotesia plutellae* (Kurdjumov) population in cabbage fields

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ABSTRACT: ***Plutella xylostella*** **(L.), an economic pest of cabbage, is controlled by use of newer chemicals like abamectin. Hence, safety of abamectin to the indigenous parasitoid *Cotesia plutellae* (Kurdjumov) was studied. Two field experiments conducted revealed that abamectin was relatively safer in comparison to the standard checks used. The lowest dose of abamectin (9 g a.i ha^{-1}) recorded 18.7 cocoons per ten plants and the higher dose (15 g a.i ha^{-1}) recorded 15 cocoons per ten plants while the control registered 23 cocoons per ten plants, a week after second spray in the first field experiment. A week after four sprays in the second field, abamectin at 9 g a.i ha^{-1} registered 20.3 cocoons per ten plants, which was on par with abamectin at 11 g a.i ha^{-1} (19.3 cocoons per ten plants), followed by abamectin at 13 g a.i ha^{-1} (18 cocoons per ten plants), while the control recorded 24.7 cocoons per ten plants. Spinosad at 75 g a.i ha^{-1} recorded 12.7 cocoons per ten plants which is better than endosulfan at 420 g a.i ha^{-1} (10 cocoons per ten plants) and cypermethrin at 70 g a.i ha^{-1} (9.3 cocoons per ten plants). Abamectin is relatively safer to *C. plutellae* in comparison to the other insecticides tested.**

KEY WORDS: Abamectin, cabbage, *Cotesia plutellae*, insecticides, parasitoid cocoons

INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L.), an important cruciferous vegetable crop, is widely grown all over India. In India, cabbage is cultivated in 280000 ha with an estimated production of 6100000 metric tonnes and a yield of 21786 kg ha^{-1} (FAO, 2004). Among the various insect pests attacking cabbage, diamondback moth (DBM), *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae), is the most dreaded pest not only in India, but also throughout the world and the annual cost incurred for managing this pest is estimated to be $1 billion (Talekar, 1990). Castelo and Guimaraes (1989) found that 10.8g a.i.ha^{-1} of abamectin applied at seven days interval recorded the best control of DBM. Murugan and Ramachandran (2000) reported that Vertimec® 1.8EC @ 15 g a.i.ha^{-1} was highly effective in checking diamondback moth larval population and also recorded significantly higher yield. Rui (2001) found that abamectin 1.5%EC + *B. t* WP at a dilution rate of 1: 750 and 1500 effected control of *P. xylostella* to an extent of 90.9 per cent. Xia *et al.* (2001) observed that spraying of 0.9 per cent abamectin EC gave good control of *P. xylostella*, with an efficacy of 68.9 on the second day and 59.7 per cent on the fifth day after spraying. Pramanik and Chatterjee (2003) and Syed *et al.* (2004) reported that abamectin was effective in reducing the DBM population and in increasing the yield of the crop over the untreated control. Abamectin has been reported to be one of the best chemicals for the control of diamond back moth, so safety of this chemical to the natural parasitoid populations in the field is essential. Selective use of insecticides to control pests without adversely affecting natural enemies is inevitable for integrated pest management. In the field conditions, *Cotesia plutellae* (Kurdjumov) (Hymenoptera: Braconidae) is found to parasitize *P. xylostella* even up to 70% (Cameron and Walker, 1997). Hence, the effects of abamectin on *C. plutellae* were studied.

MATERIALS AND METHODS

Two field experiments were conducted one each at Mukasimangalam and Vadivelampalayam, Coimbatore, during October 2003–September 2004 to test the safety of abamectin 1.9EC on *C. plutellae*. The experiments were conducted in a randomized block design with a plot size of 4x5 m with three replications. The different treatments are given in Table 1.

The treatments were imposed four times at 14 days interval commencing from 30th day after planting with pneumatic knapsack sprayer using 600 litres of spray fluid per hectare. The third round of spray was applied 21 days after the second spray since the DBM larval population did not cross the ETL in 14 days after second spray in both the experiments. Applications were done during morning hours in such a way to give uniform coverage on foliage and to avoid drift and photo-oxidation of the insecticides. Observations on the cocoons of *C. plutellae* were made from 10 randomly tagged plants per plot including the untreated check (water spray) prior to the spray application and 7 and 14 days after each spray and the mean were worked out. The analysis of variance was carried out by randomized block design using IRRISTAT version 3.1. The observed data were transformed into $\sqrt{x+0.5}$. The mean values of treatments were separated using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The results of the field experiment conducted at Mukasimangalam to assess the effect of abamectin 1.9EC on *C. plutellae* revealed that abamectin at all concentrations had some effect on the incidence of *C. plutellae*. The maximum number of cocoons was recorded in untreated check and it ranged from 22 to 26 per 10 plants (Table 1), followed by the plots applied with abamectin 9 g a.i. ha^{-1} (18.3-22.7 per 10 plants). There was a slight increase in cocoon population on 14 days after first spray in all the treatments when compared to that on 7DAT. Seven days after first spray, abamectin at 9g a.i. ha^{-1} had reduced the number of cocoons to 18.3 from 21.3 per ten plants whereas abamectin at higher dose of 15g a.i.ha^{-1} reduced the number of cocoons to 14.3 from 21.0 per ten plants. A week after second spray, the cocoon number was found to be 18.7 with abamectin 9g a.i. ha^{-1} and 15 per ten plants with abamectin 15g a.i.ha^{-1}. Cypermethrin at 70g a.i. ha^{-1} reduced the cocoons drastically to 9.7 per ten plants whereas the control registered 23.0 cocoons per ten plants (Table 1). At 14 days after three sprays of abamectin, the number of cocoons observed was 21.7 with the lowest dose of abamectin (9g a.i. ha^{-1}) and 13.0 with the highest dose of abamectin (15g a.i. ha^{-1}). The control registered 25.0 number of cocoons per 10 plants. Though the number of cocoons increased gradually, it was only 14.7 in the highest dose of abamectin and 22.7 in the lowest dose while it was 26.0 per ten plants in untreated check at 14 DAT after fourth spray. Among the insecticides other than abamectin, cypermethrin 10EC at 70g a.i. ha^{-1} registered the lowest number of cocoons (11 per ten plants), followed by endosulfan at 420g a.i. ha^{-1} (12.3 per ten plants) and spinosad at 75g a.i. ha^{-1} (13.0 cocoons per 10 plants).

The results of the effect of different doses of abamectin on *C. plutellae* at Vadivelampalayam are presented in Table 2. The number of cocoons before the application of treatments ranged from 20.7 to 22.3. A week after, the population varied from 8.3 to 17.7 per 10 plants among the insecticide treatments, while the untreated check recorded 21.3 per 10 plants. Fourteen days after the second spray,

Table 1. Relative effect of abamectin on the number of parasitoid cocoons on cabbage plants at Mukasimangalam

Treatments	Number of parasitoid cocoons per 10 plants*								
	PTC	I Spray		II Spray		III Spray		IV Spray	
		7 DAT	14 DAT	7 DAT	14 DAT	7 DAT	14 DAT	7 DAT	14 DAT
T_1-Abamectin 1.9EC@ 9g a.i. ha^{-1}	21.3	18.3^{b} (4.34)	19.0^{b} (4.41)	18.7^{b} (4.38)	22.3^{a} (4.78)	20.0^{b} (4.53)	21.7^{b} (4.71)	20.3^{b} (4.56)	22.7^{b} (4.81)
T_2- Abamectin 1.9EC @ 11g a.i. ha^{-1}	22.0	17.7^{bc} (4.26)	18.0^{bc} (4.30)	17.3^{c} (4.22)	22.0^{a} (4.74)	19.3^{b} (4.45)	20.3^{c} (4.56)	19.7^{c} (4.49)	21.3^{c} (4.67)
T_3- Abamectin 1.9EC@ 13g a.i. ha^{-1}	20.7	16.7^{c} (4.14)	17.3^{c} (4.22)	15.7^{d} (4.02)	17.7^{b} (4.26)	16.3^{c} (4.10)	18.3^{d} (4.34)	18.7^{d} (4.38)	20.0^{d} (4.53)
T_4- Abamectin 1.9EC@ 15g a.i. ha^{-1}	21.0	14.3^{d} (3.85)	15.7^{d} (4.02)	15.0^{d} (3.94)	15.3^{c} (3.98)	12.0^{d} (3.53)	13.0^{e} (3.67)	13.3^{e} (3.72)	14.7^{e} (3.89)
T_5- Spinosad 45SC@ 75g a.i. ha^{-1}	21.3	13.0^{e} (3.67)	14.0^{e} (3.81)	13.7^{e} (3.76)	14.0^{d} (3.81)	11.0^{de} (3.39)	11.7^{f} (3.49)	12.7^{f} (3.63)	13.0^{f} (3.67)
T_6-Cypermethrin 10EC@ 70g a.i. ha^{-1}	20.7	9.3^{g} (3.13)	11.3^{f} (3.44)	9.7^{f} (3.19)	10.7^{e} (3.34)	10.3^{e} (3.29)	10.7^{g} (3.34)	10.3^{h} (3.29)	11.0^{g} (3.39)
T_7-Endosulfan 35EC@ 420g a.i. ha^{-1}	21.0	10.7^{f} (3.34)	13.7^{e} (3.76)	10.3^{f} (3.29)	11.3^{e} (3.44)	10.3^{e} (3.29)	11.3^{f} (3.44)	11.3^{g} (3.44)	12.3^{f} (3.58)
T_8- Untreated Check	20.7	22.0^{a} (4.74)	22.7^{a} (4.81)	23.0^{a} (4.85)	23.3^{a} (4.88)	24.3^{a} (4.98)	25.0^{a} (5.05)	25.3^{a} (5.08)	26.0^{a} (5.15)

* Mean of three observations; PTC – pre-treatment count; DAT – days after treatment; figures in parentheses are $\sqrt{x + 0.5}$ transformed values; in a column, means followed by the same letter(s) are not significantly different by DMRT (P = 0.05)

Table 2. Effect of abamectin 1.9 EC on the number of parasitoid cocoons on cabbage plants at Vadivelampalayam

Treatments	Number of parasitoid cocoons per 10 plants*								
	PTC	I Spray		II Spray		III Spray		IV Spray	
		7 DAT	14 DAT	7 DAT	14 DAT	7 DAT	14 DAT	7 DAT	14 DAT
T$_1$-Abamectin 1.9EC@ 9g a.i. ha^{-1}	21.3	17.7^{b} (4.26)	18.0^{b} (4.30)	17.3^{b} (4.22)	20.7^{b} (4.60)	19.7^{b} (4.49)	21.0^{b} (4.64)	20.3^{b} (4.56)	22.7^{b} (4.81)
T$_2$- Abamectin 1.9EC @ 11g a.i. ha^{-1}	22.0	16.3^{c} (4.10)	16.7^{c} (4.14)	17.0^{b} (4.18)	18.7^{c} (4.38)	19.3^{b} (4.45)	20.0^{bc} (4.53)	19.3^{bc} (4.45)	21.0^{c} (4.64)
T$_3$- Abamectin 1.9EC@ 13g a.i. ha^{-1}	20.7	15.7^{c} (4.02)	16.3^{c} (4.10)	15.0^{c} (3.94)	16.7^{d} (4.14)	17.3^{c} (4.22)	18.7^{c} (4.38)	18.0^{c} (4.30)	19.3^{d} (4.45)
T$_4$- Abamectin 1.9EC@ 15g a.i. ha^{-1}	21.0	13.7^{d} (3.76)	14.7^{d} (3.89)	13.3^{d} (3.72)	15.3^{e} (3.98)	14.7^{d} (3.89)	15.7^{d} (4.02)	16.0^{d} (4.06)	16.7^{e} (4.14)
T$_5$- Spinosad 45SC@ 75g a.i. ha^{-1}	21.3	12.0^{e} (3.53)	12.7^{e} (3.63)	13.7^{e} (3.72)	13.7^{f} (3.76)	12.0^{ee} (3.53)	13.0^{e} (3.67)	12.7^{f} (3.63)	14.7^{f} (3.89)
T$_6$-Cypermethrin 10EC@ 70g a.i. ha^{-1}	20.7	8.3^{g} (2.97)	9.7^{g} (3.19)	10.3^{f} (3.29)	12.0^{g} (3.53)	10.0^{f} (3.24)	10.7^{g} (3.34)	9.3^{f} (3.13)	10.7^{g} (3.34)
T$_7$-Endosulfan 35EC@ 420g a.i. ha^{-1}	21.0	9.7^{f} (3.19)	11.0^{f} (3.39)	11.3^{e} (3.44)	12.3^{g} (3.58)	11.3^{e} (3.44)	11.7^{f} (3.49)	10.0^{f} (3.24)	11.3^{g} (3.44)
T$_8$- Untreated Check	20.7	21.3^{a} (4.67)	23.0^{a} (4.85)	23.7^{a} (4.92)	23.0^{a} (4.85)	24.0^{a} (4.95)	24.3^{a} (4.98)	24.7^{a} (5.02)	25.0^{a} (5.05)

* Mean of three observations; PTC – pre-treatment count; DAT – days after treatment; figures in parentheses are $\sqrt{x + 0.5}$ transformed values; in a column, means followed by the same letter(s) are not significantly different by DMRT (P = 0.05)

significant reduction in cocoon population was observed in all the insecticide treatments. Among them, the maximum population was observed in abamectin at 9g a.i. ha^{-1} (20.7 per 10 plants), followed by abamectin at 11g a.i. ha^{-1} (18.7 per 10 plants). Seven days after third spray, abamectin at 9g a.i. ha^{-1} registered 19.7 cocoons per ten plants, which was on par with abamectin at 11g a.i. ha^{-1} (19.3 cocoons per ten plants), followed by abamectin at 13g a.i. ha^{-1} (17.3 cocoons per ten plants). Abamectin at 15g a.i. ha^{-1} registered 14.7 cocoons per ten plants whereas it was 24.0 cocoons in ten plants in untreated check. A week after fourth spray, abamectin at 9g a.i. ha^{-1} registered 20.3 cocoons per ten plants, on par with abamectin 11g a.i. ha^{-1} (19.3 cocoons per ten plants). Abamectin 15g a.i. ha^{-1} recorded 16.0 cocoons per ten plants whereas it was 24.7 cocoons per ten plants in untreated check. Among the other insecticides tested, spinosad at 75g a.i. ha^{-1} recorded 12.7 cocoons per ten plants, which was better than endosulfan at 420g a.i. ha^{-1} (10.0 cocoons per ten plants), which was on par with cypermethrin at 70g a.i. ha^{-1} (9.3 cocoons per ten plants).

It was concluded that abamectin was safer to *C. plutellae* compared to spinosad, cypermethrin and endosufan. The results are in agreement with the findings of Franca *et al.* (1998) who stated that abamectin did not have any measurable impact on the populations of *Diadegma* sp. and *Apanteles* sp. This is also supported by the findings of Sengonca and Liu (2001) who reported that GCSC-*Bt*A express low toxicity to *C. plutellae*. Smith *et al.* (1998) found that abamectin (1.8% EC) caused significant mortality of adults of the scale parasitoid *Aphytis lingnanensis* Compere when they were exposed to freshly sprayed leaves for 24h. There was no significant residual effect one and two days after spraying on oranges since abamaectin has half-life residue of 12h only under sunlight. In the present study, spinosad was found to be relatively safer to *C. plutellae* in comparison to conventional insecticides. This is in agreement with the findings of Elzen (2001) who reported that spinosad was significantly less toxic to *Geocoris punctipes* Say than fipronil and endosulfan.

Several workers have reported the safety of abamectin to natural enemies. Abamectin residue is found within the mesophyll layer of the leaf tissue, predatory mites and insects continue to proliferate because of the short lived surface residue of abamectin (Lasota and Dybas, 1991). Abamectin was found to be less toxic to natural enemies than conventional insecticides by Kok *et al.* (1996). Fein *et al.* (1994) found that abamectin was safer to natural enemies and hence can be used in conjunction with biological control agents such as *Encarsia formosa* (Gahan), *Aphelinus semiflavus* Howard and *Diaeretiella rapae* (M' Intosh). Nian *et al.* (1997) reported that abamectin is safe to *Trichogramma chilonis* Ishii populations in cotton fields. However, Weintraub (1999) found that spray applications of abamectin and cyromazine significantly reduced the eulophid parasitoid, *Diglyphus isaea* (Walker).

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