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Efficacy of granulosis virus (GV) used in conjunction with abamectin and indoxacarb in the management of *Plutella xylostella* (L.) (Yponomeutidae: Lepidoptera) on cauliflower

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Abstract : **Two field trials were taken up to test the combined efficacy of PXGV with abamectin and indoxacarb against the diamondback moth *Plutella xylostella* (L.) on cauliflower at Irruttupalllam near Coimbatore during January-June 2001. The results revealed that the application of PXGV at 0.75×10^{13} OB ha^{-1} in conjunction with abamectin at 4.75g a.i. ha^{-1} was the most effective in controlling the pest and increasing the yield of flower heads. This combination was on par with abamectin 9.5 g a.i. ha^{-1} in the first trial. In both the trials GV at 1.5×10^{13} OB ha^{-1} was the next best treatment which was comparable with GV at 0.75×10^{13} OB ha^{-1} + indoxacarb 14.5g a.i ha^{-1}. GV at 0.75×10^{13} OB ha, abamectin at 4.75 g a.i ha^{-1} and indoxacarb at 14.5 g a.i ha^{-1} were ineffective against *P. xylostella.* In the first trial *Bacillus thuringiensis at* 0.5 kg ha^{-1} was on par with GV at 1.5×10^{13} OB ha^{-1}, but in the second, the GV was found to be better.**

Key words : ***Plutella xylostella, Granulosis virus, Bacillus thuringiensis, Abamectin, Indoxacarb, Cauliflower.***

Introduction

The diamondback moth DBM, *Plutella xylostella* (L.) (Yponomeutidae: Lepidoptera). Though miniscule in size the pest can cause colossal losses to cruciferous crops. It is estimated that about US $1 billion is being spent annually in controlling this baneful pest (Talekar and Shelton, 1993). In spite of the diverse management tools available, chemicals still remain as the most powerful one in the elimination of the pest. However the indiscriminate use of several hundreds of insecticides have left them less useful as the pest has developed resistance to most of these (Talekar *et al.* 1990a). Microbials in general are found to synergize with the chemical insecticides as well as to mitigate insecticide—detoxifying enzymes resulting in the prevention of development of resistance. Hence experiments were conducted to evaluate the efficacy of PXGV in conjunction with abamectin and indoxacarb.

Materials and Methods

Two field trials were conducted during January - June 2001 at Iruttupallam near Coimbatore on cauliflower (Var: century and krishna Double Cross). The experiments were conducted in a randomized block design with a plot size of 3x 3.5m with three replications. The dose of the virus tested was 1.5×10^{11} OB/ha. The two chemicals selected were indoxacarb 14.5% SC and abamectin 1.9% EC. The doses of the insecticides were 200 and 500 ml/ha respectively (Recommended field doses by the manufacturer). The details of the treatment are presented in Tables 1 & 2. Application of different treatments were carried out from pre-flowering stage at an interval of 7 days, using a backpack hydraulic sprayer with a spray fluid volume of 500 l/ha. Krishna double cross-had a longer duration hence more number of sprays were given. The spraying was done during evening hours and in such a way to give uniform coverage of foliage, to avoid drift and the influence of UV fraction of sunlight. In the first trial three rounds of sprays were given whereas in the second, five rounds of sprays were applied (Spraying started at the time of primordia initiation and continued till harvest). The observations on larval populations were taken 3 and 7 days after spraying and measured in terms of 10 randomly selected plants from each plot. The consequent yield response was diameter and weight of flower heads. The larval counts in field experiments were transformed to x + 0.5 value as per the method developed by Poisson for statistical analysis (Snedecor and Cochran, 1967). Analysis of variance was arried out for field experiments by randomized block design (Panse and Sukatme, 1985) and means were separated by Duncan's new multiple range test.

Table 1. Efficacy of PxGV with abamectin and indoxacarb against *P. xylostella* on cauliflower (Var. century): Trial I (Jan-Mar. 2001).

Treatment	Pre-treatment count Larvae/10 plants	Number of *P.xylostella* (larvae per 10 plants) days (3 and 7) after spray (I - III)						Mean diameter (cm) of flower heads	Cauliflower yield (tonnes/ha)
		I		II		III			
		3	7	3	7	3	7		
GV (1.5 x 10^{13} OB ha^{-1})	20.0	20.0cf	10b	14.6b	9.0a	11.0d	6.33a	14.6 bc	13.9b
Indoxacarb 29 g a.i ha^{-1}	20.6	10.0a	14d	9.3a	13.3c	6.3b	7.33b	15.6c	13.9b
Abamectin (9.5 g a.i ha^{-1})	19.0	8.0a	10.66b	7.3a	9.3ab	6.7b	6.33a	15.3ab	14.6a
Abamectin (4.75 g a.i ha^{-1})	20.0	13.0bc	13.33dc	10.0a	12.6c	7.3bc	8.00c	15.4abc	11.1d
Idoxacarb (14.5 g a.i ha^{-1})	19.6	15.3cd	16.0d	11.6ab	13.0c	7.6bc	9.33e	16.8ab	11.1d
GV (0.75 x 10^{13} OB ha^{-1})	16.6	17.0d	12.3c	15.0b	11.6bc	170e	833	15.9b	11.5cd
GV (0.75 x 10^{13} OB ha^{-1})+ Indoxacarb (14.5 g a.i ha^{-1})	21.6	14.3d	10.6b	7.3a	11.6bc	5.7ab	6.33a	16.3ab	13.7b
GV (0.75 x 10^{13} OB ha^{-1})+ Abamectin (4.75 g a.i ha^{-1})	22.0	8.0a	9.0a	7.6a	7.67a	4.3a	7.33b	17.9ab	14.9a
B.t (0.5 kg ha^{-1})	20.3	9.3ba	11.3c	8.6a	16.3d	7.3b	9.33e	15.5c	13.9bc
Control	21.6	22.6f	26.0f	23.0c	30.3e	25.3f	30.0f	8.4d	8.8e

Column figures followed by similar letters are not significantly different (P=0.05) by DMRT

Table 2. Efficacy of PxGV with abamectin and indoxacarb against *P. xylostella* on cauliflower (Var Krishna Double Cross): Trial II (Jan-Mar 2001).

Treatments	Pre-treatment count Larvae/10 plants	Number of P.xylostella (larvae per 10 plants) days (3 and 7) after spray (I-V)										Mean diameter (cm) of flower heads	Cauliflower yield (tonnes/ha)
		I		II		III		IV		V			
		3	7	3	7	3	7	3	7	3	7		
GV (1.5 x 10^{13} OB ha^{-1})	29.0	29.3c	14.3b	12.0b	14.6d	12.3abc	10.3ab	13.6cd	11.3ab	15.66c	14.3b	20.0c	22.2b
Indoxacarb 29 g a.i ha^{-1}	29.0	12.6a	16.3c	14.3cd	14.0cd	14.7c	13.6cd	13.0bc	16.6cd	13.66bc	15.3cd	15.2d	19.4d
Abamectin (9.5 g a.i ha^{-1})	28.0	11.0a	12.0a	11.3b	11.3abc	11.7ab	12.0bc	11.3ab	14.6cd	11.66ab	14.3bc	19.7c	23.0b
Abamectin (4.75 g a.i ha^{-1})	26.0	16.0b	18.3d	15.6d	12.6bcd	13.3bc	15.0de	13.6cd	16.6cd	15.66c	15.6cde	15.5d	17.7e
Indoxacarb (14.5 g a.i ha^{-1})	27.0	18.0b	20.6e	19.0d	15.0d	13.7bc	15.3de	14.0cd	17.3d	15.00c	16.3de	13.2c	15.7f
GV (0.75 x 10^{13} OB ha^{-1})	29.0	24.6d	18.6d	15.6d	14.6d	14.3c	13.3cd	15.6d	14.3bc	13.33bc	14.6bc	14.6de	17.1e
GV (0.75 x 10^{13} OB ha^{-1}) + Indoxacarb (14.5 g a.i ha^{-1})	30.0	20.6c	16.3c	11.6b	10.3ab	12.7bc	12.0bc	12.3abc	13.3ab	13.33a	13.3ab	21.6b	22.7b
GV (0.75 x 10^{13} OB ha^{-1}) + Abamectin (4.75 g a.i. ha^{-1})	30.0	17.0b	12.3a	9.0a	9.6a	10.0a	9.6a	10.6a	11.6a	10.66a	11.3a	23.7a	24.3a
B.t (0.5 kg ha^{-1})	30.0	18.0b	14.3b	12.6bc	14.0cd	12.0bc	17.3c	13.3bcd	16.6c	15.32c	14.3bc	13.3c	20.7c
Control	29.0	30.8c	31.6f	29.6f	30.5e	31.0d	31.0f	32.6e	32.6d	32.66e	32.6f	10.3g	11.1g

Column means followed by similar letters are not significantly different (P=0.05) by DMRT

Results and Discussion

At the start of the first trial, the larval population of *P. xylostella* ranged from 16.7 to 22 per 10 plants. Subsequent to the treatment sprays, larval population was reduced significantly in all the treatments on all the days of observations. A combination of GV 0.75 X 10^{13} OB/ha + abamectin 4.75 g a.i./ha was found to be the most effective in reducing the larval population of *P. xylostella* (Table 1). In most of the observations, abamectin 9.5 g a.I. ha^{-1} and in some observations GV 0.75 x 10^{13} OB/ha + indoxacarb 14.5 g a.i./ha was found to be on par with the above combination. On two occasions GV at 1.5 x 10^{13} OB/ha was also on par with the above treatments. Reduced doses of GV (0.75 x 10^{13} OB/ha), indoxacarb (14.5 g a.i./ha) or abamectin (4.75 g a.i./ha) were inferior in efficacy. Flower head diameter was significantly higher in all the treatments than in control plots. The highest yield of cauliflower (14.99 tonnes/ha) was observed in GV 0.75 x 10^{13} OB + abamectin 4.75 g a.i. ha^{-1} and this was on par with abamectin 9.5 g a.I. ha^{-1}. Next in order were GV 1.5 x 10^{13} OB ha^{-1}, indoxacarb 29 g a.i. ha^{-1}, B.t. 500 g ha^{-1} or a combination of GV 0.75 x 10^{13} OB ha^{-1} + indoxacarb 14.5g a.i./ha. Reduced doses of GV 0.75 x 10^{13} OB ha^{-1}, abamectin4.75 g a.i ha^{-1} or indoxacarb 14.5 g a.i ha^{-1} were inferior in efficacy compared to the other treatments.

In the second experiment, the larval population was higher than in the first trial, ranging from 26-30 per 10 plants and totally five rounds of sprays had to be given. Results of the second trial also showed that spraying a combination of GV 0.75 x 10^{13} OB ha^{-1} + abamectin 4.75 g a.i. ha^{-1} was the most effective in controlling the larval populations and increasing the yield (Table 2). Though in most of the observation abamectin 9.5 g a.i. ha^{-1} and in some GV at 1.5 x 10^{13} OB ha^{-1} were as effective as the above combination in controlling the larval population, they were found to record lowest yields. Both GV 1.5 x 10^{13} OB ha^{-1} and *B.t.* 500g ha^{-1} were however more effective than reduced doses of either the GV or the insecticides. As in the first trial abamectin was significantly better than indoxacarb. It has been reported to be less harmful to parasitoids and predators it as it is known to degrade very rapidly (Krishnamohan, 2001). In the present study, a combination of GV at 0.75 x 10^{13} OB + abamectin at 4.75 g a.i. ha^{-1} was the most effective recording the lowest larval population and highest yield of cauliflower. Field efficacy of GV against *P. xylostella* has been demonstrated on cauliflower (Saira Banu, 2000).

Huang and Dai (1991) have reported synergistic interaction of GV and insecticides on *Pieris brassicae,* in a field trial, a mixture of GV and acephate at reduced doses were found to be significantly better than either of them used alone at higher concentration against *P. brassicae* on cabbage. Results of laboratory studies by Rajagopal Babu (2001) have shown that *P. xylostella* larvae treated with GV *a priori* were significantly more susceptible to abamectin and several other insecticides and a study of enzyme profiles showed that the GV infection was responsible for the mitigation of pesticide detoxifying enzyme like mixed function oxygenase (MFO), glutathione-s-transferase (GST) and carboxyl esterase (CEH). *P. xylostella* is known to have developed resistance to a wide range of chemical insecticides (Talekar et al. 1990a;b) and the present field studies have shown that the GV can play an important role in insecticide resistance management in *P. xylostella* unlike the first experiment GV at 1.5 x 10^{13} OB/ha was as effective as abamectin 9.5 g a.i /ha in increasing the yield.

One or two larvae present at the primordia during flower formation may cause drastic effects on the formation of head. These two experiments have clearly demonstrated the usefulness of GV, abamectin and indoxacarb either alone or in combination with GV at reduced doses in the management of *P. xylostella* on cauliflower. Su (1987a; 1987b) has reported the usefulness of GV in the management of *P. xylostella* in Taiwan. In India, a virulent strain of GV of *P. xylostella* was reported by Rabindra *et al.* (1998) and subsequent field trials on cauliflower have demonstrated the usefulness of this baculovirus in the management of the pest (Saira Banu, 2000). In view of its specificity to the target pest and safety to non-target species, the granulosis virus can be used without any deleterious effects on the parasitoid populations. Talekar *et al.* (1990b) have indicated the usefulness of parasitoids in the management of *P. xylostella* and in field trials on cauliflower. Plots receiving GV recorded significantly a higher number of cocoons of

Apanteles plutellae than did those that received chemical insecticides (Saira Banu, 2000).

In the present trials abamectin a formulation product from *Streptomyces avermetilis* at a dose of 9.5g a.i./ha was found to be effective in reducing the loss in cauliflower yield due to *P. xylostella*. The usefulness of this product in the management of *P. xylostella is* being reported for the first time in this paper. Since the product is effective at a low dose of 9.5g a.i./ha, it can confer a fair amount of environmental safety. Abamectin, though it exhibits direct toxicity it has been reported to be less harmful to parasitoids and predators as it is known to degrade very rapidly (Krishnamohan, 2001). In the present study, a combination of GV at 9.75×10^{13} OB+abamectin at 4.75 g a.i/ha was the most effective recording the lowest larval population and highest yield of cauliflower. Field efficacy of GV against *P.xylostella* has been demonstrated on cauliflower (Sairabanu, 2000).

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