

Enhancing the bio-efficacy of pyrethroids against cotton bollworms through synergistic effect of Omite – a field investigation

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ABSTRACT

American bollworm (*Helicoverpa armigera* Hüb.) is a major and insecticide resistant pest in the Indian cotton ecosystem. The resistance to the most widely used pyrethroids viz., cypermethrin and fenvalerate is quite evident in this pest. Field investigations were carried out at Dharwad (Karnataka – India) to investigate the synergistic effect of Omite with cypermethrin 10 EC and fenvalerate 20 EC as tank mixture to spray solution. The popular intraspecific cotton hybrid of locality DHH-11 was used in the study. There was variation between the treatments in the *Helicoverpa* larval population due to synergistic effect of Omite with synthetic pyrethroids. The mean larval population was 1.45/plant in cypermethrin treated plots and 0.53/plant when Omite (1000 ml/ha) was added to cypermethrin. The total damage to fruiting bodies (squares/bolls) was 22.46 percent in straight use of cypermethrin against 17.59 percent in cypermethrin + Omite. A similar effect was also noticed when Omite was mixed with fenvalerate. The damage due to bollworms was 24.33 percent in fenvalerate applied plots, where as 18.16 percent in fenvalerate + Omite (1000 ml/ha) treated plots. The utility of Omite as a synthetic pyrethroid synergist increased the efficacy of cypermethrin and fenvalerate against spotted and pink bollworms also. The yield advantage gained through Omite synergism ranged from 18 to 40 percent.

Introduction

Insecticide resistance to pyrethroids in the important Heliiothine species is a worldwide problem. Varied climatic situations and cropping patterns in India have created an opportunity for survival and dominance of dreaded pests like *Helicoverpa armigera* (Hübner). India occupies one of the prime positions among cotton growing countries with 20 percent of the area and 12 percent of the production of global terms. Karnataka is one of the leading states for cotton cultivation in India.

There is a heavy dependence on pesticides especially fenvalerate and cypermethrin for management of insect pests (Anonymous, 2002). Resistance to many insecticides including pyrethroids in *Helicoverpa armigera* (Hübner) over the entire country has been assessed and documented through network research since 1992. The resistance to pyrethroids is ubiquitous and stable at around 50-80 percent in most areas of India (Russell *et al.*, 1998). Even in Karnataka the in-

sensitivity of this pest has been noticed and control failures have been experienced by the farmers. There was a high level of resistance to pyrethroids in different cotton growing zones of Karnataka and resistance to cypermethrin was reported to be 15.76 times (Basavangouda and Lingappa, 2001).

The attempts to understand the resistance mechanism to pyrethroids in India and abroad (Armes *et al.*, 1996; Kranthi, 1998; Phokela and Mehrotra, 1989) revealed the fact that mixed function oxidases action (MFOs) is the major cause apart from nerve insensitivity, cuticular impermeability and esterases. Plenty of reports are available on the synergistic effect of piperonyl butoxide (PBO) with pyrethroids for reduction of resistance. Profenophos synergism to combat pyrethroids resistance has been well documented. Many organophosphate insecticides also synergise the efficacy (Gunning *et al.*, 1998). However, none of these are practicable by the farmers for obvious reasons. Hence, depend farmers heavily on combinations of insecticides or tank mixtures.

In the present investigation attempts have been made to study the synergistic effect of Omite 57 EC, an acaricide (propargite), with cypermethrin and fenvalerate to enhance their efficacy against bollworms.

Experimental procedure

The field experiments were conducted for two years (2000-01, 2001-02) at the Agricultural Research Station, Dharwad Farm, (Karnataka, India), which is located at an altitude of 678 m, latitude 15.7° N, longitude 76.6° E. The soil type in the farm is medium deep black. The experiment was laid out in randomized block design, each plot size was 5.4 m x 4.8 m with a spacing of 90 cm x 60 cm, the DHH - 11 (intraspecific hybrid), cotton was used for investigation and the crop was sown in the second week of July. The level of resistance in the field population was assessed by using the discriminating dose method during October to November months. Omite was used at 0.5, 0.75 and 1.0 ml per liter of spray volume to assess the synergistic effect with cypermethrin 10 EC (0.5 ml/l water) and fenvalerate 20 EC (0.5 ml/l) for management of bollworms. Required quantity of Omite was directly added to the spray volume prepared with the test insecticide and water. Omite mixed well with the spray solution.

Mixing of Omite directly with the insecticides was also tested and there was no problem in using Omite with these pyrethroids in either of the methods.

Total spray volume used per hectare was thousand liters. The total number of sprays given against bollworms was six. The management of sucking pests was common to all treatments. Observations were made regarding the number of *Helicoverpa* larvae per

plant, percent damage to fruiting bodies and yield of seed cotton.

Results and Discussion

During the first year of investigation the survival at a discriminating dose of cypermethrin (0.1 mg/ml) was 47.52 percent. Results summarized in Table 1 indicated that cypermethrin 10 EC (0.5 ml/l) + Omite 57 EC (1.00 ml/l) had significantly less number of *Helicoverpa* larvae (0.53 larvae/plant). Cypermethrin (0.5 ml/l) + Omite 57 EC (0.5 ml/l) was the next best treatment (1.02 larvae /plant). Where as in the untreated check, the *Helicoverpa* larvae/plant were 2.82. However the percent damage to fruiting bodies in cypermethrin 10 EC (0.5 ml/l) + Omite 57 EC (0.5 ml/l), cypermethrin 10 EC (0.5 ml/l) + Omite 57 EC (0.75 ml/l) and cypermethrin 10 EC (0.5 ml/l) + Omite 57 EC (1.0 ml/l) was at par with each other, recording 18.95, 18.54 and 17.59 percent damage respectively. These treatments were significantly superior to the treatment where cypermethrin alone was used (22.46%). In untreated check plot the damage was 30.76 percent. The impact of enhanced bio-efficacy of cypermethrin was also evidenced through higher seed cotton yield. The maximum yield (21.07 q/ha) was harvested from the treatment where Omite was added @ 1.0 ml/l, and was followed by addition of Omite @ 0.75 ml/l. The treatment where synergism was not induced could give about 17.72 q/ha seed cotton which was statistically on par with cypermethrin + Omite (0.5 ml/l). However, the yield in the latter was 19.28 q/ha.

Confirmation studies during the next season (2001-02) also revealed the similar impact of Omite on cypermethrin (Table 2). The survival with cypermethrin at the discriminating dose was 50.35 percent and of fenvalerate (0.2 mg/ml) was 55.60 percent. The best synergistic effect was seen in the treatment with addition of Omite @ 1.0 ml/l (0.69 larvae/plant, 11.07 percent damage and 14.97 q/ha yield). However, this treatment was on par with addition of Omite @ 0.75 ml/l in all aspects. Further Omite synergism was also convincing in combination with fenvalerate 20 EC. The incidence of *Helicoverpa armigera* larvae was 1.55/plant in Fenvalerate 20 EC (0.5 ml/l) + Omite 57 EC (1.0 ml/l) as against 2.12/plant in the absence of Omite. There was significant difference in the damage caused by bollworms and seed cotton yield between these two treatments. Thus the addition of Omite was found to play a vital role in enhancing the bio-efficacy of two widely used pyrethroids, as it has a propynyl or carbon to carbon triple bond which allows it to bind and disrupt some enzymes found in synthetic pyrethroids resistant to *H. armigera*. The effect of propargite as a synergist is similar to that of piperonyl butoxide (PBO), in that both disrupt MFO enzymes. Both propargite and PBO disrupt some of the MFO enzymes (Anonymous, 1999). Synergism by PBO has been widely documented (Armes *et al.*, 1998;

Kranthi *et al.*, 1998; Basavangouda and Lingappa, 2001; Phokela *et al.*, 1999). Thus the results of field investigations open up the possibility that Omite synergist be used in India to restore some pyrethroids susceptibility in *Helicoverpa armigera*, which could be a boost in cotton pest management strategies.

Conclusion

The verification for Omite synergism is undergoing field experimentation in various parts of India under the All India Co-ordinated Cotton Improvement Project. The detailed investigations in this regard can also be conducted. However, in the absence of availability of a commercial scale synergist, Omite can conveniently be used with pyrethroids. The acaricidal property of Omite will remain as an added advantage.

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Table 1. Effect of Omite as a synergist with cypermethrin against cotton bollworms.

Treatment details	American bollworms ¹	Damage to fruiting bodies (%) ¹	Yield (q/ha) ¹
Cypermethrin 10EC (0.5 ml/l) + Omite 57EC (0.5 ml/l)	1.02b	18.95a	19.28ab
Cypermethrin 10EC (0.5 ml/l) + Omite 57EC (0.75 ml/l)	0.74ab	18.54a	20.92a
Cypermethrin 10EC (0.5 ml/l) + Omite 57EC (1.0 ml/l)	0.53a	17.59a	21.07a
Cypermethrin 10EC (0.5 ml/l)	1.49cd	22.46b	17.72bc
Untreated check	2.82f	30.76e	11.09e

¹ Values in a column followed by the same letter do not differ significantly by DMRT (p=0.05)

Table 2. Effect of Omite as a synergist with cypermethrin and fenvalerate against cotton bollworms.

Treatment details	American bollworms ¹	Damage to fruiting bodies (%) ¹	Yield (q/ha) ¹
Cypermethrin 10EC (0.5 ml/l) + Omite 57EC (0.5 ml/l)	1.17 bc	15.09 ab	13.24 bc
Cypermethrin 10EC (0.5 ml/l) + Omite 57EC (0.75 ml/l)	0.72 a	13.55 ab	14.07 ab
Cypermethrin 10EC (0.5 ml/l) + Omite 57EC (1.0 ml/l)	0.69 a	11.07 a	14.97 a
Cypermethrin 10EC (0.5 ml/l)	1.72 de	20.82 cd	11.82 cd
Fenvalerate 20EC (0.5 ml/l) + Omite 57EC (1.0 ml/l)	1.55 cd	18.16 bc	11.55 d
Fenvalerate 20EC (0.5 ml/l)	2.12 e	24.33 d	08.06 e
Omite 57 EC (1.0 ml/l)	2.69 f	30.55 e	06.55 f
Untreated check	3.11 f	34.82 e	05.02 g

¹ Values in a column followed by the same letter do not differ significantly by DMRT (p=0.05)