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Integrated management of the Yellow Mite, *Polyphagotarsonemus latus* (Banks), on sweet pepper grown under polyhouse

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ABSTRACT

Different IPM modules were evaluated for the management of yellow mite, *Polyphagotarsonemus latus* (Banks) on sweet pepper grown under protected cultivation at the Indian Institute of Horticultural Research, Bangalore. Results indicated that application of module 1(spray of abamectin followed by ethion and abamectin) or module 2 (spray of abamectin followed by profenophos and abamectin) was significantly more effective (3.91-6.58 mites/leaf) than module 3 (spray of dicofol followed by pongamia oil and neem seed kernal extract (5.79 -6.95 mites/leaf) in the first two trials (Sept. 2002- Mar. 2003 and June – Dec.2003). IPM modules like module 4 (spray of dicofol followed by release of *Amblyseius tetranychivorus* and spray of *Verticillium lecanii* and module 5 (spray of dicofol followed by release of *A. tetranychivorus* and spray of pongamia oil (9.25-15.53 mites/leaf) were marginally effective during the first two trials. However, in the third trial (Mar. - Sept., 2004) all the revised modules, viz., abamectin followed by dicofol (M_1), dicofol-fenazaquin (M_2), fenazaquin-pongamia oil (M_3) and organic module oxymetrin-neem soap (M_4) were effective (2.30-3.03 mites/leaf) against the yellow mite.

Key words: IPM, polyhouse cultivation, *Polyphagotarsonemus latus*, sweet pepper

INTRODUCTION

Protected (polyhouse) cultivation is gaining popularity in India and is recognized as a useful technology to augment production of high quality vegetables. Sweet pepper, *Capsicum annuum* L., is one of the vegetables commercially suited for polyhouse cultivation, yielding 100 to 120 t ha^{-1} compared to 20 to 40 t/ha in open field (Prabhakara *et al*, 2004). Among different pests reported on sweet pepper, the yellow mite, *Polyphagotarsonemus latus* (Banks) is a major pest causing yield loss upto 96.4% in North Karnataka (Borah, 1987) and 25% in West Bengal (Ahmed *et al*, 1987) under open field is reported. Adults and nymphs suck the sap from terminal leaves, auxiliary shoots and developing fruits. Affected leaves become narrow and twisted resulting in downward curling (Eswara Reddy, 2005). Information on yield loss due to *P. latus* infestation and its management on sweet pepper grown under protected cultivation is lacking in the tropics. Hence, a study was carried out to study the effect of various IPM modules against *P. latus* on sweet pepper.

MATERIAL AND METHODS

Experiments were conducted under a polyhouse (30 x 7 m) during September 2002 - March 2003, June - December 2003 and March - September 2004 at the Indian Institute of Horticultural Research, Bangalore. Thirty five day old, indeterminate, hybrid sweet pepper seedlings raised under polyhouse (*Indra*, Syngenta India Ltd.) was transplanted as recommended (Prabhakara *et al*, 2004). Experiments were carried out in a Randomized Block Design (RBD) to evaluate six pest management modules in the first two trials. The third trial consisted of five modules. There were four replications and the plot size was 1.75 sq m.

Modules were revised during the third season to accommodate one more variable with no chemicals/ pesticides or botanicals.

Treatment sprays were imposed as soon as the first infestation of yellow mite, *P. latus,* was noticed (first spray was given 22 weeks after planting, second and third sprays) 23 and 25 weeks after plantings respectively in the first trial. Correspondingly, it was 12, 15 and 17 weeks in the second trial and 6 and 9 weeks in the third trial. All pesticide sprays were applied with n adjuvant (Teepol, 0.5 ml/l) using a high volume sprayer.

Observations on the incidence of *P. latus* were recorded a day prior to treatment and 7 and 14 days after

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Table 1: Modules evaluated against *P. latus* on sweet pepper under polyhouse (September 2002-March 2003 and June-December 2003)

Module	Spray sequence
M_1	Abamectin 0.00095% - Ethion 0.05% - Abamectin 0.00095%
M_2	Abamectin 0.00095% - Profenophos 0.05% - Abamectin 0.00095%
M_3	Dicofol 0.037% - Pongamia oil 1% - Neem seed kernel extract 4%
M_4	Dicofol 0.037% -*Amblyseius tetranychivorus* - *Verticilium lecanii* 0.30%
M_5	Dicofol 0.037% - *A. tetranychivorus* – Pongamia oil 1%
M_6	Control (No spray)

Table 2: Modules evaluated against *P. latus* on sweet pepper in polyhouse (March -September 2004)

Module	Spray sequence
M_1	Abamectin 0.00095% - Dicofol 0.037%
M_2	Dicofol 0.037% - Fenazaquin 0.01%
M_3	Fenazaquin 0.01% - Pongamia oil 1%
M_4	Oxymetrin 0.0009%- Neem soap 1%
M_5	Control (no spray)

each spray. The number of nymphs and adults of *P. latus* were counted under a stereo-binocular microscope from two terminal leaves/plant on 5 randomly selected plants/ treatment. Mature, green sweet pepper fruits were harvested 60 days after planting in all the trials and repeated at regular intervals. Data on incidence of mites were subjected to square root transformation and subjected to analysis of variance (ANOVA). Module details for the experiments are presented in the tables 1 and 2.

Rationale of module selection

The selected IPM modules were basically derivatives of similar modules evaluated for management of *Tetranychus urticae* on ornamental crops. This was necessary in the absence of similar work on vegetables. The main logic was to compare the efficacy of the most effective molecule (Abamectin) for management of *P. latus* and gradual, step-wise replacement of this molecule with moderately effective but less expensive (dicofol) molecules and, if possible, to develop a module using only botanicals and predators.

Predatory mite

Information regarding phytoseiid mite adults, *Amblyseius tetranychivorus* (Gupta), was supplied by M/s. Bio-Control Research Laboratories (BCRL), Bangalore, in plastic vials (200 mites/vial) containing artificial diet and bran. The predator was released by sprinkling the bran containing mites on leaves @ 20 mites/plant.

RESULTS AND DISCUSSION

Among the modules evaluated against *P. latus* on swet pepper, module 1 (abamectin followed by ethion and abamectin), module 2 (abamectin followed by profenophos and abamectin) and module 3 (dicofol followed by pongamia oil and neem seed kernel extract) were more effective in controlling *P. latus* (3.91-6.95 mites/leaf) (Tables 3, 4). Module 4 (dicofol followed by *Amblyseius tetranychivorus* and *Verticilium lecanii*) and module 5 (dicofol followed by *A. tetranychivorus* and pongamia oil) recorded moderately high infestation (13.99 -15.53 mites/ leaf). Release of *A. tetranychivorus* following application of dicofol did not significantly reduce the infestation of *P. latus*. Similarly, a comparison of module 4 and module 5 indicates that application of pongamia oil was more effective in suppressing *P. latus* numbers than the application of *V. lecanii* (Table 3, 4).

The efficacy of module 1 and 2 can be attributed to the effect of abamectin on *P. latus*. Our results are in agreement with the findings of Honnamma Rani (2001) who

Table 3: Effect of various modules on management of *P. latus* on sweet pepper under polyhouse (September 2002- March 2003)

Module	Mean number of mites/leaf (Days after spray)								
	I spray			II spray			III spray		Mean
	Pre-count	7	14	Pre-count	7	14	7	14	
M_1	46.55 (6.85)	0.00 (0.71)[a]	0.00 (0.71)[a]	24.55 (4.99)	0.00 (0.71)[a]	2.83 (1.82)[a]	0.00 (0.71)[a]	0.00 (0.71)[a]	3.91 (1.96)[a]
M_2	47.55 (6.92)	0.00 (0.71)[a]	0.00 (0.71)[a]	28.58 (5.34)	4.68 (2.27)[c]	5.08 (2.35)[c]	0.00 (0.71)[a]	0.00 (0.71)[a]	5.48 (2.28)[b]
M_3	35.75 (6.01)	0.00 (0.71)[a]	0.00 (0.71)[a]	33.43 (5.77)	1.85 (1.53)[b]	3.53 (2.00)[b]	0.30 (0.89)[b]	1.45 (1.40)[c]	5.79 (2.61)[c]
M_4	36.98 (6.10)	0.00 (0.71)[a]	0.00 (0.71)[a]	26.38 (5.16)	23.00 (4.84)[e]	19.88 (4.51)[e]	16.50 (4.11)[d]	12.15 (3.54)[d]	13.99 (3.89)[e]
M_5	40.93 (6.40)	0.00 (0.71)[a]	0.00 (0.71)[a]	24.03 (5.29)	20.43 (4.57)[d]	18.48 (4.35)[d]	0.48 (0.98)[c]	1.33 (1.35)[b]	9.25 (3.06)[d]
M_6	41.63 (6.48)	73.25 (8.59)[b]	71.45 (8.48)[b]	41.00 (6.38)	51.05 (7.18)[f]	41.93 (4.07)[f]	24.15 (4.96)[e]	21.23 (4.66)[e]	46.29 (7.01)[f]
SEM±	0.11	0.01	0.01	0.20	0.05	0.06	0.04	0.03	0.03
CD *(P=0.05)*	-	0.02	0.03	-	0.10	0.14	0.09	0.08	0.18

Figures in parentheses indicate “x+0.5 transformations
Figures in columns followed by the same letter are not significantly different

Table 4: Effect of various modules on management of *P. latus* on sweet pepper under polyhouse (June - December 2003)

Module	Mean number of mites/leaf (Days after spray)									
	I spray			II spray			III spray			Mean
	Pre-count	7	14	Pre-count	7	14	Pre-count	7	14	
M_1	69.60 (8.35)	0.00 (0.71)^{a}	0.00 (0.71)^{a}	25.55 (5.07)	0.65 (1.07)^{a}	1.65 (1.46)^{c}	15.30 (3.95)	0.45 (0.97)^{a}	0.50 (1.00)^{a}	5.51 (1.87)^{a}
M_2	72.60 (8.52)	0.00 (0.71)^{a}	0.00 (0.71)^{a}	26.40 (5.09)	0.80 (1.14)^{b}	1.05 (1.24)^{a}	23.10 (4.83)	0.63 (1.06)^{b}	0.63 (1.06)^{a}	6.58 (1.98)^{a}
M_3	73.70 (8.97)	0.00 (0.71)^{a}	0.00 (0.71)^{a}	29.30 (5.44)	0.70 (1.09)^{a}	1.35 (1.36)^{b}	21.33 (4.67)	1.23 (1.31)^{c}	1.70 (1.48)^{b}	6.95 (2.10)^{b}
M_4	77.23 (8.80)	0.00 (0.71)^{a}	0.00 (0.71)^{a}	27.75 (5.31)	19.55 (4.47)^{d}	16.98 (4.18)^{e}	22.80 (4.81)	21.15 (4.65)^{d}	18.98 (4.41)^{d}	15.53 (3.61)^{d}
M_5	76.90 (8.78)	0.00 (0.71)^{a}	0.00 (0.71)^{a}	26.90 (5.19)	16.15 (4.08)^{c}	16.03 (4.06)^{d}	24.33 (4.93)	1.20 (1.30)^{c}	6.35 (2.61)^{c}	10.70 (2.88)^{c}
M_6	75.28 (8.69)	94.18 (9.72)^{b}	30.65 (5.57)^{b}	21.90 (4.69)	23.45 (4.89)^{e}	23.08 (4.85)^{f}	25.15 (5.01)	31.10 (5.62)^{e}	48.65 (7.00)^{e}	37.89 (5.98)^{e}
SEM±	0.39	0.09	0.07	0.17	0.03	0.03	0.12	0.03	0.04	0.03
CD *(P=0.05)*	-	0.19	0.15	-	0.06	0.06	-	0.06	0.09	0.17

Figures in parentheses indicate “x+0.5 transformations
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reported that dicofol (0.05%), abamectin (0.0007%), ethion (0.1%) and wettable sulphur (0.2%) were more effective against *P. latus* on chilli and potato under the field condition. Green and Dybas (1990) Onkarappa (1999) and Mallik *et al* (2002) also reported effect of the same molecules against *Tetranychus urticae* on rose in polyhouse. Abamectin is also the acaricide of choice in India for control of mites in ornamentals and vegetables grown under protected and open field cultivations.

The efficacy of abamectin persists for 35 to 40 days, while other molecules retain their efficacy for 10 to 15 days only. Several reports indicate that dicofol, ethion, profenophos and fenazaquin are also effective acaricides for the management of *T. urticae* and *P. latus* on a number of crops (Khalid Ahmed *et al*, 2000; Honnamma Rani, 2001; Jhansi Rani, 2001; Mallik *et al*, 2001; Mallik *et al*, 2002; Anon, 2005). Efficacy should be viewed from the point of reduction in pest population as well as persistence (of the efficacy). Thus, while dicofol may not meet the stringent requirement for export of roses where zero tolerance is advocated, it can be a very important component of IPM in the management *P. latus* on sweet pepper as this crop is not exported. Hence, use of abamectin may be more advantageous to the floriculture industry whereas the use of dicofol, ethion or pongamia oil is pragmatic for management of *P. latus* on sweet pepper grown under polyhouse. It is not surprising that in our trials, module 4 (dicofol followed by *Amblyseius tetranychivorus* and *Verticilium lecanii*) and module 5 (dicofol followed by *A tetranychivorus* and pongamia oil) were not effective as predators when released 30 days after the first application of dicofol. A number of workers have observed that A *etranychivorus* is an effective bio-control agent for control of *T. urticae* on rose under protected cultivation (Mallik *et al*, 1998; Jhansi Rani, 2001). Further, dicofol is highly toxic to the predatory mite, *A. tetranychivorus*, *e*ven at nine days from spray (Krishnamoorthy, 1983). Hence, it is likely that the potential of predatory mites is reduced in the presence of dicofol.

All revised modules viz., abamectin followed by dicofol (M_1), dicofol - fenazaquin (M_2), fenazaquin – pongamia oil (M_3) and organic module oxymetrin - neem soap (M_4) during the third trial were significantly superior (2.30 -3.03 mites/leaf) (Table 5). One of the reasons for choosing polyhouse cultivation is to grow crops with higher yields besides being qualitatively superior. However, there is value addition if the produce is pesticide residue -free or is organically grown. Module 4 (spray of oxymetrin followed by neem soap) shows promise in this direction and may turn out to be extremely useful.

Table 5: Effect of various modules on management of *P. latus* on sweet pepper under polyhouse (March - September 2004)

Module	Mean number of mites/leaf (Days after spray)						
	I spray			II spray			Mean
	Pre-count	7	14	Pre-count	7	14	
M_1	61.59 (7.87)	0.00 (0.71)^{a}	0.38 (0.94)^{a}	8.05 (2.88)	0.00 (0.71)^{a}	3.05 (1.88)^{a}	2.30 (1.42)^{a}
M_2	53.15 (7.32)	0.00 (0.71)^{a}	1.60 (1.45)^{a}	9.68 (3.15)	0.00 (0.71)^{a}	2.38 (1.69)^{a}	2.73 (1.54)^{a}
M_3	49.37 (7.04)	0.00 (0.71)^{a}	1.28 (1.33)^{a}	9.83 (3.16)	1.18 (1.29)^{a}	3.23 (1.93)^{a}	3.10 (1.68)^{a}
M_4	41.25 (6.36)	0.00 (0.71)^{a}	0.63 (1.06)^{a}	9.15 (3.07)	1.78 (1.51)^{a}	3.58 (2.02)^{a}	3.03 (1.67)^{a}
M_5	53.41 (7.33)	90.85 (9.51)^{b}	26.25 (5.17)^{d}	17.20 (4.20)	16.30 (4.10)^{c}	11.45 (3.45)^{b}	32.41 (5.29)^{b}
SEM±	0.19	0.42	0.18	0.15	0.14	0.08	0.17
CD *(P=0.05)*	-	2.53	1.11	1.00	0.87	0.47	1.04

Figures in parentheses indicate “x+0.5 transformations
Figures in columns followed by the same letter are not significantly different

Table 6: Effect of various modules on yield for management of *P. latus* on sweet pepper under polyhouse

Module	Yield (t ha^{-1})		
	Sept. 02 –Mar. 03	June-Dec.2003	Mar.-Sept 2004
M_1	97.17^{a}	116.71 ^{a}	109.79^{a}
M_2	93.84^{ab}	95.58^{ab}	105.00^{a}
M_3	93.02^{ab}	97.69^{ab}	102.63^{a}
M_4	83.22^{c}	86.71^{b}	99.29^{a}
M_5	91.33^{b}	82.01^{b}	74.36^{b}
M_6	69.28^{d}	57.16^{c}	——
S. Em ±	0.88	8.78	2.71
C.D *(P=0.05)*	5.32	18.72	16.38

Figures in columns followed by the same letter are not significantly different

Effect of module on yield

Fruits harvested from polyhouse grown sweet pepper were completely free from feeding scars. Marketable fruit yield in different modules during the first and second trials indicated that module 1 (abamectin followed by ethion and abamectin) recorded significantly higher yield (97.17-116.71 t ha^{-1}) and was on par with module 2 (abamectin-profenophos- abamectin) (93.84-95.58 t ha^{-1}) and module 3 (dicofol-pongamia oil-NSKE) (93.02-97.69 t ha^{-1}), followed by module 4 (dicofol- *A. tetranychivorus* -*V. lecani*) and module 5 (dicofol-*A. tetranychivorus*-pongamiaoil). Control recorded significantly low yield (57.16-69.29 t ha^{-1}). All the revised modules during the third trial viz., abamectin-dicofol (M_1), dicofol-fenazaquin (M_2), fenazaquin-pongamia oil (M_3) and oxymetrin-neem soap (M_4) were significantly superior (99.29-109.79 t ha^{-1}) to control which recorded less yield (74.36 t ha^{-1}) (Table 6).

Resistance to insecticides under polyhouse cultivation has been documented earlier (Anon, 2005). Intensive polyhouse cultivation is practiced round the year and resistance can easily surface in mines under repeated selection pressure. Modular approach for the management of mites can contribute to greater selection pressure. Need based chemical application is a better approach in IPM of vegetables than a modular approach that is better suited for export in floriculture.

Based on efficacy, economics and persistence, dicofol application followed by pongamia oil and NSKE, or, fenazaquin followed by pongamia oil, or, oxymetrin followed by neem soap, can be recommended for control of *P. latus* on sweet pepper grown under polyhouse.

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