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EFFICACY EVALUATION OF SPIROMESIFEN AGAINST RED SPIDER MITE, *TETRANYCHUS URTICAE* KOCH ON PARTHENOCARPIC CUCUMBER UNDER PROTECTED ENVIRONMENT

A. K. SOOD*, SOMALI SOOD AND VINAY SINGH
Department of Entomology
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur - 176 062, H.P., INDIA
e-mail: sood_hpau@yahoo.co.in

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***Corresponding author**

ABSTRACT
Novel acaricide, spiromesifen was evaluated at 96, 120 and 144 g ai/ha with standard acaricides namely, dicofol and propargite against *Tetranychus urticae* Koch on parthenocarpic cucumber under naturally ventilated polyhouse conditions. Application of spiromesifen 240 SC @ 144g a.i. /ha significantly reduced red spider mite infestation when sprayed at 21 days interval and was most efficacious in reducing mite population. Spiromesifen 240 SC @ 144g a.i. /ha also resulted in highest yield per plant. It was followed by dicofol and propargite. Phytotoxicity observations of spiromesifen recorded upto 15 days after application revealed no phytotoxicity symptoms at evaluated doses of 120, 144, 288 and 576 g a.i./ha under test conditions.

INTRODUCTION

Parthenocarpic cucumber (*Cucumis sativus* L.) is one of the most important greenhouse crops and can be grown round the year (Sabir *et al.,* 2011; Singh, 2013). Protected cultivation is the most intensive method of crop production and provides protection to crop plants from adverse environmental conditions. The protected environment also provides stable and congenial micro-climate which is favourable for the multiplication of insect-pests which in turn become one of the limiting factors for the successful crop production under protected environment (Kaur *et al.,* 2010). In India, aphids, *Myzus persicae* (Sulzer) and *Aphis gossypii* Glover; red spider mites, *Tetranychus ludeni* Zacher, *T. neocalidonicus* Marc Andre and *T. urticae* Koch; tobacco caterpillar, *Spodoptera litura* Fabricius; whiteflies, *Bemisia tabaci* (Gennadius) and *Trialeurodes vaporariorum* (Westwood), and leaf miner, *Liriomyza trifolii* (Burgess) are of importance (Vashisth, 2009; Sood *et al.,* 2012). Amongst them, red spider mite is the predominant pest of cucumber in Himachal Pradesh.

T. urticae is widespread in the tropics and has been recorded from over 300 plant species worldwide (Bolland *et al.,* 1998; Zhang, 2002). In India, it commonly occurs on many cultivated crops, especially vegetable crops causing substantial losses by ingesting leaf cell contents, reducing plant photosynthesis and decreasing fruit quality (Singh and Raghuraman, 2011). Due to their short life cycle and high fecundity, frequent acaricidal applications are needed to suppress them, which leads to development of resistance to pesticides (Kumar *et al.,* 2014).There is a need to evaluate novel acaricides to manage mite pests. The studies conducted by Alam *et al.* (2014) revealed significant reduction of red spider mites and higher yield of tomato by application of spiromesifen 240 SC @ 150 g a.i./ha. Also, Singh *et al.* (2014) reported that newer acaricide clofentezine 50 SC was effective in controlling *T. urticae* in okra and to be relatively safe to the natural enemies.

Current study was aimed to evaluate the comparative efficacy of spiromesifen, a broad spectrum insecticide and acaricide with novel mode of action of inhibition of acetyl-CoA-carboxylase (Nauen *et al.*, 2005; Marcic *et al.,* 2011; Lummen *et al.,* 2014), vis-à-vis conventional acaricides (propargite and dicofol) against red spider mites on cucumber under protected cultivation. The phytotoxicity of spiromesifen was also studied.

MATERIALS AND METHODS

Efficacy studies

The experimentation was done to study the bioefficacy of spiromesifen against two spotted red spider mite on parthenocarpic cucumber during two crop seasons, namely, summer (May-August) and autumn (September-December) under naturally ventilated polyhouse at CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 1290 m asl. Five acaricidal treatments comprising spiromesifen (Oberon 240 SC @ 96, 120 and 144 g ai/ha), propargite (Omite 57 EC @ 430 g ai/ha) and dicofol (Super Nomite 18.5 EC @ 250 g ai/ha) were evaluated as two consecutive foliar applications at

21day interval.

Parthenocarpic cucumber F_1 hybrid Kian was raised in silty clay-loam soil. The crop was raised in insecticide free environment by following package and practices for production of cucumber under naturally ventilated polyhouse (Anonymous, 2010). Twenty day old seedlings raised in pro-trays in soilless medium comprising coco-peat: vermiculite: perlite in the ratio of 3:1:1 were transplanted for raising summer and autumn season crop at spacing of 60 cm x 30 cm (row and plant wise, respectively). Basal dose of fertilizer (N: P: K @ 50: 50: 50 kg/ha) was applied at the time of transplanting. Thereafter, N: P: K was supplied through water soluble complex fertilizer (N:P:K :: 19: 19: 19) @ 5g/m^2 through fertigation at weekly interval upto flowering initiation stage and twice a week thereafter. Fertigation was initiated at three weeks after transplanting and ceased two weeks before final harvesting of the crop. All standard agronomic practices were followed along with disease control measures. Cucumber plants were trained on single stem by undertaking regular pinching.

Prior to initiating the experimentation, mite adults (n = 20) were released artificially on cucumber plants and allowed to multiply for 30 and 21 days in summer and autumn season, respectively. The experimentation was done in randomised block design with plot size of 2x1m, replicating four times. The observations were recorded on motile mites from five leaves (three leaves from top and two leaves from the middle part of the plant) from randomly tagged five plants as suggested by Kanika *et al.* (2013). The mites were counted before application of miticides (pre-count) as well as 3, 7, 10, 14 and 21days after each treatment. Yield was recorded per plant at different pickings and was cumulated to work out total yield per plant. The data was subjected to statistical analysis.

Phytotoxicity studies

Phytotoxicity studies on spiromesifen were made at four dosages namely, 120, 144, 288 and 576 g ai/ha. Applications were made 40 days after transplanting. Phytotoxicity observations were recorded on 0-10 scale (0: No phytotoxicity; 1: 1-10%; 2: 11-20%; 3: 21-30%; 4: 31-40%; 5: 41-50%; 6: 51-60%; 7: 61-70%; 8: 71-80%; 9: 81-90% and 10: 1: 91-100%) for leaf chlorosis, leaf tip burning, leaf necrosis, leaf epinasty, leaf hyponasty, yellowing, vein clearing, wilting and rosetting after 1, 3, 7, 10 and 15 days of application as suggested by Prasanna *et al.* (2004).

RESULTS AND DISCUSSION

Field Efficacy

A perusal of data contained in Table 1 revealed that at the initiation of experimentation in summer crop, mean population ranged from 101.7 to 141.3 mites per five leaves and variability was non-significant in different treatments. At all observational dates, population in all the treatments reduced significantly as compared to untreated check. Three days after treatment (DAT), dicofol (250 g ai/ha) resulted in significantly minimum population (8.2 mites/ five leaves) being on a par to propargite (430 g ai/ha). After 7 DAT, also same trend was observed. However, 21 days after first application, spiromesifen (144g ai/ha) resulted in minimum mite population, being on a par to dicofol (250 g ai/ha) and spiromesifen (120 g ai/ha). Spiromesifen at the minimum dosage of 96g ai/ha proved least effective. It was also evident from the Table1 that 21 days after second application, spiromesifen (144g ai/ha) resulted in

Table 1: Field efficacy of insecticides against two spotted red spider mite in cucumber during May-August cropping season (summer crop)

Treatment	Dosage (g ai/ha)	Mean mite population per five leaves on indicated days after application										
		1st spray						2nd spray				
		-1	3	7	10	14	21	3	7	10	14	21
Spiromesifen	96	141.3(11.8)	62.5(7.7)	9.7(3.3)	13.8(3.8)	13.5(3.8)	16.8(4.2)	4.0(2.2)	1.8(1.7)	1.5(1.6)	1.7(1.6)	3.1(2.0)
Spiromesifen	120	104.4(10.3)	35.9(5.7)	5.8(2.6)	14.1(3.9)	4.1(2.3)	5.9(2.6)	2.0(1.7)	1.2(1.5)	1.0(1.4)	0.9(1.4)	1.8(1.7)
Spiromesifen	144	134.9(11.6)	13.8(3.8)	5.0(2.4)	2.8(1.9)	3.0(2.0)	4.7(2.4)	0.8(1.3)	0.2(1.1)	0.3(1.2)	0.4(1.2)	1.3(1.5)
Propargite	430	101.7(10.1)	12.0(3.6)	2.6(1.9)	6.1(2.7)	6.7(2.8)	9.5(3.2)	0.8(1.3)	0.7(1.3)	0.9(1.4)	0.8(1.4)	1.6(1.6)
Dicofol	250	111.3(10.5)	8.2(3.0)	2.4(1.8)	3.3(2.0)	3.9(2.2)	5.5(2.4)	0.8(1.3)	0.7(1.3)	0.8(1.4)	1.1(1.5)	2.3(1.8)
Untreated check	Water spray	138.5 (11.7)	109.8(10.4)	143.1(11.9)	148.2(11.8)	150.5(12.2)	141.8(11.8)	108.1(10.4)	99.7(10.0)	93.1(9.7)	99.1(10.0)	86.7(9.4)
CD (P = 0.05)		NS	(2.1)	(1.4)	(2.4)	(1.1)	(1.4)	(0.6)	(0.4)	(0.3)	(0.4)	(0.2)

Figures in parentheses are the arc sine values

Table 2: Field efficacy of insecticides and biopesticides against two spotted red spider mite in cucumber during September-November cropping season (autumn crop)

Treatment	Dosage (g ai/ha)	Mean mite population per five leaves on indicated days after application										
		1st spray						2nd spray				
		-1	3	7	10	14	21	3	7	10	14	21
Spiromesifen	96	14.4(3.9)	7.8(2.9)	6.9(2.8)	7.2(2.9)	9.2(3.2)	11.4(3.5)	3.4(2.1)	3.0(2.0)	2.9(2.0)	2.4(1.8)	4.2(2.3)
Spiromesifen	120	18.3(4.3)	6.4(2.7)	4.1(2.3)	4.9(2.4)	5.9(2.6)	6.5(2.7)	3.0(2.0)	2.7(1.9)	1.7(1.6)	1.3(1.5)	2.8(1.9)
Spiromesifen	144	14.0(3.9)	2.9(2.0)	3.5(2.1)	4.2(2.3)	5.2(2.5)	6.0(2.6)	1.3(1.5)	1.9(1.7)	0.4(1.2)	0.6(1.2)	1.6 (1.6)
Propargite	430	13.7(3.9)	4.0(2.2)	4.2(2.3)	4.8(2.4)	5.4(2.5)	7.9(3.0)	1.5(1.6)	1.9(1.7)	1.4(1.5)	2.5(1.9)	3.6(2.1)
Dicofol	250	14.6(3.9)	3.0(2.0)	2.7(1.9)	3.9(2.2)	7.2(2.8)	6.8(2.8)	0.9(1.4)	1.7(1.6)	1.1(1.4)	2.1(1.7)	3.9(2.2)
Untreated check	Water spray	16.9(4.2)	17.7(4.3)	19.5(4.5)	23.1(4.9)	32.6(5.8)	63.4(8.0)	68.2(8.2)	76.8(8.8)	103.2(10.2)	117.4(10.8)	101.9(10.1)
CD (P = 0.05)		NS	(0.6)	(0.4)	(0.4)	(0.6)	(0.6)	(1.0)	(0.6)	(0.8)	(0.7)	(0.7)

Figures in parentheses are the arc sine values

Table 3: Yield recorded in the experiment on evaluation of insecticides (miticides) against red spider mite in cucumber

Treatment	Trade Name	Dosage (g ai/ha)	Cucumber yield (q/ ha) Summer crop	Autumn crop
Spiromesifen	Oberon 240 SC	96	640.0	772.0
Spiromesifen	Oberon 240 SC	120	786.7	833.3
Spiromesifen	Oberon 240 SC	144	886.7	966.9
Propargite	Omite 570 EC	430	800.0	898.7
Dicofol	Super Nomite 18.5EC	250	853.3	914.7
Untreated check	Water spray	-	413.3	528.0
CD (P=0.05)			167.6	146.6

Table 4: Evaluation of phyto-toxicity of spiromesifen on cucumber at different tested doses in summer and autumn crop

Treatments	Dosage g ai/ha	Formulation (ml/ha)	Mean phytotoxicity rating (0-10 scale) 1	3	7	10	15
Spiromesifen (Oberon 240 SC)	120	500	0	0	0	0	0
Spiromesifen (Oberon 240 SC)	144	600	0	0	0	0	0
Spiromesifen (Oberon 240 SC)	288	1200	0	0	0	0	0
Spiromesifen (Oberon 240 SC)	576	2400	0	0	0	0	0
Untreated check (water spray)	-	-	0	0	0	0	0

minimum mite population followed by propargite and spiromesifen (120g ai/ha) which in turn were on a par to each other. Spiromesifen (96g ai/ha) resulted in lowest efficacy which in turn was on a par to dicofol. During autumn crop, at the initiation of experimentation, mite population ranged from 13.7 to 18.3 mites per five leaves, and the variation being non-significant. The population varied from 6.0 to 11.4 mites per five leaves in the treated plots as compared to the population level of 63.4 mites as recorded in untreated check 21 days after first application. Whereas 21 days after second application all the treatments were equally effective and the population was on a par to each other. The minimum mite population corresponded to spiromesifen (144g ai/ha), followed by spiromesifen (120g ai/ha), propargite (430g ai/ ha), dicofol (250g ai/ha) and spiromesifen (96g ai/ha), all differing significantly to untreated check.

Yield

A perusal of data contained in Table 3 revealed that in summer crop of parthenocarpic cucumber, spiromesifen (144g ai/ha) resulted in highest yield (886.7 q/ha) followed by dicofol (853.3 q), propargite (800 q) and spiromesifen (120g/ai) (786.7 q), being on a par to each other. Yield recorded in spiromesifen (96 g/ai) was also on a par to the yield recorded in spiromesifen (120g/ai) and propargite. The untreated check yielded minimum to the extent of only 413.3 q/ha. Almost similar trend in yield was recorded in autumn crop with spiromesifen (144g ai/ha) resulting in significantly highest yield (966.9 q/ ha) followed by dicofol (914.7 q) and propargite (898.7 q). The untreated check yielded minimum (528 q/ha).

The findings of Sekh *et al.* (2007) are in line with the present observations. They reported higher efficacy of spiromesifen 240 SC against red spider mite, *Tetranychus* sp. on brinjal along with significant increase in yield as compared to other acaricides. Kumar *et al.* (2009) evaluated spiromesifen 240 SC @ 0.7ml/l along with dicofol (4 ml/l), propargite 57 EC (4 ml/l) and fenpyroximate 5 EC (0.8 ml/l) for the management of *T. urticae* in brinjal. Contrary to present findings, they recorded highest per cent reduction in mite count as well as increase in fruit yield in dicofol, closely followed by fenpyroximate, spiromesifen and propargite. Spiromesifen being less efficacious to other acaricides can be attributed to lower dose evaluated (0.7 mL/L) (~80 g ai/ha) by Kumar *et al.* (2009), which is in line to present observations. Reddy and Pushpa Latha (2013) also observed fenazaquin, spiromesifen, hexythaizox and fenpyroximate to be more efficacious as compared to dicofol against two spotted spider mite, *T. urticae* on ridge gourd. Similar results were obtained by Alam *et al.* (2014) whose studies revealed spiromesifen 240 SC @ 150 g a.i. /ha to reduce red spider mite infestation which also resulted in highest yield with excellent residual activity over three weeks. Reddy *et al.* (2014) while evaluating five new acaricides viz., abamectin, fenazaquin, spiromesifen, fenpyroximate and hexythiazox along with standard acaricides, dicofol and propargite for efficacy against two spotted spider mite also observed higher mortality in spiromesifen treatment compared to propargite and dicofol, which is in line to present studies.

Phytotoxicity

Observations on phytotoxicity recorded 1, 3, 7, 10 and 15 days after application revealed that under test conditions no phytotoxicity symptoms were evident at evaluated doses (Table 4). Kavitha *et al.* (2006) in the studies on evaluation of phytotoxicity of spiromesifen 240 SC on chilli at three doses *i.e.,* 96, 192 and 384 g a.i. /ha also observed no phytotoxicity upto 20 days after application. Similar to present studies, Fanigliulo *et al.* (2010) observed no phenomena of phytotoxicity of spiromesifen in capsicum.

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