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Effectiveness of bio-rationales and newer pesticides against damage due to yellow mite, *Polyphagotarsonemus latus* (Banks) on capsicum (*Capsicum annum* L.) under shade net house during summer

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Abstract
Field experiment was conducted under shade net house at Hi-Tech Horticulture farm, Rajasthan Agricultural Research Institute (Sri Karan Narendra Agriculture University, Jobner) Durgapura, Jaipur, (Rajasthan) to investigate the effectiveness of eleven bio-rationale and newer pesticides against yellow mite, *Polyphagotarsonemus latus* (Banks) during summer 2014 and 2015 on capsicum (*Capsicum annum* L). The results revealed that during 2014 and 2015 all the treatments proved significantly superior in reducing the downward leaf curling in comparison to the control at 7,11 and 13 week after transplanting (WAT). The minimum leaf curling (5.84%) was recorded in the treatment of spiromesifen 22.9 SC at 0.0229 per cent which was significantly superior followed by propargite 57 EC at 0.114 per cent (7.50%) at 7 WAT. At 11 WAT, minimum leaf curling (4.17%) was recorded in the treatment of spiromesifen 22.9 SC at 0.0229 per cent which was significantly superior. The minimum leaf curling (5%) was recorded in the treatment of spiromesifen 22.9 SC at 0.0029 per cent which was significantly superior followed by propargite (6.75%) at 13 WAT. The overall effect indicated that the minimum leaf curling (4.45%) was recorded in the treatment of spiromesifen 22.9 SC at 0.0029 per cent followed by propargite 57 EC at 0.114 (5.84%) and emamectin benzoate 5 SG at 0.002% (7.23%). Thus spiromesifen 22.9 SC @ 1 ml/l could be suggested to the farmers for the management of yellow mite on capsicum under shade net house conditions during summer for off season production.

Keywords: *Polyphagotarsonemus latus, Capsicum annum*, effectiveness, newer pesticides, shade net house

Introduction
Capsicum (*Capsicum annum* L.) family- Solannaceae which is also known as sweet pepper, bell pepper or green pepper is one of the most popular and highly remunerative vegetable crops grown in most parts of the world, *viz.*, China, Spain, Mexico, Romania, Yugoslavia, Bulgaria, USA, India, Europe, Central and South America are the major countries producing capsicum. In India, capsicum is extensively cultivated in Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu, Himachal Pradesh, and hilly areas of Uttar Pradesh. Nutritionally, it is rich in vitamins particularly vitamins A and vitamins C. It is a cool season crop but it can be grown round the year using protected structures. Protected cultivation is the most intensive method of crop production which provides protection to crop plant from adverse environment condition (Sood *et al.*, 2015) [16]. The protected environment also provides stable and congenial micro-climate which is favourable for the multiplication of insect pests which in turn becomes a limiting factor for the successful crop production. (Kaur *et al.*, 2010) [8]. Often, the natural enemies that keep pests under control outside are not present under protected environment. For these reasons, pest situations often develop in the indoor environment more rapidly and with greater severity than outdoors. Often the productivity of capsicum is very low due to several limiting factors. Among them, insect pests cause severe losses. Capsicum is attacked by several insect and mite pests from seedling to fruiting stage. About 35 species of insect and mite pests were reported (Vos and frinking 1998, Sorenson 2005, Berke *et al.*, 2003) [21, 17, 2] under Punjab conditions that pose severe problems. Sunitha (2007) [18] pointed out that the aphids, thrips and mites are major pests in capsicum. Reddy (2005) [14] reported that chilli mite, *P latus* and thrips, *Scrirtothrips dorsalis* are major pests infesting sweet

pepper both under protected and open field conditions. Meena *et al.* (2013) [10] reported the chilli mite as important pest infesting chilli in Rajasthan. The yellow or broad mite, *Polyphagotarsonemus latus* (Banks) is fast emerging as major pest of capsicum and chilli in Rajasthan. Feeding of these mites caused downward curling of leaves, elongation of petioles on older leaves and clustering of tender leaves at the tip of the branches. The growth of plant is arrested and the entire plants look like a leaf curl plant. It is multiply in large numbers under controlled temperature, relative humidity and due to developing of resistance against pesticides there by leading to significant crop loss. This has been well documented in protected flower crops such as rose, carnation, chrysanthemum etc. Mites cause about 53 per cent damage on rose plants (Dhooria, 1999) [6]. However, in other related crops like chilli yellow mite, *P. latus* is the major pest causing yield loss up to 96.4 per cent in North Karnataka (Borah, 1987) [3] and 34.14 per cent in West Bengal (Ahmed *et al*., 1987) [1] under open field conditions. No serious attempt has been made in the past to evaluate the efficacy of newer insecticides against yellow mite under shade net house conditions in Rajasthan.

There is continual need for application of new acaricides with newer biochemical mode of action, but their use to be optimized in order to prevent or delay the evolution of resistance and prolong their life span (Deskeyser, 2005) [5]. Due to their short life cycle and high fecundity, frequent acaricides application is needed to suppress them, which lead development of resistance to pesticide (Kumar *et al*., 2014) [9]. Looking to the severity of damage due to yellow mite on capsicum crop, it is found essential and urgent need to know efficacy of yellow mite under shade net house. Considering the economic importance of pest, the study was conducted to test the efficacy of bio-rationale and newer insecticides molecules against yellow mite under shed net house conditions.

Materials and Methods

The experiments were conducted for two consecutive years during summer 2014 and summer 2015 under shade net house at Hi-Tech Horticulture farm, Rajasthan Agriculture Research Institute (Sri Karan Narendra Agriculture University, Jobner) Durgapura, Jaipur, (Rajasthan). The experiment was laid out in a Randomized Block Design with 12 treatments and three replications including untreated check. Thirty days old seedling of capsicum variety, PSO 26 were transplanted in each treatments with plot size 3.5 X 1.0 m^2, keeping row to row and plant to plant distance of 0.50 m and 0.40 m. Eleven bio-rationale and newer pesticides of different chemistry *viz*., spiromesifen 22.9 SC @ one ml/l, emamectin benzoate 5 SG @ 0.4gm/l, acephate 75 SP @ one gm/l, indoxacarb 14.5 SC @ 0.8ml/l, propargite 57 EC @ two ml/l, fipronil 5 SC @ one ml/l, novaluron 10 EC one ml/l, imidacloprid 17.8 SL @ 0.33 ml/l, azadirachtin 0.15 EC @ two ml/l NSKE 5% and spinosad 45 SC 0.3 ml/l were evaluated for the management of yellow mite in the field. Three consecutive sprays were applied at twenty day interval, starting from sufficient pest build up. Treatments were imposed by using pre calibrated Knapsack sprayer @ 500-600 liters sprays solution/ha depending on stage of the crop. Care was taken to check the drift of insecticides by putting polythene sheet screen around each plot at the time of spraying. Leaf curl index based on grades were assigned thrice in 7, 11, and 13 week after transplanting (WAT) Leaf curl damage due to mites was recorded based on visual method of symptom of damage (Plate1.) and then leaf curl index/plant was worked out as per the method described by Niles (1980) [13] (Table1), thereafter per cent leaf curl was calculated at 7, 11 and 13 week after transplanting and transformed to arc sine values and subject to analysis of variance for 2014 and 2015 separately and pooled.

Table 1: Scoring procedure for pests damage by Niles (1980)

S. No.	Score	Symptoms
1	0	No symptoms
2	1	1 to 25% leaves per plant showing curling or damage
3	2	26 – 50% leaves showing curling in a plant – moderately damaged or leaf skeletonizing
4	3	51 to 75% leaves per plant showing curling, heavily damaged, malformation of growing points, and reduction in plant height or leaf skeletonizing
5	4	>75% leaves per plant showing curling, severe and complete destruction of growing points, drastic reduction in plant height, skeletonizing and severe malformation

Results and Discussions

Eleven bio-rationale and newer pesticides, *viz.*, spiromesifen, propargite, fipronil, emamectin benzoate, acephate, indoxacarb, novaluron, imidacloprid, spinosad, azadirachtin and NSKE were evaluated against the yellow mite, *Polyphagotarsonemus latus* (banks) damage on capsicum under shade net house conditions**.** The observations were taken one day before first spray on mite damage in all the treatments including untreated check revealed non-significant among them in both the years. Analysis of variance shows that treatment application had significant effect on minimize downward leaf curling due to yellow mite over the untreated control in all application during both the years. However, the significant difference existed among them. The data on per cent downward leaf curling obtained 7, 11 and 13 week after transplanting are summarized in table-2. The trend of relative effectiveness of various treatments has been described below on the basis of pooled data**.**

The observation on per cent downward leaf curling due to yellow mite at 7 week after transplanting revealed that spiromesifen at 0.0229 per cent showed significantly the lowest leaf curling (5.84%) and it was on par with the treatment of propargite at 0.114 per cent (7.50%). Both these treatments were comparable to each other and forming a group of first order of effectiveness. The next, in order of effectiveness, were emamectin benzoate at 0.002 per cent and spinosad at 0.0135 per cent with 10.00 and 11.67 per cent leaf curling, respectively, however, emamectin benzoate at 0.002 per cent was found at par with propargite at 0.114 per cent. The treatment of novaluron at 0.01per cent and imidacloprid at 0.0058 per cent proved least effective with 20 per cent leaf curling.

Eleven weeks after transplanting, the treatment spiromesifen at 0.0229 per cent inflicted lowest per cent leaf curling (4.17%) due to mites which was significantly superior. The next, in order of effectiveness were emamectin benzoate at

0.002 per cent, propargite at 0.114 per cent and fipronil at 0.005 per cent with 5.84, 5.84 and 6.67 per cent leaf curling, respectively, forming a group of second order of effectiveness. The treatment of novaluron at 0.01 per cent proved least effective with 20.84 per cent leaf curling.

Thirteen weeks after transplanting, the minimum leaf curling (3.34%) was recorded in the plots treated with spiromesifen at 0.0229 per cent which was significantly superior followed by propargite 0.114 per cent (4.17%), forming a group of first order of effectiveness. The next, in order of effectiveness were emamectin benzoate at 0.002 per cent and fipronil at 0.005 per cent with 5.84 and 6.67 per cent leaf curling, respectively, forming a group of second order of effectiveness. The treatment of novaluron at 0.01 per cent and imidacloprid at 0.0058 per cent proved least effective with 19.17 per cent leaf curling. On the basis of pooled and overall efficacy in 2014, the minimum leaf curling (3.31%) was recorded in the treatment of spiromesifen at 0.0229 per cent followed by propargite at 0.114 per cent (4.45%) and emamectin benzoate at 0.002 per cent (6.11%).

The treatment of novaluron at 0.01 per cent proved least effective with 19.44 per cent leaf curling. More or less a similar trend of leaf curling due to mites was found in 2015 as the minimum leaf curling (5.56%) was recorded in the treatment of spiromesifen at 0.0229 per cent followed by propargite at 0.114 per cent (7.22%) and emamectin benzoate at 0.002 per cent (8.34%). Imidacloprid at 0.0058 per cent proved least effective with 21.11 per cent leaf curling. The pooled data indicated that the minimum leaf curling (4.45%) was recorded in the treatment of spiromesifen at 0.0229 per cent followed by propargite at 0.114 per cent (5.84%) and emamectin benzoate at 0.002 per cent (7.23%). Imidacloprid at 0.0058 per cent and novaluron at 0.01 per cent proved least effective with 20.00 per cent leaf curling (Fig.1.). The present findings are in agreement to that of Nagaraj *et al*. (2007) [11] who reported lowest LCI due to mites in spiromesifen and abamectin. Varghese and Mathew (2013) [20] are also in support of present findings as they reported lowest LCI in spiromesifen and propargite. Studies of Nandini (2010) [12] are in conformity with present findings and reported that propargite and abamectin showed lowest LCI on capsicum. Findings of Tatagar (2004) [19] support present findings who reported lower LCI by abamectin. Samanatha *et al*. (2017) [15], Halder *et al.* (2015) [22] and Chakrabarti *et al*. (2014) [4] also corroborated present finding.

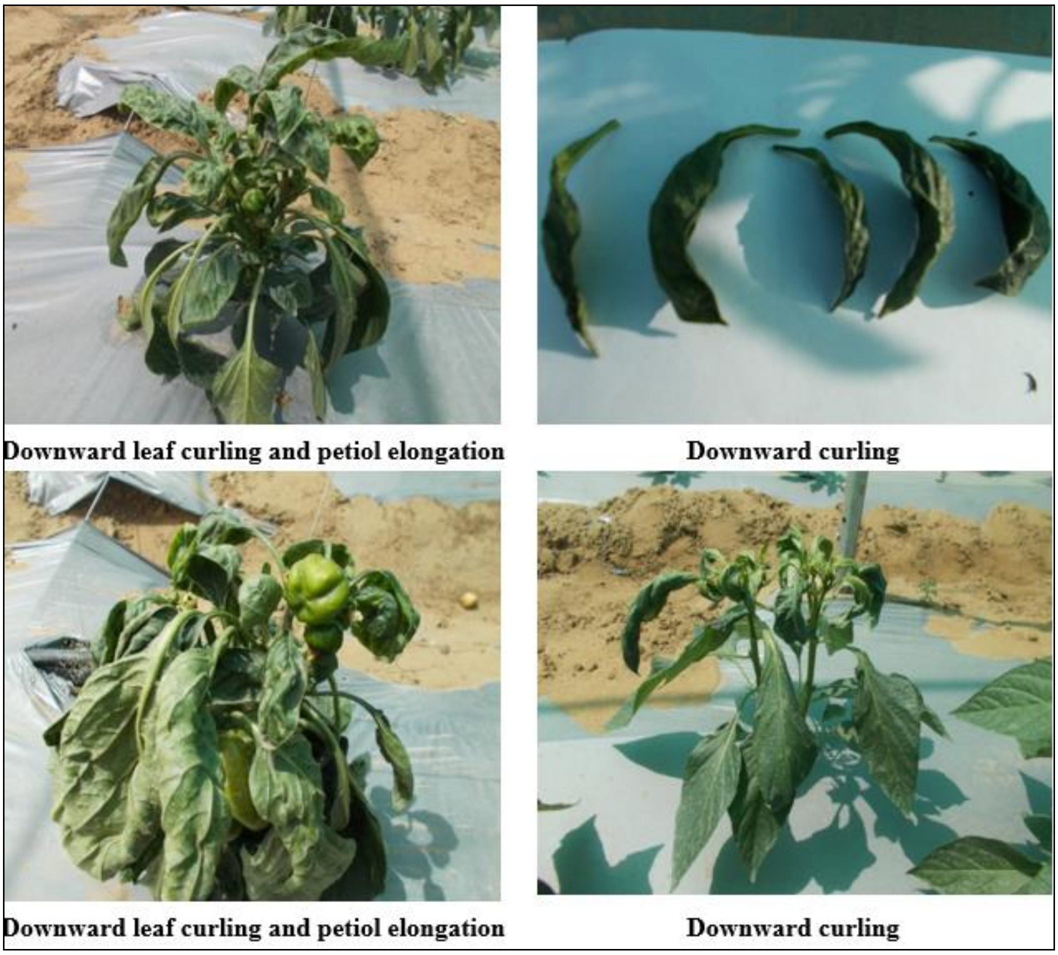

Plate 1: Downward leaf curling due to mite, *Polyphagotarsonemus latus* (Banks)

Table 2: Effect of different treatments on leaf curling due to yellow mite, *Polyphagotarsonemus latus* (Banks) on capsicum during 2014 and 2015

S. No.	Treatments	Conc. (%)	Per cent leaf curling due to mite(Weeks After Transplanting)											
			7			11			13			Over all		
			2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled	2014	2015	pooled
1	Spiromesifen 22.9 SC	0.0229	5.00 (12.92)*	6.67 (14.76)	5.84 (13.84)	3.33 (8.61)	5.00 (12.9)	4.17 (10.77)	1.67 (4.31)	5.00 (12.92)	3.34 (8.62)	3.33	5.56	4.45
2	Emamectin benzoate 5SG	0.002	8.33 (16.6)	11.67 (19.89)	10.00 (18.25)	5.00 (12.92)	6.67 (14.76)	5.84 (13.84)	5.00 (12.92)	6.67 (14.76)	5.84 (13.84)	6.11	8.34	7.23
3	Acephate 75 SP	0.075	16.67 (24.05)	18.33 (25.31)	17.50 (24.68)	11.67 (19.89)	13.33 (21.34)	12.50 (20.62)	11.67 (19.89)	15.00 (22.79)	13.34 (21.34)	13.34	15.55	14.45
4	Indoxacarb 14.5 SC	0.0116	16.67 (24.05)	18.33 (25.31)	17.50 (24.68)	10.00 (18.43)	11.67 (19.89)	10.84 (19.16)	10.00 (18.43)	18.33 (25.31)	14.17 (21.87)	12.22	16.11	14.17
5	Propargite 57 EC	0.114	6.67 (14.76)	8.33 (16.6)	7.50 (15.68)	5.00 (12.92)	6.67 (14.76)	5.84 (13.84)	1.67 (4.31)	6.67 (14.76)	4.17 (9.54)	4.45	7.22	5.84
6	Fipronil 5 SC	0.005	11.67 (19.89)	13.33 (21.34)	12.50 (20.62)	6.67 (14.76)	6.67 (14.76)	6.67 (14.76)	5.00 (12.92)	8.33 (16.6)	6.67 (14.76)	7.78	9.44	8.61
7	Novaluron 10 EC	0.01	20.00 (26.57)	20.00 (26.57)	20.00 (26.57)	20.00 (26.57)	21.67 (27.71)	20.84 (27.14)	18.33 (25.31)	20.00 (26.57)	19.17 (25.94)	19.44	20.56	20.00
8	Imidacloprid 17.8 SL	0.0058	20.00 (26.57)	20.00 (26.57)	20.00 (26.57)	18.33 (25.31)	23.33 (28.86)	20.83 (27.09)	18.33 (25.31)	20.00 (26.57)	19.17 (25.94)	18.88	21.11	20.00
9	Azadirachtin 0.15%	0.0003	13.33 (21.34)	15.00 (22.79)	14.17 (22.07)	13.33 (21.34)	13.33 (21.34)	13.33 (21.34)	13.33 (21.34)	13.33 (21.34)	13.33 (21.34)	13.33	13.89	13.61
10	NSKE (self-prepared)	5	13.33 (21.34)	15.00 (22.79)	14.17 (22.07)	15.00 (22.79)	13.33 (21.34)	14.17 (22.07)	13.33 (21.34)	13.33 (21.34)	13.33 (21.34)	13.89	13.89	13.89
11	Spinosad 45 SC	0.0135	10.00 (18.43)	13.33 (21.34)	11.67 (19.89)	11.67 (19.89)	11.67 (19.89)	11.67 (19.89)	11.67 (19.89)	11.67 (19.89)	11.67 (19.89)	11.11	12.22	11.67
12	Untreated check		25.00 (30.00)	26.67 (31.07)	25.84 (30.54)	26.67 (31.07)	28.33 (32.14)	27.50 (31.61)	28.33 (32.14)	30.00 (33.21)	29.17 (32.68)	26.67	28.33	27.50
	S Em±		(0.98)	(1.3)	(0.81)	(1.43)	(1.27)	(0.96)	(1.97)	(1.25)	(1.17)			
	CD (P=0.05)		(2.88)	(3.8)	(2.32)	(4.19)	(3.74)	(2.73)	(5.78)	(3.66)	(3.32)			

* Figures in parentheses are arc sine transformed values

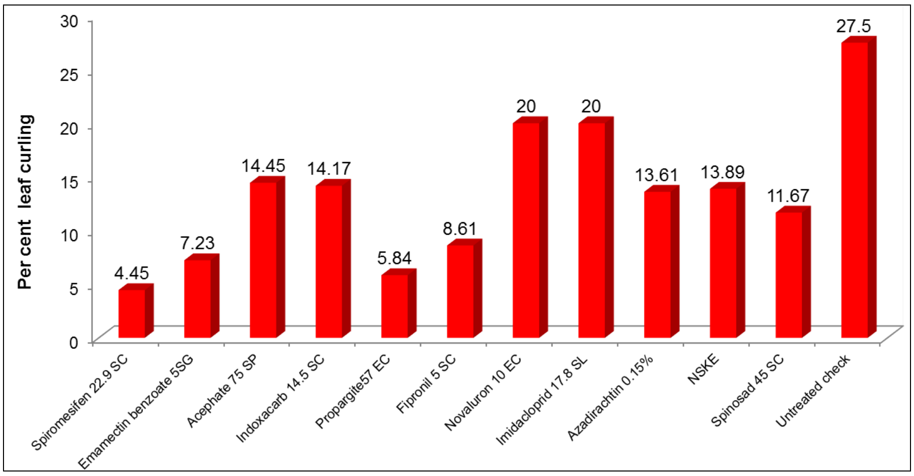

Fig 1: Overall effectiveness of bio-rationales and newer pesticides on leaf curling due to yellow mite, *Polyphagotarsonemus latus* (Banks)

Conclusion

On the basis of results emerging out from the present investigation, that the spray of spiromesifen 22.9 SC @ 1 ml/l could be suggested to the farmers for the management of yellow mite on capsicum under shade net house conditions during summer for off season production.

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