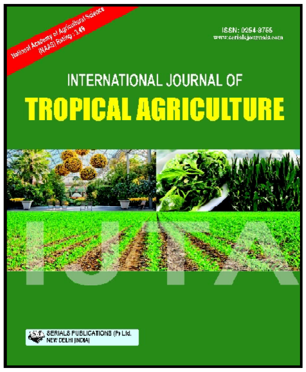

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Survey on Insect Pests of Capsicum (*Capsicum annuum* L. var. grossum Sendt.), Management of Thrips and Dissipation of Spinosad Under open and Poly House Conditions

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Abstract: Fixed plot survey in and around Hyderabad, Telangana revealed that thrips, *Scirtothrips dorsalis* Hood, mites, *Polyphagotarsonemus latus* Banks cut worm, *Agrotis ipsilon* (Hufn.), blossom midge, *Asphondylia capsici* Barnes and fruit borer, *Spodoptera litura* Fab incidence was recorded under open field conditions where as aphids and whiteflies were recorded in addition to above insect pests under poly house conditions. Bio-efficacy of insecticides against thrips of capsicum, both under open and poly house conditions in the 2013-14 and 2014-15, revealed that mean thrips population in pre count ranged from 2.52 to 7.94 and post count population was lowest in spinosad (0.88 thrips/leaf) followed by diafenthiuron (1.72 thrips/leaf) and were significantly superior over untreated check (11.21 thrips/leaf) and at par with each other. In polyhouse conditions, pre count ranged from 1.07 to 4.34 and post count population was lower with spinosad (0.06 thrips/leaf) followed by diafenthiuron (0.50 thrips/leaf) and thiomethoxam (1.30 thrips/leaf) which were significantly superior over untreated check (5.6 thrips/leaf) and at par with each other. The mean LCI of two years revealed that, LCI was significantly reduced in spinosad treated plants followed by diafenthiuron and thiomethoxam. Whereas, LCI was significantly increased from one DBS to 10 DAS in chlorantraniliprole , flubendiamide, spiromesifen and triazophos and untreated check in the both the situations of the study. Dissipation dynamics of spinosad was estimated by QuEChERS method, the qualitative and quantitative analysis of spinosad was performed on LC- MS/MS (PDA). Initial deposits of 0.60 mg kg^{-1} were detected in capsicum samples collected from open filed, which dissipated to BDL in 7.0 days while in poly house, initial deposits of 1.61 mg kg^{-1} were dissipated to BDL in 20.0 days. The waiting period for safe harvest was worked out to be 7.0 and 20.0 days when spinosad 45 SC @ 75 ml a.i.ha^{-1} sprayed thrice in open and poly house conditions, respectively.

Key words: capsicum, survey, bioefficacy,thrips,dissipatiob, waiting periods

INTRODUCTION

Capsicum (*Capsicum annuum* L. var. grossum Sendt.) is also called as bell pepper or sweet pepper and is one of the popular and remunerative annual herbaceous vegetable crop. It is different from chilli (*Capsicum annuum* L. var. longum) in size, shape, capsanthin content, usage and belongs to the family Solanaceae. It is known by other names such as shimla mirch and green pepper. In India, it is cultivated in an area of 30,000 ha with production of 1.71 lakh tons (National Horticultural Board, 2014-15). Jharkand is the major capsicum cultivating state with an area of 1,960 ha and production of 0.2 lakh tons. In Telangana, in and around Hyderabad, Rangareddy, Medak districts and in Andhra Pradesh, Guntur, Chittoor, Ananthapoor are the major capsicum cultivating districts.

Among the biotic factors, insect pests reduces the quality of produce and even a small blemish on the fruit will drastically reduce its market value. Butani (1976) reported over 20 insect species on chillies (*Capsicum* spp.) from India of which thrips, *Scirtothrips dorsalis* Hood is the most damaging pest under field and poly house conditions (Barwal, 2004 and Kaur *et al*., 2010). Estimated crop loss of 40 to 60 tons per ha of capsicum when the crop was not subjected to insecticidal control (Reddy and Kumar, 2006). In order to control the thrips and get higher market price, farmers are indiscriminately using insecticides. As capsicum is consuming fresh there is a need to minimize the pesticide residues in marketable capsicum, hence the present study was conducted to find pest complex of capsicum both in field and poly house conditions, effective insecticide to manage and residue levels of effective insecticide on capsicum.

MATERIAL AND METHODS

Survey on insect pests of capsicum

Survey was carried out in and around Hyderabad, Telangana where the capsicum is extensively cultivated. Fixed plot survey was conducted in few selected villages of Ranga Reddy district, scattered around Hyderabad and the data was collected from three villages in Chevella, one village in Vikarabad, one village in Shabad mandals of Ranga Reddy, in which capsicum is cultivated under poly house (PH) conditions. In all these five villages, a total of nine poly houses were surveyed. Four villages in Shamshabad mandal were surveyed, in which capsicum is cultivated under open field (OF) conditions. During the survey, for collecting data, five spots (1 m^2 each) were selected in each location (one from centre and four from four corners). In each spot five plants were randomly selected and tagged, from which mean population per leaf (sucking pests) and per cent damage per plant (non sucking pests) were recorded. Mean population / per cent damage of each pest from fourteen fortnights per location was calculated and cumulative mean of four open fields and nine poly houses for each pest was reported and discussed. Expected yield loss and insecticide usage pattern were recorded as per centage and cumulative means were reported and discussed.

2. Bio-efficacy of new insecticide molecules against thrips in capsicum

Poly house experiments were conducted at Horticulture Garden, College of Agriculture, Rajendranagar, Hyderabad in Randamized Block Design (RBD) with three replication. The popular capsicum hybrid, Royal Wonder (Seminis Pvt. Ltd) was choosen for the study. Individual plots were formed with size of 9 m^2 (3 m X 3 m). Capsicum seeds were sown on 9th August, 2013 and 16th October, 2014 in the well prepared raised nursery bed *i.e* 1 m width and 5 m length. The 30-35 days age seedlings were transplanted in the main field after providing good irrigation. An inter row spacing of 45 cm and intra row spacing of 30 cm was adopted, to maintain optimum plant population in the field. Transplanting was done on 16-09-2013 and 20-11-

2014 during first and second year of investigation. Recommended agronomical practices were followed to raise the sound crop in open and poly house conditions. Different groups of chemicals were selected as treatments and the dosages were applied as foliar sprays against the thrips on capsicum. The efficacy of seven insecticides viz., spinosad @ 125 ml ha^{-1}, flubendiamide @ 200 ml ha^{-1}, chlorantraniliprole @ 200 ml ha^{-1}, spiromesifen @ 750 ml ha^{-1}, thiomethoxam @150 g ha^{-1} and triazophos @ 1250 ml ha^{-1} along with untreated check were evaluated against the thrips, *Scirtothrips dorsalis* Hood on capsicum. The first spray was applied when the insect population reached economic threshhold levels (ETL) (Thrips, 2 no./ leaf, Kumar *et al.*, 2007) and second spray was given at 7 days after first spray. A total of three sprays were applied during the entire experimentation in both the seasons. Same procedure was followed to both open field and poly house conditions. Data was recorded from five terminal leaves (2 from top, 2 from middle and 1 from bottom) per plant. Pre count (1 day before spray) and post count (1,3,5 and 7 days after spray) of the insects was recorded by using destructive sampling procedure. Per cent reduction over control was calculated by using the following formula.

$$\text{Per cent reduction over control} = 1 - \frac{\frac{\text{Post count population in the control}}{\text{Post count population in the treatment}}}{\text{Post count population in the control}} \times 100$$

Pre count (1 DBS) and post count (mean of 1,3,5 and 7 DAS) population and per cent reduction over control were calculated after each spray. Cumulative mean of three sprays in 2013-14 and 2014-15 under open and poly house conditions and pooled mean of two years were represented in tables and discussed for each recorded pests.

Leaf Curl Index (LCI) was recorded one day before and 10 days after each spray following the methodology of Kumar *et al.* (1996). The observations recorded from the open field and poly house were subjected to statistical analysis (RBD) to know the significance of difference among different treatments. The values in percentages were transformed to angular values and values in number were transformed into square root values before analysis (Gomez and Gomez, 1984).

3. Dissipation dynamics of spinosad

Certified Reference Materials (CRMs) of spinosad was obtained from Dr. Erhenstorfer, Germany were used to prepare primary standards. Intermediary and working standards were prepared using acetone and hexane as solvents (1 : 9 ratio). Working standards of spinosad was prepared in the range of 0.01 ppm to 0.5 ppm in 10 ml calibrated graduated volumetric flask using distilled n-hexane as solvent. All the standards were stored in deep freezer maintained at -40^{0}C. For sample preparation Primary Secondary Amine (Agilent), magnesium sulfate anhydrous (Emsure grade of Merck), sodium sulfate anhydrous (Emparta ACS grade of Merck), acetonitrile (LC MS gradient grade of Merck), acetic acid glacial (LC MS grade of Merck), acetone (Emplure grade of Merck), n-hexane (LC MS grade of Merck) were used during the study. Spinosad 45 SC was procured from local market. The working standards of spinosad was injected in Liquid Chromatograph with Photo Diode Array (PDA). Under LC operational parameters given in Table 1, the retention time of spinosad are 4.25 min. Working standards of above insecticide (0.05 ppm, 0.075 ppm, 0.10 ppm, 0.25 ppm and 0.50 ppm) were injected six times.For confirmatory analysis, samples were also injected in LC-MS/MS.

The AOAC official method 2007.01 (Pesticide Residues of Foods by Acetonitrile Extraction and Partitioning with Magnesium Sulphate) was slightly modified to suit to the facilities available at the laboratory and the same was validated for estimation of LOQ (Limit of Quantitation) in capsicum matrix. The final extract of the sample was evaporated using turbovap and made up to 1 ml (equal to 1 g sample)

Table 1
Details of LC-MS/MS operating parameters for the analysis of spinosad

LC-MS/MS	SHIMADZU LC-MS/MS 8040			
Detector	Mass Spectrophotometer			
Column	KINETEX, 100 X 3, 2 um			
Column Oven Temperature	40°C			
Retention Time (RT)	5.1			
Nebulizing gas	Nitrogen			
Nebulizing flow gas	2.0 lit.min^{-1}			
Pump Mode/ flow	Gradient/ 0.4 ml. min^{-1}			
Retention time,	Spinosad- 4.25 min.			
LC Program	A : Ammonium formate in water			
	B: Ammonium formate in methanol			
	Insecticide	*Time*	*methanol*	*Water*
	Spinosad	4.25	55	45
Precursor ion and Quantifier ion	Insecti-cide	Prec-ursor ion	Quantifier ion	
	Spinosad	433.40	223.40	

using suitable solvent (n-Hexane: Acetone (9:1) for LC analysis, filtered 1 ml final extract (equal to 0.5 g sample) was directly injected in LC and the residues of pesticides recovered from fortified samples were calculated using the standard formula.

RESULTS AND DISCUSSION

1. Survey on insect pests of capsicum: The insect pests, viz., thrips, *S. dorsalis,* mite, *P. latus,* cut worm, *A. ipsilon,* blossom midge, *A. capsici* and fruit borer, *S. litura* incidence were recorded, whereas, in poly house in addition to the above pests, aphids, *M. persicae* and whiteflies, *B. tabaci* incidence were also noticed. The cumulative means of insect population and damage caused by the pests under four open fields and nine poly house conditions are discussed here under. (Table 2).

During the crop season of 2013-14, the mean population of thrips (no./leaf) ranged from 9.60±0.47 to 12.24±1.20 and for mites 5.94 ±0.79 to 10.64±2.34, respectively. The per cent damage per plant caused by cut worm, blossom midge and fruit borer ranged from 2.12± 0.78 to 5.33 ± 0.56,

Table 2
Population and damage levels of insect pests under open field, poly house conditions of Telangana

Name of the Insect Pest	*Telangana*			
	Open Field		*Poly House*	
	Mean + SD		*Mean+SD*	
	Lower limit$	*Upper limit*$	*Lower limit*	*Upper limit*
Thrips*	9.60±0.47	12.24±1.2	1.87±0.66	4.99±1.75
Mites *	5.94±0.79	10.64±2.34	1.10±0.65	4.56±1.42
Aphids *	0.00	0.00	0.68±0.77	2.94±2.06
Whiteflies *	0.00	0.00	0.05±0.30	1.13±0.45
Cut worm#	2.12 ± 0.78	5.33 ± 0.56	1.01 ± 0.70	4.04 ± 0.98
Blossom midge #	2.75±0.49	9.26±3.19	0.66±0.59	4.05±1.53
Fruit Borer #	5.26±0.91	17.8±3.89	1.03±0.59	5.42±0.81

*Mean population per leaf/plant, # Per cent damage per plant. $ Lower and upper limit of insect pest population.

2.75±0.49 to 9.26±3.19 and 5.26±0.91 to 17.8±3.89, respectively under open field conditions. In poly house the mean population of thrips, mites, aphids and whiteflies ranged from 1.87 ±0.66 to 4.99 ± 1.75, 1.10 ± 0.65 to 4.56 ±1.42, 0.68 ±0.77 to 2.94 ±2.06 and 0.05 ±0.3 to 1.13 ±0.45, respectively. The per cent damage per plant caused by cut worm ranged from 1.01± 0.70 to 4.04 ± 0.98, blossom midge, 0.66 ±0.59 to 4.05 ±1.53 and fruit borer, 1.03 ± 0.59 to 5.42 ±0.8181, respectively during crop season.

The incidence of thrips and mites recorded under open field conditions in the present survey is in line with the findings of Manjunatha *et al.* (2001). They stated that maximum thrips count ranged from zero to 7.80 per leaf while yellow mite counts ranged from zero to 20.40 per leaf. Similar findings were also reported by Reddy and Kumar (2005) and Reddy and Kumar (2006), Kumar *et al.* (2007), Sunitha *et al.* (2007), Manyam and Byadgi (2013), Shah *et al.* (2013) and Kumar and Gupta (2014). All the above findings confirm the present reports on thrips and mite incidence under open field conditions in Telangana.

Fruit borer was observed damaging the fruits of capsicum during reproductive stage causing maximum per cent damage of 17.8 ± 3.89 in all the four open fields during the survey period. Sunitha *et al.* (2007) also reported 20.68 per cent fruit damage at reproductive stage of capsicum in the open field conditions by fruit borer. The present findings are also in line with the observations made by Nandini *et al.* (2010) who reported up to 12.50 per cent damage caused by *S. litura*.

The over all observations recorded on the pest incidence in capsicum under poly house conditions are in line with the findings of Sumit *et al.* (2013) who reported the incidence of *T. vaporariorum*, *M. persicae*, *S. litura*, *H. armigera* and *S. dorsolis* in 82 poly houses of Himachal Pradesh. The present survey carried out on fruit borer is in agreement with the findings of Vos and Frinkling (1998), Wood *et al.* (1987), Sunitha *et al.* (2007) and Nandini *et al.* (2010) who recorded 20.00, 20.68, 26.16 and 20.00 per cent damage, respectively by fruit borer on sweet pepper under protected conditions.

The survey carried out in and around Hyderabad on capsicum pests under poly house cultivation revealed that in addition to thrips and mites, aphids and whiteflies were reported on capsicum.

2. Bioefficacy of insecticides against thrips, *S. dorsalis:* The results on the efficacy of insecticidal treatments during against thrips, *S. dorsalis* in capsicum are presented in Table 3.

Open field : The results with regards to overall cumulative mean efficacy of the treatments against thrips, *S. dorsalis* during the two years under open field conditions are presented in Table 3. Mean thrips population in pre count ranged from 2.52 to 7.94 and post count population was lowest in spinosad (0.88 thrips/leaf) followed by diafenthiuron (1.72 thrips/leaf) and were significantly superior over untreated check (11.21 thrips/leaf) and at par with each other. Thiamethoxam (3.27 thrips/leaf), chlorantraniliprole (5.83 thrips/leaf), flubendiamide (5.92 thrips/leaf), spiromesifen (6.02 thrips/leaf) and triazophos (6.55 thrips/leaf) were found to be on par with untreated check (11.21 thrips/leaf) (Table 3).

The per cent reduction over untreated check indicated the order of efficacy of insecticides in descending order as spinosad (88.30%) followed by diafenthiuron (79.47%) which were at par with each other and significantly superior over the untreated check. The other treatments that followed in the descending order of efficacy were thiamethoxam (64.71%), chlorantraniliprole (41.94%), spiromesifen (39.86%), flubendiamide (39.05%) and triazophos (33.71%) which were found to be on par with untreated check except thiamethoxam (Table 3).

The mean LCI of two years revealed that, LCI at one DBS (1.54) was significantly reduced to 0.98 in spinosad treated plants followed by diafenthiuron

Table 3

Cumulative efficacy of certain insecticide molecules against thrips, *S. dorsalis* on capsicum under open field and poly house conditions during 2013-14 and 2014-15

Tr.No	Treatments	Dose (g or ml ha^{-1})	Open field: Pre count (Mean no. of thrips/ leaf) (1 DBS)*	Open field: Post count (Mean of 1,3,5,7 DAS)*	Open field: Per cent Reduction$	Poly house: Pre count (1 DBS)*	Poly house: Post count (1,3,5,7 DAS mean)*	Poly house: Per cent Reduction$	LCI Open field: 1 DBS	LCI Open field: 10 DAS	LCI Poly house: 1 DBS	LCI Poly house: 10 DAS
T_1	Spinosad 45 SC	125	2.52(1.87)^{d}	0.88(1.37)^{c}	88.3(69.97)^{a}	1.07(1.43)^{c}	0.06(1.03)^{c}	98.05(81.94)^{a}	1.55(1.59)	0.98(1.40)^{c}	1.55(1.59)	0.98(1.40)^{c}
T_2	Flubendiamide 480 SC	200	5.46(2.54)^{abc}	5.92(2.63)^{ab}	39.05(38.66)^{cd}	3.35(2.08)^{abc}	3.81(2.19)^{ab}	24.71(29.79)^{de}	3.00(2.00)	3.21(2.05)^{ab}	3.00(2.00)	3.21(2.05)^{ab}
T_3	Chlorantraniliprole 20 SC	200	5.33(2.51)^{abc}	5.83(2.61)^{ab}	41.94(40.34)^{cd}	3.20(2.04)^{abc}	3.55(2.13)^{ab}	27.56(31.65)^{d}	3.04(2.01)	3.27(2.06)^{ab}	3.04(2.01)	3.27(2.06)^{ab}
T_4	Diafenthiuron 25 WP	750	3.02(2.00)^{cd}	1.72(1.64)^{bc}	79.47(63.03)^{ab}	1.46(1.56)^{bc}	0.50(1.22)^{c}	87.52(69.28)^{b}	2.02(1.78)	1.34(1.53)^{bc}	2.02(1.78)	1.34(1.53)^{bc}
T_5	Spiromesifen 22.9 SL	750	5.52(2.55)^{abc}	6.02(2.65)^{ab}	39.86(39.13)^{cd}	3.16(2.04)^{abc}	3.61(2.14)^{ab}	28.26(32.10)^{d}	3.08(2.02)	3.34(2.08)^{ab}	3.08(2.02)	3.34(2.08)^{ab}
T_6	Thiamethoxam 25 WG	150	4.21(2.28)^{bcd}	3.27(2.06)^{abc}	64.71(53.53)^{bc}	2.01(1.73)^{abc}	1.30(1.51)^{bc}	72.98(58.66)^{c}	2.11(1.76)	1.43(1.55)^{abc}	2.11(1.76)	1.43(1.55)^{abc}
T_7	Triazophos 40 EC	1250	5.81(2.61)^{ab}	6.55(2.74)^{ab}	33.71(33.17)^{d}	3.65(2.15)^{ab}	4.24(2.28)^{ab}	19.45(25.63)^{e}	3.18(2.04)	3.39(2.09)^{a}	3.18(2.04)	3.39(2.09)^{a}
T_8	Untreated check	—	7.94(2.90)^{a}	11.21(3.23)^{a}	0.00^{d}	4.34(2.28)a	5.60(2.47)a	0.00f	3.36(1.98)	3.67(2.07)ab	3.36(1.98)	3.67(2.07)^{ab}
		SEm±	3.00	3.84	4.28	0.09	0.16	1.52	0.33	0.48	0.33	0.48
		CD(P= 0.05)	9.18	11.77	13.13	0.27	0.51	4.68	1.23	1.25	1.23	1.25
		CV (%)	13.25	14.57	17.59	13.82	15.55	16.44	16.50	14.21	16.50	14.21

mean of five leaves per plant, ten plants per replication, three replications per treatment., * Figure in the parenthesis are square root transformed values.

$ Figure in the parenthesis are Arc-sin transformed values

DOS : Ist Spray : 15-11-2013., IInd spray: 22-11-2013., IIIrd spray : 29-11-2013., DBS : Days Before Spray., DAS : Days After Spray., NS : Non significant

DMRT : Means followed by a common letter are not significantly different (P= 0.05)

(2.02 to 1.34) and thiamethoxam (2.11 to 1.43). Whereas, LCI was significantly increased from one DBS to 10 DAS in flubendiamide (3.00 to 3.21) chlorantraniliprole (3.05 to 3.27), spiromesifen (3.08 to 3.34) and triazophos (3.18 to 3.39) and untreated check (3.36 to 3.67) (Table 3).

Poly house : The results with regards to overall cumulative mean efficacy of the treatments against thrips, *S. dorsalis* during the two years under poly house conditions are presented in Table 3. Mean thrips population in pre count ranged from 1.07 to 4.34 and post count population was lower with spinosad (0.06 thrips/leaf) followed by diafenthiuron (0.50 thrips/leaf) and thiomethoxam (1.30 thrips/leaf) which were significantly superior over untreated check (5.6 thrips/leaf) and at par with each other. The descending order of efficacy in the treatments was chlorantraniliprole (3.55 thrips/leaf) > spiromesifen (3.61 thrips/leaf) > flubendiamide (3.81 thrips/leaf) > triazophos (4.24 thrips/leaf) which were found to be at par with untreated check (5.60 thrips/leaf).

The per cent reduction over untreated check revealed that, the highest per cent reduction of thrips population was in spinosad (98.05%) which was significantly superior over other treatments. Diafenthiuron (87.52%) and thiomethoxam (72.98 %) were next best treatments. The other treatments in the descending order of efficacy were spiromesifen (28.26), chlorantraniliprole (27.56), flubendiamide (24.71) and triazophos (19.45) which were found to be significantly superior over untreated check.

The mean LCI of two years revealed that, LCI at one DBS (1.25) was significantly reduced to 0.51 in spinosad treated plants followed by diafenthiuron (1.69 to 0.90) and thiomethoxam (1.82 to 1.16). Whereas, LCI was significantly increased from one DBS to 10 DAS in chlorantraniliprole (2.41 to 2.51), flubendiamide (2.43 to 2.55), spiromesifen (2.51 to 2.64) and triazophos (2.53 to 2.72) and untreated check (2.71 to 2.96) (Table 3).

The results obtained from the both years of poly house experiment clearly showed that, spinosad was significantly superior over rest of the treatments and showed lowest mean no. of thrips per leaf (0.06) and mean reduction of thrips population (98.05 %). Next best treatment was diafenthiuron in reducing mean thrips population (0.50) and increased mean per cent reduction of population (87.52%) followed by thiomethoxam which showed significant superiority in reducing mean thrips population (1.30) and moderate mean per cent reduction of thrips population (72.98).

The results obtained from both years of open field experiment clearly showed that, spinosad was significantly superior over most of the treatments and showed lower mean no. of thrips per leaf (0.88) and mean reduction of thrips population (88.3%). Spinosad, a naturally occurring mixture of spinosyn A and spinosyn D, is a secondary metabolite from the aerobic fermentation of *Saccharopolyspora spinosa* on nutrient media. The superior efficacy is due to the excitation of insect nervous system leading to involuntary muscle contraction, prostration with tremors and paralysis. These effects are consistent with the activation of nicotinic acetylcholine receptors by a mechanism that is clearly novel and unique. Spinosad also effects GABA receptor function that may contribute further to its insect activity (Sparks *et al.* 2001).

The present results are in concurrence with Prasad and Ahmed (2009), Hossaini *et al.* (2014), Bheemanna *et al.* (2009), Srinivas *et al.* (2002), Vanisree *et al.* (2011), Ishaaya *et al.,* 1995 and Mandal (2012).

3. Dissipation dynamics of spinosad: Spinosad @ 125 ml ha^{-1} was sprayed thrice and the dissipation dynamics was studied in open field and poly house situations by collecting samples at 0, 1, 3, 5, 7, 10, 15 and 20 days after third spray and results are presented in Tables 4 and 5 and and Fig. 1.

Table 4
Dissipation of spinosad in capsicum in open field conditions

Days after last spray	*Residues of spinosad ($mg\ kg^{-1}$)*				*Dissipation %*
	R1	*R2*	*R3*	*Average*	
0	0.61	0.59	0.63	0.60	0.00
1	0.39	0.34	0.29	0.34	44.26
3	0.13	0.16	0.13	0.14	77.04
5	0.06	0.06	0.07	0.07	88.52
7	BDL	BDL	BDL	BDL	100.00
10	BDL	BDL	BDL	BDL	—
15	BDL	BDL	BDL	BDL	—
20	BDL	BDL	BDL	BDL	—

Regression equation Y = 2.767 + (- 0.210) X
R^2 0.994
Half-life 1.43 days
Safe waiting period : 7.00 days

Table 5
Dissipation of spinosad in capsicum in poly house conditions

Days after last spray	*Residues of spinosad ($mg\ kg^{-1}$)*				*Dissipation %*
	R1	*R2*	*R3*	*Average*	
0	1.63	1.54	1.62	1.61	1.59
1	1.15	1.17	1.19	1.17	26.41
3	0.95	0.98	0.97	0.97	39.62
5	0.75	0.72	0.79	0.75	52.83
7	0.45	0.47	0.36	0.43	73.58
10	0.22	0.23	0.20	0.22	86.79
15	0.05	0.06	0.09	0.07	96.22
20	BDL	BDL	BDL	BDL	100.00

Regression equation Y = 3.170 + (-0.060) X
R^2 0.949
Half-life 3.37days
Safe waiting period : 20 days

Initial deposits of 0.60 mg kg^{-1} of spinosad were detected at 2 hours (0 days) after last spray, dissipated to 0.34, 0.14 and 0.07 mg kg^{-1} at 1, 3 and 5 days after last spray, respectively in open field conditions. The residues reached BDL at 7th day after spray. The dissipation pattern showed decrease of residues from first day to 7th day and residues dissipated by 44.26, 77.04, 88.52 and 100.00 per cent at 1, 3, 5 and 7 days, respectively. The regression equation was Y = 2.767 + (- 0.210) X with R^2 of 0.994. The half - life and safe waiting period for capsicum when spinosad @ 125 ml ha^{-1} sprayed thrice were 1.43 and 7.00 days.

In poly house, initial deposits of 1.61 mg kg^{-1} of spinosad were detected at 2 hours after last spray, dissipated to 1.17, 0.97, 0.75, 0.43, 0.22 and 0.07 mg kg^{-1} at 1, 3, 5, 7 , 10 and 15 days after last spray, respectively. The dissipation pattern showed decrease of residues from first day to 20th day and the residues dissipated by 26.41, 39.62, 52.83, 73.58, 86.79, 96.22 and 100.00 per cent at 1, 3, 5, 7, 10, 15 and 20 days, respectively. The regression equation was Y = 3.170 + (-0.060) X with R^2 of 0.949. The half - life value was 3.37 while safe harvest period for capsicum when spinosad @ 125 ml ha^{-1} was sprayed thrice in poly house condition was 20.00 days after last spray.

Anjali *et al.* (2008) found the dissipation behaviour of spinosad on chilli at two application rates (73.0 g a.i ha^{-1} and 146 g a.i ha^{-1}), half - life and waiting periods were 1.48 days and 0.70 days respectively, for 73.0 g a.i.ha^{-1}. whereas 6.72 days and 5.55 days, respectively for 146 g a.i.ha^{-1} application rate. Dissipation kinetics of spinosad on cauliflower was worked out by Mandal *et al.* (2009). After three application of spinosad (Success 2.5 SC) at 15 and 30 g a.i ha^{-1}, the initial deposits of spinosad were observed as 0.57 and 1.34 μg kg^{-1}, respectively and a waiting period of 6 days was suggested for the safe consumption of spinosad treated cauliflower.

The variation in the initial deposits (0.61 and 1.60 mg kg^{-1} in open and poly house conditions respectively) half - life (1.43 and 3.37 days), waiting periods (7.00 and 20.00 days) and dissipated to BDL (7.00 and 20.00 days) of capsicum to chilli may be due to variation in dosages of application, change in matrix and climatic conditions. Similar reports by Singh *et al.* (2012) and Vijayasree *et al.* (2014).

Comparison of dissipation pattern of spinosad in capsicum in open field and poly house conditions indicated that, initial deposits, half - life and waiting periods were less in open field conditions than poly house conditions (Fig. 1). This data infers that the dissipation is slow in poly houses compared to open fields due to varying factors such as cool climatic conditions and less sun light penetration in poly house.

The study was concluded that, capsicum cultivation in the open field and poly house conditions harbour the insect pests from seedling stage to harvest of the crop. Among the insect pests, thrips is the major pest of capsicum. Spinosad @ 125 75 ml a.i.ha^{-1} found to be effective insecticide to manage the thrips in open and poly house conditions. The waiting period for safe harvest was 7.0 and 20.0 days when spinosad 45 SC @ 75 ml a.i.ha^{-1} sprayed thrice in open and poly house conditions, respectively.

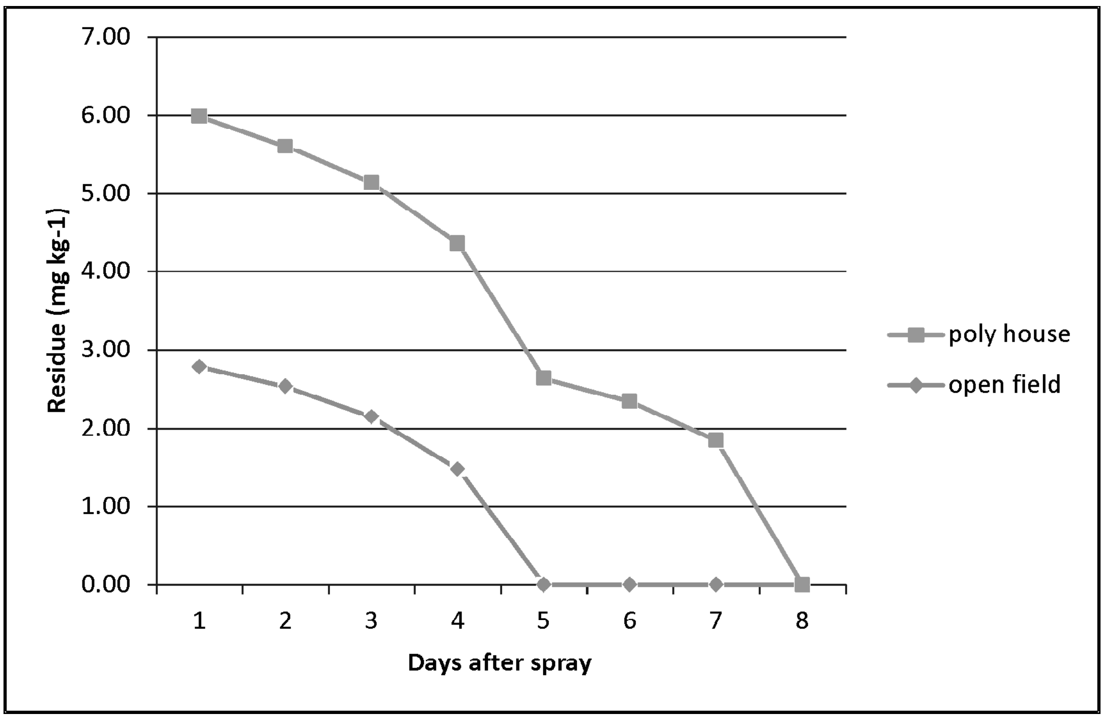

Figure 1: Dissipation of spinosad in capsicum under open field and poly house

REFERENCES

Anjali, S., Anjana, S, Rama, B and Srivastava, P.C. (2008), Dissipation behavior of spinosad insecticides in chilli and soil. *Asian Journal of Water, Environment and Pollution.* 5 (2) : 49-52.

Barwal, R. N. (2004), Loss to sweet pepper, *Capsicum annum* Linn. Seedlings by the first generation caterpillars of cabbage cutworm, *Agrotis ipsilon* (Hufn,). *Pest Management in Horticultural Ecosystem.* 5 (2): 139-141.

Bheemanna, M., Patil, B.V., Hanchinal, S.G., Hosamani, A.C and Kengegowda, N. (2009), Bioefficacy of Emamectin Benzoate (proclaim) 5% SG against okra fruit borer. *Pestology,* (6) : 14-16.

Butani, D. K., (1976), Pests and diseases of chilli and their control. *Pesticides*, 10: 38-41.

Ishaaya, I., Yablonski, S and Horowitz, A. R. (1995), Comparative toxicity of ecdysteroid agonists, RH-2485 and RH-5992 on susceptibile and pyrethroid resistant strains of the Egyptisn cotton leaf worm, *Spodoptera littoralis*. *Phytoparasitica*. 23 : 139- 145

Kaur, S., Kaur, S., Srinivasan, R., cheema, D.S., Tarsem Lal., Ghai,T.R and Chadha, M.L. (2010), Monitoring of major pests on cucumber, sweet pepper and tomato under net house conditions in Punjab, India. *Pest Management in Horticultural Ecosystems.* 16 (2): 148-155.

Kumar, N.K.K, Aaradhya, M., Deshpande, A.A., Anand, N and Ramachander, P.R. (1996), Screening of chilli and sweet pepper germplasm for resistance to chilli thrips, *Scirtothrips dorsalis* Hood. *Euphytica*. 89: 319-324.

Kumar, A.H., Kulkarni, K.A., Patil, B.V., Giraddi, R.S., Srikanth, K and Salimath, P. (2007), Management of chilli murda complex in irrigated ecosystem. *Thesis submitted to University of Agricultural Sciences, Dharwad. Karnataka.*

Kumar, M and Verma, V. (2009), Bell Pepper (*Capsicum annuum* L.) production in low cost naturally ventilated poly houses during winters in the mid hills of India. *Acta Horticulture.*4 : 807.

Mandal, K., Jyot, G and Singh, B. (2009), Dissipation Kinetics of Spinosad on Cauliflower (*Brassica oleracea var.* botrytis) under subtropical conditions of Punjab, India. *Bulletin of Environmental Contamination and Toxicology*. 83 : 808-811

Manjunatha, M., Hanchinal, S.G., Reddy, G.V.P. (2001), Survey on Yellow mite and thrips on chilli in North Karnataka. *Insect Environment*. 6 (4):178.

Manyam, P and Byadgi, A.S. (2013), Status of chilli murda disease in Northern Karnataka and its management. *Trends in Bio-Sciences* 6 (6) : 784 -788.

Nandini, R.S., Giraddi, S.M., Mantur and Mallapur C.P. (2010), Survey and management of pests of capsicum under protected cultivation. *Thesis submitted to University of Agricultural Sciences, Dharwad, Karnataka, India.*

Prasad, N.V.V. S. D and Ahmed, K. (2009), Bio-efficacy of insect growth regulator, Lufenuron 5 EC against thrips, *Scirtothrips dorsalis* Hood and Pod borer, *Spodoptera litura* Fab, on chillies. *Pest Management in Horticultural Ecosystems.* 15(2) : 126-130.

Reddy, E. S. G and Kumar, K. N. K. (2005), A comparison of management of thrips, *Scirtothrips dorsalis* Hood on sweet pepper grown under protected and open field cultivation. *Pest Management in Horticultural Ecosystams*. 12 (1): 45-54.

Reddy, E. S. G and Kumar, K. N. K. (2006), Integrated management of yellow mite, *Polyphagotarsonemus latus* Banks on sweet pepper grown under poly house. *Journal of Horticultural Science*. 1 (2) : 120-123.

Shah, T.A., Prajapathi, C. R and Bhat, M. A. (2013), Incidence of chilli mosaic in commercially cultivated chilli areas of Kashmir valley. *Society for Plant Research.* (26) : 308-310.

Singh, B., Battu, R.S., and Kooner,R and Singh, B. (2012), Simple and efficient method for the estimation of residues of flubendiamide and its metabolic des-iodo flubendiamide. *Journal of Agricultural Food Chemistry*. 56: 2299 -2304.

Sparks, T.C., Course, G.D and Durst, G. (2001), Natural products as insecticides: the biology, biochemistry and quantitative structure-activity relationship of spinosyns and spinosoids. *Pest Management Science.* 57: 896-905.

Srinivas, N., Mallik, B., Onkarappa, S and Guruprasad, H. (2002), Bio-effecacy of newer acaricidal molicules against chilli mite, *(Polyphagotarsonemus latus.* Banks). In: *International Vegetable Conference.* Nov.11-14, *Bengaluru. India*. pp: 25.

Sunitha, T.R., Naik, K., Giraddi, R.S., Hosamani, R.M., Patil, M. S. (2007), Insect pests of *capsicum annum var. fruitescence (L.)* and their management. *Thesis submitted to University of Agricultural Sciences, Dharwad, Karnataka, India.*

Vanisree, K., Rajashekar, P., Upender, S., Rao, R.G and Rao,V.S. (2011), Insecticidal resistance in chilli thrips, *Scirtothrips dorsalis* Hood in Andhra Pradesh. *Indian Journal of Plant Protection*. 39(3): 239-241.

Vijayasree, V., Bai, H., Mathew, T.B., George, T., Xavier, G., Kumar, N. P and Kumar, S.V. (2014), Dissipation kinetics and effect of different decontamination techniques on the residues of emamectin benzoate and spinosad in cowpea pod. *Environment monitoring and Assessment*.186 (7) : 4499-4506.

Vos, J.G.M and Frinking, H.D. (1998), Pests and disease of hot pepper (*Capsicum* spp) in tropical low lands of Java, Indonesia. *Journal of Plant protection of Tropicals*. 11(1) : 53-71.

Wood, T.G., Bendnarzik, M and Aden, H. (1987), Damage to crops by *Microtermus najdensis* in irrigated semi desert areas of the Red sea coast. *Tropical Pest Management*. 33 (2) : 142 – 150.