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ISSN: 2320 – 7051
Int. J. Pure App. Biosci. SPI: **6 (3):** 511-525 (2018)
Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Bio-efficacy, Dissipation of New Insecticide Molecules on Capsicum (*Capsicum annuum* L. var. grossum Sendt) Pest Complex under Poly House Conditions

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Received: 12.06.2018 | Revised: 27.07.2018 | Accepted: 10.08.2018

ABSTRACT

Bioefficacy of seven insecticides viz., spinosad @ 125 ml ha^{-1}, flubendiamide @ 200 ml ha^{-1}, chlorantraniliprole @ 200 ml ha^{-1}, Diafenthiuron 25 WP @ 750 g ha^{-1}, spiromesifen @ 750 ml ha^{-1}, thiamethoxam @150 g ha^{-1} and triazophos @ 1250 ml ha^{-1} along with untreated check were evaluated against thrips, mite and aphids during 2013-14 and 2014-15 under poly house conditions. Among seven insecticides, spinosad 45 SC @ 125 ml ha^{-1} was the best and effective treatment in reducing the thrips population and recording highest per cent reduction over control followed by diafenthuiron 25 WP @ 750 g ha^{-1} and thiamethoxam 25 WG 150 g ha^{-1}. Against mite, spiromesifen 22.9 SL @ 750 ml ha^{-1} was the most effective one with a maximum reduction of population followed by diafenthuiron 25 WP @ 750 g ha^{-1}.Highest per cent reduction of aphid population was recorded with thiamethoxam 25 WG 150 g ha^{-1}. Spinosad 45 SC sprayed @ 125 ml ha^{-1} at thrice 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, 20.0 days Spiromesifen 22.9 SL @ 750 ml ha^{-1} was sprayed thrice, initial deposits of 1.61 mg kg^{-1}, dissipated to BDL at 10.0 days. The waiting period was worked out for safe harvest of capsicum was 10.0 days in poly house conditions, respectively. Thiamethoxam 25 WG @ 150 g a.i.ha^{-1} recorded initial deposits of 2.77 mg kg^{-1}, dissipated to BDL at 15.0 days.

Key wards: *Capsicum, Bioefficacy, Insecticides, Dissipation, Waiting periods*

INTRODUCTION

Capsicum (*Capsicum annuum* L. var. grossum Sendt.) is also called as bell pepper or sweet pepper and is one of the most popular and highly remunerative annual herbaceous vegetable crop. Capsicum is cultivated in most parts of the world, especially in temperate regions of Central and South America and European countries, tropical and subtropical regions of Asian continent mainly in India and China.

Cite this article: Pathipati, V.L., Singh T.V.K., Vemuri S.B., Reddy, R.V.S.K. and Bharathi N.B., Bio-efficacy, Dissipation of New Insecticide Molecules on Capsicum (*Capsicum annuum* L. var. grossum Sendt) Pest Complex under Poly House Conditions, *Int. J. Pure App. Biosci.* SPI: **6(3):** 511-525 (2018).

Various biotic (pest and diseases), abiotic (rainfall, temperature, relative humidity and light intensity) and phenological factors (flower and fruit drop) limits the yield and fruit quality under open field conditions[10]. 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[7] reported over 20 insect species on chillies (*Capsicum* spp.) from India of which thrips, *Scirtothrips dorsalis* Hood, mite, *Polyphagotarsonemus latus* Banks are among the most damaging pests[2,14,16] under field conditions. In addition to these pests, aphid, *Myzus persicae* (Sulz.), whitefly, *Bemisia tabaci* (Gennadius), leaf miner, *Liriomyza trifolii* (Burgess), gall midge, *Asphondylia capsici* Barens and nematodes, *Meloidogyne incognita* Chitwood are serious problems on capsicum under protected condition[5,12]. Reddy and Kumar[23] estimated crop loss of 40 to 60 tons per ha of capsicum when the crop was not subjected to insecticidal control. In order to control the thrips, mite, aphids and get higher market price, farmers are indiscriminately using insecticides and acaricides just before marketing. Under poly house conditions, cultivation of capsicum gives early and prolonged yield compared to open field cultivation[26] but pesticide dissipation takes slow and longer period than in open field conditions[25]. Since capsicum is consumed afresh, they may carry residues which warrant judicious use of pesticides in respect of persistence, dissipation, metabolism, movement and accumulation of residues. The analysis of pesticide residues in capsicum is therefore essential to avoid the health hazards to the consumers by prescribing the waiting periods. Hence the present experiments were carried out.

MATERIAL AND METHODS

Bio-efficacy of new insecticide molecules against thrips, mite and aphids in capsicum

Poly house experiments were conducted in 2013-14 and 2014 -15 at Horticultural Garden, College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad to evaluate the new insecticides for the management of thrips, mite and aphids with leading popular capsicum variety Royal Wonder of Seminis Pvt. Ltd. The experiments were conducted in Randomized Block Design (RBD) with three replications. Capsicum seedlings raised in the nursery were transplanted at age of 40 days in the main field by adopting a spacing of and 30 X 30 cm in poly house conditions. Plot size was maintained 6m X 6m. All the recommended agronomical practices were implemented to raise crop except plant protection measures against pod borers.

The selected insecticides belonging to different groups *viz.*, Organophosphates (Triazophas), Neonicotinoids (Thiamethoxam), Microbial insecticide (Spinosad,), Thiourea derivatives (Diafenthiuron), Diamides (Chlorantraniliprole), Pthalic acid diamides (Flubendiamide) and Ketones (Spiromesifen) along with untreated control were evaluated for two years.

Observations on insect populations *viz*., thrips**,** *Scirtothrips dorsalis* Hood, mites, *Polyphagotarsonemus latus* Banks, Aphids, *Myzus persicae* (Sulzer) were recorded in ten randomly tagged plants, 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.

$$\text{Percent population reduction} = 1 - \frac{\text{Post treatment population in treatment}}{\text{Pre treatment population in treatment}} \times \frac{\text{Pre treatment population in untreated control}}{\text{Post treatment population in untreated control}} \times 100$$

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 are 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*.[15],

2. Dissipation studies of effective insecticides (Spinosad, Spiromesifen and thiamethoxam):

i. Preparation of working standards

Certified Reference Materials (CRMs) of **spinosad,** spiromesifen and thiamethoxam **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 spiromesifen and thiamethoxam were 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, Spiromesifen and thiamethoxam commercial grade were procured from local market.

2 . Limit of detection and linearity of spinosad, spiromesifen and thiamethoxam

The working standards of spinosad, **spiromesifen and thiamethoxam** were injected in Liquid Chromatograph with Photo Diode Array (PDA). The detector for estimating the lowest quantity of above insecticides which can be detected under standard operating parameters are given in Table 2.

Under LC operational parameters given in Table 2, the retention time of spinosad, **spiromesifen and thiamethoxam** are 4.25, 3.84 and 4.12 min, respectively. Working standards of above insecticides (0.05 ppm, 0.075 ppm, 0.10 ppm, 0.25 ppm and 0.50 ppm) were injected six times and the linearity lines were drawn.

For confirmatory analysis, samples were also injected in LC-MS/MS. The LC operating parameters for spinosad, **spiromesifen and thiamethoxam** detection and estimation are presented in Table 2.

Based on the response of the detector (PDA) to different quantities (ng) of CRM standards injected under the LC- MS/MS operational parameters given in table 3.6, it was found that the LOD (limit of detection) for spinosad, spiromesifen and thiamethoxam was 0.05 ng and the linearity was in the range of 0.05 ng to 0.10 ng , respectively.

iii. Method validation

Prior to pesticide application and field sample analysis, the residue analysis method was validated following the SANCO document (12495/2011). The capsicum fruits (5 kg) collected from untreated control plots were brought to the laboratory and the stalks were removed prior to samples preparation. The sample was homogenized using Robot Coupe Blixer (High volume homogenizer) and homogenized sample of each 15 g was taken into 50 ml centrifuge tubes. The required quantity of spinosad, spiromesifen and thiamethoxam intermediate standards prepared from CRM were added to each 15 g sample to get fortification levels of 0.05 ppm, 0.25 ppm and 0.5 ppm in three replications each. These foritifcation levels were selected to know the suitability of the method to detect and quantify pesticides in capsicum below Maximum Residue Limits (MRLs) of Codex Alimentarius Commission (CAC).

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 facilties available at the laboratory and the same was validated for estimation of LOQ (Limit of

Quantitation) in capsicum matrix. The method followed is presented in the flow chart given below in Fig 3.11 and plate 3.7, 3.8, 3.9 and 3.10.

The final extract of the sample was evaporated using turbovap and made up to 1 ml (equal to 1 g sample) using suitable solvent (n-Hexane: Acetone (9:1) for analysis on GC, while 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 following formula.

$$\text{Residues (mg kg}^{-1}\text{)} = \frac{a \times b \times c \times d}{e \times f \times g} \times R$$

where a : sample peak area
b : concentration of standard (ppm)
c : µl standard injected
d : final volume of the sample
e : standard peak area
f : weight of sample analysed
g : µl of sample injected
R : recovery factor

$$\text{Weight of the sample analysed} = \frac{\text{Sample weight (15 g) X aliquot taken}}{\text{Volume of acetonitrile (30 ml)}}$$

Samples of capsicum were collected from both the poly house and open field from individual treatments in all the replications after three sprays, in labeled polybags. Care was taken to avoid contamination by wearing hand gloves. Pest damage free and crack free capsicum fruits collected in separate polythene bags were brought to the laboratory at regular intervals *i.e*. 0, 1, 3, 5, 7, 10, 15 and 20 days after last spray from both poly house and open field. Collected samples were analyzed for residues by the validated methods.

iii. Dissipation pattern of insecticides on capsicum

1 Sample collection

Samples of capsicum were collected from both the poly house and open field from individual treatments in all the replications after three sprays, in labeled polybags. Care was taken to avoid contamination by wearing hand gloves. Pest damage free and crack free capsicum fruits collected in separate polythene bags were brought to the laboratory at regular intervals *i.e*. 0, 1, 3, 5, 7, 10, 15 and 20 days after last spray from both poly house and open field.

2 Sample analysis

Collected samples were analyzed for residues following the validated QuEChERS method. The following parameters were calculated to know the dissipation pattern of the insecticides on capsicum.

i. Dissipation per centage:

$$\text{Per cent dissipation} = \frac{\text{Initial deposit - Residues at given time}}{\text{Initial deposit}} \times 100$$

ii. Waiting period: Waiting period (T_{tol}) is defined as the minimum number of days to lapse before the insecticide reaches the tolerance limit.

The waiting periods were calculated wherever MRLs are available as per the Codex Alimentarius Commission (CAC) / Food

Safety and Standards Authority of India (FSSAI) by the following formula.

$$T_{tol} = \frac{[a - \text{Log tol}]}{b}$$

where,

T_{tol} : Minimum time (in days) required for the pesticide residue to reach below the tolerance limit.
a : Log of apparent initial deposits obtained in the regression equation (Y = a+bX)
tol : Tolerance limit of the insecticide (MRL)
b : Slope of the regression line

iii. Half-life (RL_{50}): The time in days required to reduce the pesticide residues to half of its initial deposits. Mathematically, it is

$$RL_{50} \text{ (or) } t_{1/2} = \frac{Ln(2)}{b} \quad \frac{0.693147}{b}$$

where,

b : Slope of regression line

RESULTS AND DISCUSSION

1. Bio-efficacy of new insecticide molecules against thrips, mite and aphids in capsicum

i. Thrips, (*S. dorsalis*)

Pooled mean of 2013 -14 and 2014-15: 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 4and Figure 1).

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).

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. The present results are in concurrence with Prasad and Ahmed[19] who reported that spinosad was superior in reducing thrips, *S. dorsalis* population and increased fruit yield of chilli in Andhra Pradesh. Similar reports by Hossain *et al*.[11], using spinosad @ 0.4 ml l^{-1} + White sticky trap @ 40 traps ha^{-1} resulted in the lowest thrips (*T. tabaci)* population with highest marginal benefit cost ratio (1 :1.99) in garlic insect pest management. The efficacy of spinosad @ 75 g a.i.ha^{-1} against *S. dorsalis* in cotton was also reported by Srinivas *et al*.[27], Bheemanna *et al*.[6].

In the present study, the next best treatment was diafenthiuron in reducing mean thrips population (1.72) and increased mean per cent reduction of population (79.47). Next in priority was thiomethoxam 25 WG 150 g ml ha^{-1}, which showed significant superiority in reducing mean thrips population and moderate mean per cent reduction of thrips population. Similar finding were reported by Nandini *et al*.[17], Raj *et al*.[20], Rajaram and Ramamurthy[21] on efficacy of thiomethoxam against thrips. It is interesting to note that spinosad, diafenthiuron and thiomethoxam reduced the incidence of the thrips population after the three sprays while the rest of the insecticides increased the incidence compared to before spraying. This observation indicated that these three insecticides effectively controlled thrips up to a week after spraying.

ii. mite (*Polyphagotarsonemus latus* Banks) Pooled mean of 2013-14 and 2014 -15:

The results with regards to overall cumulative mean efficacy of the treatments against mite, *P. latus* during the two seasons under poly house conditions are presented in Table 5. Mean mite population in pre count ranged from 2.66 to 8.67 and post count population was less with spiromesifen (0.06 mites/ leaf) followed by diafenthiuron (2.21 mites/ leaf), triazophos (3.68 mites/ leaf) (Table 5).

The per cent reduction over untreated check in order of efficacy of insecticides along with the highest per cent reduction of mite population was recorded in spiromesifen (99.55 %) followed by diafenthiuron (79.12 %), triazophos (59.82 %) and thiamethoxam (59.23 %), which was found to be significantly superior over rest of the treatments and untreated check. The mean LCI of two years revealed that, LCI at one DBS (1.57) was significantly reduced to 0.00 at 10 DAS in spiromesifen treated plants followed by diafenthiuron (0.91 to 0.36) and triazophos (1.33 to 0.93) (Table 6 and Figure 2).

The results obtained from both seasons of poly house experiment showed that, spiromesifen was significantly superior over rest of the treatments by recording lower mean no.of mites per leaf (0.62) and mean reduction of mite population (97.29 %). Spiromesifen is a tetraonic acid derivative insecticide and acaricide effective against *P. latus*[9].

The present results are in concurrence with Varghese and Mathew who tested certain insecticides and acaricides against chilli mite, *P. latus.* Spiromesifen 45 SC @ 100 g a.i.ha^{-1} and propargite 57 EC @ 570 g a.i. ha^{-1} were found to be effective in reducing chilli mite population.

Similarly the efficacy of spiromesifen 45 SC at 100 g a.i.ha^{-1} in reducing chilli mite in comparison to other insecticides was reported by Nagaraju *et al*.[18], The efficacy of spiromesifen 45 SC at 120 g a.i.ha^{-1} in reducing chilli mite in comparison to dicofol 18.5 EC @ 185 g a.i.ha^{-1} was reported by Kavitha *et al*.[13], Spiromesifen 45 SC @ 120 g a.i.ha^{-1} showed long lasting efficacy by reducing the leaf curl damage from 41.8 per cent to 12.5 per cent. In the present study, the next best treatment was diafenthiuron in reducing the mean mite population (4.08 mites/ leaf) with increased mean per cent reduction of population (71.32 %). The present results are in concurrence with Srinivas *et al*.[27], Dhandapani *et al*.[8], who reported that the diafenthiuron 600 g a.i ha^{-1} brought down the eggs and active stages of *P. latus* by 90 - 95 per cent followed by fenzaquin 125 g a.i ha^{-1}. Bifenthrin and fenpropathrin were found to be less effective against *P. latus.*

Triazophos @ 750 g a.i.ha^{-1}was found highly effective in reducing the mite incidence for 7-14 days after spray and recorded the highest yield compared to thiodicarb @ 750g a.i.ha^{-1} and fenezaquin @ 200 g a.i.ha^{-1} in chilli ecosystem[1]. Treatments with triazophos gave the highest yields (> 3.25 t/ha), followed by phosalone and amitraz in chilli[22]. These findings confirm the present results that triazophos 40 EC @ 1250 ml ha^{-1} was effective insecticide against mites on capsicum under open field conditions.

The acaricides, spiromesifen reduced the incidence of mite population up to seven days after spraying, while in others an increase the mite population after spray. Among the effective insecticides against mite, spiromesifen @ 96 ml a.i.ha^{-1} was the most effective in reducing mite population hence dissipation studies were done.

iii.aphids (*Myzus persicae* (Sulz.) Pooled mean of 2013-14 and 2014-15 : The results with regards to overall cumulative mean efficacy of the treatments against aphids, *M. persicae* during the two years under poly house conditions are presented in Table 7. Mean aphid population in pre count ranged from 2.48 to 9.90 and post count population was less with thiamethoxam (1.02 aphids/ leaf) followed by diafenthiuron (1.24 aphids/ leaf) which were at par with each other and significant superior over other treatments and untreated check (11.38 aphids/ leaf). The descending order (based on population) of efficacy with the other treatments was chlorantraniliprole (5.05 aphids/ leaf) > flubendiamide (6.28 aphids/ leaf) > spinosad (6.46 aphids/ leaf) > spiromesifen (6.91 aphids/ leaf) > triazophos (7.38 aphids/ leaf) were significantly superior over untreated check.

The per cent reduction over untreated check in the order of efficacy of insecticides *i.e* the highest per cent reduction of aphid population was recorded in thiamethoxam (92.10 %) followed by diafenthiuron (89.60 %) which were at par with each other and significantly superior over rest of the treatments and untreated check. The descending order of efficacy with the other treatments was chlorantraniliprole (52.57 %) > flubendiamide (41.57 %) > spinosad (40.20 %) > spiromesifen (36.39 %) > triazophos (32.76 %), respectively and were significantly superior over untreated check (Fig 3).

The mean of two years revealed that LCI at one DBS (1.44) was significantly reduced to 0.87 in thiamethoxam treated plants which was followed by diafenthiuron (1.58 to 1.15), chlorantraniliprole (1.78 to 1.77). Whereas, significant increase in LCI from one DBS to 10 DAS was in spinosad (2.07 to 2.15) flubendiamide (2.09 to 2.14), spiromesifen (2.10 to 2.21), triazophos (2.21 to 2.57) and untreated check (2.37 to 2.57) (Table 8 and Fig 3).

From the results, it is observed that thiamethoxam and diafenthiuron were found to be effective in reducing aphid population. The present findings are in line with Smriti *et al*. (2015) who evaluated the bio-efficacy of insecticides against aphid on capsicum in protected cultivation**.** Among the flonicamid 50WG @ 150 and 200 g ha^{-1}, and thiamethoxam 25 WG @ 75 and 100 g ha^{-1}, lowest no. of aphids (0.17 aphids/ ten plants) were recorded with thiamethoxam than flonicamid (3.33 aphids/ ten plants). The literature on bioefficacy of thiomethoxam and diafenthiuron against aphids was scanty.

II. Dissipation studies of effective insecticides (Spinosad, Spiromesifen and thiamethoxam

i.spinosad : Spinosad @ 125 ml ha^{-1} was sprayed thrice and the dissipation dynamics was studied in 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 9. 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.

Dissipation of spinosad @ 17.5 g a.i ha^{-1} in cabbage and cauliflower. It persisted up to 10 days in cabbage and cauliflower. The half - life of spinosad residues were 2.8 days, respectively. The variation in intial deposits and half - life (1.43 and 3.37 days, open and poly house conditions respectively) in capsicum to cabbage and cauliflower may be due to variation in dosages of application and change in matrix (Anjali *et al*.[3],

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} (Anjali *et al*.[4], whereas 6.72 days and 5.55 days, respectively for 146 g a.i.ha^{-1} application rate. Dissipation kinetics of spinosad in cabbage when applied in two doses @ 15 and 30 g a.i.ha^{-1} of spinosad the initial deposits were observed as 0.33 and 0.56 μg kg^{-1} at single and double dosages, respectively, and dissipated below its limit of quantification of 0.01 μg kg^{-1} after 5 and 7 days at single and double doses, respectively (Mandal *et al*., Spinosad dissipation kinetics in cowpea pods found that initial deposits of 0.94 and 1.9 μ g kg^{-1} reached below detectable level on the 7th day and 15th day at single and double doses. 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, cow pea may be due to variation in dosages of application, change in matrix and climatic conditions .

ii.spiromesifen: In poly house, initial deposits of 1.61 mg kg^{-1} of spiromesifen detected at 2 hours after last spray, dissipated to 1.33, 0.72, 0.31 and 0.17 by 1, 3, 5 and 7 days after last spray, respectively. The residues reached BDL at 10th day after spray. The dissipation pattern showed decrease of residues from first day to 10th day and the residues dissipated by 17.39, 55.27, 80.74, 89.44 and 100.00 per cent at 1, 3, 5, 7, and 10 days, respectively. The regression equation was Y = 3.246 + (- 0.137) X with R^2 of 0.973. The half life and safe waiting period for harvest of capsicum fruits when spiromesifen sprayed @ 125 ml ha^{-1} in poly house conditions was 2.09 and 10.00 days, respectively (Table-9).

Sharma *et al*.[24], reported the persistence of spiromesifen in apple in four locations and the initial deposits of spiromesifen were 0.91, 0.99, 0.99 and 0.88 μg.kg^{-1} at recommended dose, respectively. Raj *et al*.[20], reported the dissipation of spiromesifen on okra and the initial deposits 0.96 and 1.81μ g g^{-1} at standard (48 g.a.i.ha^{-1}) and double (96 g.a.i.ha^{-1}) dose, gradually declined and persisted up to 3rd and 5th day at lower and higher dose. The residues fell below quantification limit of 0.01 μ. g^{-1} on the 5th and 7th day at standard and double the dose. The variation in the initial deposits (1.29 and 1.61 mg kg^{-1} in open and poly house conditions, respectively) half - life (1.06 and 2.09 days), waiting periods (7.00 and 10.00 days) and dissipated to BDL (7.00 and 10.00 days) of capsicum to other crops reported by earlier workers may be due to variation in dosages of application, change in matrix and climatic conditions.

iii.Thiamethoxam:

In poly house, initial deposits of 2.77 mg kg^{-1} thiamethoxam detected at 2 hours after last spray, dissipated to 2.04, 1.75, 0.84, 0.42 and 0.08 mg kg^{-1} by 1, 3 5, 7 and 10 days after last spray, respectively (Table-10). The residues reached BDL at 15th day after spray. The dissipation pattern showed decrease of residues from first day to 15rd day and the residues dissipated by 26.35, 36.82, 69.67, 84.83, 97.11 and 100.00 per cent at 1, 3, 5, 7, 10 and 15 days, respectively. The regression equation is Y = 3.444 + (-0.095) X with R^2 of 0.926. The half - life value was worked out by using linear semi-logarithmic regression analysis and found to be 2.03 days. The safe harvest time interval after three sprays of thiamethoxam @ 150 g ha^{-1} in poly house conditions was 15.00 days.

Singh and Kulshrestha recorded the initial deposits of 0.475 µg g^{-1} after two applications of thiamethoxam at 140 and 75 g ha^{-1} doses and 95.2 per cent dissipation was recorded on the 5th day after last spray and were BDL by the 7th day. The variation in the initial deposits (1.62 and 2.77 mg kg^{-1} in open and poly house conditions, respectively) half life (2.65 and 2.03 days), waiting periods (7.00 and 15.00 days) and dissipated to BDL (7.00 and 15.00 days) of capsicum may be due to variation in dosages of application, change in matrix and climatic conditions.

Table 1. Scoring procedure for sucking pests damage

S.No	Score	Symptom
1	**0**	No symptoms
2	**1**	1-25% leaves/plant showing curling
3	**2**	25-50% leaves/plant showing curling, moderately damaged
4	**3**	51-75% leaves/plant showing curling, heavely damaged, malformation of growing points and reduction in plant height
5	**4**	>76% leaves/plant showing curling,severe and complete destruction of growing points,drastic reduction in plant height , defoliation and severe malformation

Table 2. Details of LC-MS/MS operating parameters for the analysis of spinosad, spiromesifen and thiamethoxam.

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.**			
	Spiromesifen – 3.84			
	Thiamethoxam **- 4.12 min.**			
LC Program	**A : Ammonium formate in water**			
	B : Ammonium formate in methanol			
	Insecticide	**Time**	**methanol**	**Water**
	Spinosad	**4.25**	**55**	**45**
	Spiromesifen	**10.00**	**95**	**5**
	Thiamethoxam	**4.01**	**35**	**65**
Precursor ion and Quantifier ion	**Insecticide**	**Precursor ion**	**Quantifier ion**	
	Spinosad	**433.40**	**223.40**	
	Spiromesifen	**371.00**	**273.10**	
	Thiamethoxam	**293.50**	**211.10**	

Table 4. Cumulative efficacy of certain insecticide molecules against thrips, *S. dorsalis* on capsicum under poly house conditions during 2013-14 and 2014-15

T.No	Treatments	Dose (g or ml ha^{-1})	2013-14			2014-15			Mean of 2013-14 and 2014-15		
			Mean of three sprays#			Mean of three sprays#					
			Pre count (1 DBS)*	Post count (1,3,5,7 DAS mean)*	Per cent Reduction$	Pre count (1 DBS)*	Post count (1,3,5,7 DAS mean)*	Per cent Reduction$	Pre count (1 DBS)*	Post count (1,3,5,7 DAS mean)*	Per cent Reduction$
T_1	Spinosad 45 SC	125	1.14 (1.46)c	0.00 (1.00)c	100.0 (90.00)a	1.07 (1.41)b	0.12 (1.05)b	96.10 (78.57)a	1.07 (1.43)c	0.06 (1.03)c	98.05 (81.94)a
T_2	Flubendiamide 480 SC	200	3.77 (2.18)abc	4.64 (2.37)ab	42.30 (40.55)c	2.92 (1.98)ab	2.98 (1.99)a	7.12 (15.47)de	3.35 (2.08)abc	3.81 (2.19)ab	24.71 (29.79)de
T_3	Chlorantraniliprole 20 SC	200	3.41 (2.10)abc	4.02 (2.24)ab	51.00 (45.55)c	2.99 (1.99)ab	3.07 (2.01)a	4.12 (11.70)e	3.20 (2.04)abc	3.55 (2.13)ab	27.56 (31.65)d

T_4	Diafenthiuron 25 WP	750	1.52 (1.58)bc	0.52 (1.23)c	90.30 (71.82)b	1.39 (1.54)ab	0.47 (1.14)b	84.74 (66.97)b	1.46 (1.56)bc	0.50 (1.22)c	87.52 (69.28)b
T_5	Spiromesifen 22.9SL	750	3.41 (2.10)abc	4.30 (2.30)ab	47.70 (43.66)c	2.90 (1.97)ab	2.92 (1.98)a	8.83 (17.28)d	3.16 (2.04)abc	3.61 (2.14)ab	28.26 (32.10)d
T_6	Thiamethoxam 25 WG	150	2.35 (1.83)abc	1.65 (1.62)bc	77.00 (61.31)b	1.66 (1.63)ab	0.95 (1.39)b	68.97 (56.12)c	2.01 (1.73)abc	1.30 (1.51)bc	72.98 (58.66)c
T_7	Triazophos 40 EC	1250	4.29 (2.30)ab	5.42 (2.53)a	34.5 (35.29)c	3.00 (2.00)ab	3.06 (2.01)a	4.40 (11.55)e	3.65 (2.15)ab	4.24 (2.28)ab	19.45 (25.63)e
T_8	Untreated check	---	5.58 (2.47)a	7.99 (2.91)a	0.00d	3.10 (2.01)a	3.21 (2.07)a	0.00f	4.34 (2.28)a	5.60 (2.47)a	0.00f
		SEm±	0.16	0.17	2.57	0.14	0.1	0.92	0.09	0.16	1.52
		CD (P= 0.05)	0.51	0.54	7.88	0.42	0.31	2.82	0.27	0.51	4.68
		CV (%)	14.58	15.24	9.18	9.96	10.31	14.95	13.82	15.55	16.44

#No.ofthrips/leaf, 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.

DBS : Days Before Spray., DAS : Days After Spray., NS : Non significant

DOS :Istspray: 30-11-2013; IInd Spray:07-12-2013; IIIrd spray: 14-12-2013.

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

Table 5. Leaf curl index (LCI) Score caused by thrips, *S. dorsalis* on capsicum under poly house conditions during 2013-14 and 2014-15

T.No	Treatments	Dose (g or ml ha^{-1})	Mean of three sprays 2013-14		Mean of three sprays 2014-15		Mean 2013-14 and 2014-15	
			1 DBS	10 DAS	1 DBS	10 DAS	1 DBS	10 DAS
T_1	Spinosad 45 SC	125	1.37(1.53)*	0.68(1.29)c	1.13(1.49)	0.33(1.15)b	1.25(1.50)	0.51(1.22)b
T_2	Flubendiamide 480 SC	200	2.65(1.91)	2.79(1.94)ab	2.21(1.79)	2.30(1.81)a	2.43(1.85)	2.55(1.88)a
T_3	Chlorantraniliprole 20 SC	200	2.56(1.88)	2.64(1.90)ab	2.25(1.50)	2.37(1.83)a	2.41(1.84)	2.51(1.87)a
T_4	Diafenthiuron 25 WP	750	1.77(1.66)	0.90(1.37)bc	1.60(1.61)	0.90(1.37)b	1.69(1.64)	0.90(1.37)b
T_5	Spiromesifen 22.9 SL	750	2.72(1.92)	2.88(1.97)a	2.30(1.81)	2.39(1.84)a	2.51(1.87)	2.64(1.90)a
T_6	Thiamethoxam 25 WG	150	1.93(1.71)	1.12(1.45)abc	1.71(1.64)	1.20(1.48)ab	1.82(1.67)	1.16(1.47)b
T_7	Triazophos 40 EC	1250	2.74(1.93)	2.97(1.99)a	2.31(1.81)	2.47(1.86)a	2.53(1.87)	2.72(1.92)a
T_8	Untreated check	--	2.95(1.94)	3.21(1.94)ab	2.47(1.80)	2.71(1.87)a	2.71(1.87)	2.96(1.94)a
		SEm±	0.52	0.72	0.10	0.15	0.11	0.10
		CD (P = 0.05)	NS	0.46	0.31	0.48	0.35	0.32
		CV (%)	12.11	9.62	14.60	12.60	12.60	13.73

* Figure in the parenthesis are square root transformed values.

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

DBS : Day Before Spray., DAS : Days After Spray., NS : Non significant

Table 5. Cumulative efficacy of certain insecticide molecules mite, *P. latus* on capsicum under poly house conditions during 2013-14 and 2014-15

S.No	Treatments	Dose (g or ml ha^{-1})	2013-14			2014-15			Mean of 2013-14 and 2014-15		
			Mean of three sprays			Mean of three sprays					
			Pre count (Mean no. of mites/ leaf) (1 DBS)#	Post count (Mean of 1,3,5,7 DAS)	Percent Reduction$	Pre count (Mean no. of mites/ leaf) (1 DBS)#	Post count (Mean of 1,3,5,7 DAS)	Percent Reduction$	Pre count (Mean no. of mites/ leaf) (1 DBS)#	Post count (Mean of 1,3,5,7 DAS)	Percent Reduction$
T_1	Spinosad 45 SC	125	12.76 (3.70)^{a}	13.24 (3.77)^{ab}	21.58 (27.66)^{d}	3.39 (2.09)^{a}	3.44 (2.10)^{a}	17.75 (24.90)^{d}	8.08 (3.01)^{ab}	8.34 (3.05)^{ab}	19.67 (26.31)^{d}

T_2	Flubendiamide 480 SC	200	12.73 (3.70)^{a}	13.05 (3.74)^{ab}	22.08 (28.01)^{d}	3.38 (2.09)^{a}	3.43 (2.10)^{a}	18.00 (25.09)^{d}	8.06 (3.01)^{ab}	8.24 (3.04)^{ab}	20.04 (26.58)^{d}
T_3	Chlorantraniliprole 20 SC	200	13.05 (3.74)^{a}	13.40 (3.79)^{ab}	20.32 (26.78)^{d}	3.38 (2.09)^{a}	3.44 (2.10)^{a}	17.90 (24.40)^{d}	8.22 (3.03)^{ab}	8.42 (3.06)^{ab}	19.11 (25.37)^{d}
T_4	Diafenthurion 25 WP	750	6.82 (3.79)^{a}	3.71 (2.17)^{d}	76.62 (61.05)^{b}	1.74 (1.65)^{ab}	0.71 (1.30)^{bc}	81.62 (64.58)^{b}	4.28 (2.29)^{cd}	2.21 (1.79)^{cd}	79.12 (62.78)^{b}
T_5	Spiromesifen 22.9 SL	750	4.21 (2.28)^{b}	0.12 (1.05)^{e}	99.10 (84.52)^{a}	1.10 (1.44)^{b}	0.00 (1.00)^{c}	100.00 (90.00)^{a}	2.66 (1.91)^{d}	0.06 (1.03)^{d}	99.55 (86.11)^{a}
T_6	Thiamethoxam 25 WG	150	10.71 (3.42)^{a}	9.66 (3.26)^{bc}	42.56 (39.94)^{c}	1.81 (1.67)^{ab}	0.95 (1.39)^{bc}	75.90 (60.57)^{b}	6.26 (2.69)^{abc}	5.30 (2.51)^{abc}	59.23 (50.29)^{c}
T_7	Triazophos 40 EC	1250	8.63 (3.10)^{ab}	5.55 (2.55)^{cd}	64.62 (53.47)^{b}	2.52 (1.87)^{ab}	1.82 (1.67)^{ab}	55.01 (47.85)^{c}	5.58 (2.56)^{bcd}	3.68 (2.07)^{bcd}	59.82 (50.64)^{c}
T_8	Untreated check	--	13.48 (3.62)^{a}	18.46 (4.30)^{a}	0.00^{e}	3.85 (2.16)^{a}	4.20 (2.20)^{a}	0.00^{e}	8.67 (2.99)^{a}	11.33 (3.51)^{a}	0.00^{e}
		SEm+	0.09	0.24	3.84	0.99	0.14	1.59	0.20	0.15	1.54
		CD (P= 0.05)	0.29	0.73	11.77	3.71	3.08	4.87	0.64	0.46	4.72
		CV (%)	15.26	13.52	16.56	0.29	0.43	16.53	13.48	10.43	16.51

#No.of mites/leaf, 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.
DBS : Days Before Spray., DAS : Days After Spray., NS : Non significant
Dos: Istspary: 21-12-2013; IInd spray 28-12-2013; IIIrdspray: 4-1-2014. DMRT : Means followed by a common letter are not significantly different (P= 0.05)

Table 6. Leaf curl index (LCI) Score caused by mite, *P. latus* on capsicum under poly house conditions during 2013-14 and 2014-15

T.No	Treatments	Dose (g or ml ha^{-1})	Mean of three sprays 2013-14			Mean of three spray 2014-15	Mean of 2013-14 and 2014-15	
			1 DBS	10 DAS	1 DBS	10 DAS	1 DBS	10 DAS
T_1	Spinosad 45 SC	125	1.90(1.70)*	2.06(1.74)a	1.35(1.53)	1.28(1.51)ab	1.63(1.62)	1.67(1.63)a
T_2	Flubendiamide 480 SC	200	1.93(1.71)	2.18(1.78)a	1.31(1.52)	1.32(1.52)ab	1.62(1.61)	1.75(1.65)a
T_3	Chlorantraniliprole 20 SC	200	2.01(1.73)	2.22(1.79)a	1.32(1.52)	1.29(1.51)ab	1.67(1.63)	1.76(1.66)a
T_4	Diafenthurion 25 WP	750	1.22(1.49)	0.60(1.26)b	0.60(1.26)	0.12(1.05)c	0.91(1.38)	0.36(1.16)b
T_5	Spiromesifen 22.9 SL	750	0.61(1.26)	0.00(1.00)b	0.52(1.26)	0.00(1.00)c	0.57(1.25)	0.00(1.00)b
T_6	Thiamethoxam 25 WG	150	2.41(1.84)	2.82(1.95)a	1.40(1.54)	1.36(1.53)ab	1.91(1.70)	2.09(1.75)a
T_7	Triazophos 40 EC	1250	1.31(1.52)	0.81(1.34)b	1.35(1.53)	1.04(1.42)b	1.33(1.52)	0.93(1.38)ab
T_8	Untreated check	---	2.33(1.76)	2.74(1.88)a	1.76(1.64)	1.92(1.69)a	2.05(1.67)	2.33(1.76)a
	SEm+		0.53	0.29	0.18	0.30	0.16	0.11
	CD		NS	0.91	NS	0.92	NS	0.36
	CV %		13.94	10.13	9.23	10.33	14.19	15.97

* Figure in the parenthesis are square root transformed values.
DMRT : Means followed by a common letter are not significantly different (P= 0.05)
DBS : Day Before Spray, DAS : Days After Spray, NS : Non significant

Table 7. Cumulative efficacy of certain insecticide molecules against aphid, *M. persicae* on capsicum under poly house conditions during 2013-14 and 2014-15

Tr.No	Treatments	Dose (g or ml.ha^{-1})	2013-14			2014-15			Mean of 2013-14 and 2014-15		
			Mean of three sprays#			Mean of three sprays#					
			Pre count (1 DBS)*	Post count (1,3,5,7 DAS mean)*	Per cent Reduction$	Pre count (1 DBS)*	Post count (1,3,5,7 DAS mean)*	Per cent Reduction$	Pre count (1 DBS)*	Post count (1,3,5,7 DAS mean)*	Per cent Reduction$
T_1	Spinosad 45 SC	125 ml	6.44 (2.72)bcd	7.31 (2.88)b	46.30 (42.86)c	5.37 (2.52)a	5.60 (2.56)a	34.09 (35.70)d	5.91 (2.62)abc	6.46 (2.73)b	40.20 (39.33)bc
T_2	Flubendiamide 480 SC	200 ml	7.05 (2.83)bc	6.93 (2.81)b	49.42 (44.65)bc	5.38 (2.52)a	5.63 (2.57)a	33.71 (35.47)d	6.22 (2.68)abc	6.28 (2.69)b	41.57 (40.13)bc
T_3	Chlorantraniliprole 20 SC	200 ml	5.64 (2.57)bcd	5.17 (2.48)b	62.11 (51.98)b	4.85 (2.41)a	4.92 (2.43)a	43.03 (40.97)c	5.25 (2.50)abc	5.05 (2.46)b	52.57 (46.45)b
T_4	Diafenthiuron 25 WP	750 g	3.69 (2.16)cd	2.03 (1.74)c	85.46 (67.55)a	1.87 (1.69)b	0.45 (1.20)b	93.73 (75.46)b	2.78 (1.94)bc	1.24 (1.49)c	89.60 (71.15)a
T_5	Spiromesifen 22.9 SL	750 ml	7.40 (2.89)ab	7.76 (2.96)b	43.78 (41.41)c	5.71 (2.59)a	6.06 (2.65)a	28.99 (32.56)d	6.56 (2.75)ab	6.91 (2.81)ab	36.39 (37.08)c
T_6	Thiamethoxam 25 WG	150 g	3.32 (2.07)d	1.86 (1.69)c	86.57 (68.47)a	1.63 (1.62)b	0.17 (1.08)b	97.63 (81.11)a	2.48 (1.86)c	1.02 (1.42)c	92.10 (73.64)a
T_7	Triazophos 40 EC	1250 ml	7.91 (2.98)ab	8.69 (3.11)b	36.65 (36.70)c	5.69 (2.58)a	6.07 (2.65)a	28.86 (32.25)d	6.80 (2.79)a	7.38 (2.89)ab	32.76 (34.12)c
T_8	Untreated check	---	12.36 (3.56)a	14.16 (3.81)a	0.00d	7.44 (2.80)a	8.59 (2.98)a	0.00e	9.90 (3.16)abc	11.38 (3.44)a	0.00d
		SEm$\pm$	0.20	0.18	2.52	0.18	0.21	4.00	0.23	0.18	2.62
		CD (P= 0.05)	0.62	0.58	7.73	0.56	0.64	1.30	0.70	0.55	8.02
		CV (%)	12.93	12.20	9.89	13.70	15.07	15.43	15.76	12.51	10.62

#No.of aphids/leaf, 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.

DBS : Days Before Spray., DAS : Days After Spray., NS : Non significant., DOS :Istspray: 11-1-2014: IInd Spray:17-1-2014: IIIrd spray: 21-1-2014.,

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

Table 8. Leaf curl index (LCI) Score caused aphids, *M. persicae* on capsicum under poly house conditions during 2013-14 and 2014-15

T.No	Treatments	Mean of three sprays 2013-14		Mean of three sprays 2014-15		Mean of 2013-14 and 2014-15	
		1 DBS	10 DAS	1 DBS	10 DAS	1 DBS	10 DAS
T_1	Spinosad 45 SC	2.18(1.78)*	2.23(1.79)abc	1.96(1.72)	2.06(1.74)ab	2.07(1.75)	2.15(1.77)ab
T_2	Flubendiamide 480 SC	2.19(1.78)	2.25(1.80)abc	1.99(1.72)	2.03(1.74)ab	2.09(1.75)	2.14(1.77)ab
T_3	Chlorantraniliprole 20 SC	1.63(1.62)	1.31(1.52)abc	1.92(1.70)	2.22(1.79)a	1.78(1.66)	1.77(1.66)ab
T_4	Diafenthiuron 25 WP	1.52(1.58)	1.17(1.47)bc	1.63(1.62)	1.13(1.45)ab	1.58(1.60)	1.15(1.46)ab
T_5	Spiromesifen 22.9 SL	2.22(1.79)	2.35(1.83)ab	1.97(1.72)	2.07(1.75)ab	2.10(1.76)	2.21(1.79)a
T_6	Thiamethoxam 25 WG	1.34(1.53)	0.94(1.39)c	1.53(1.59)	0.80(1.34)b	1.44(1.56)	0.87(1.36)b
T_7	Triazophos 40 EC	2.42(1.84)	2.56(1.88)ab	1.99(1.72)	2.03(1.74)ab	2.21(1.79)	2.30(1.81)a
T_8	Untreated check	2.50(1.81)	2.77(1.89)a	2.23(1.73)	2.37(1.77)a	2.37(1.77)	2.57(1.83)a
	SEm+	0.26	0.53	0.36	1.08	0.22	0.62
	CD	NS	1.58	NS	3.89	NS	1.88
	CV %	13.14	12.53	10.36	11.08	12.08	13.65

* Figure in the parenthesis are square root transformed values.

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

DBS : Day Before Spray., DAS : Days After Spray., NS : Non significant

Table 9. 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					

Table 10. Dissipation of spiromesifen in capsicum in poly house conditions

Days after spray	Residues of spiromesifen (mg kg^{-1})				Dissipation %
	R1	R2	R3	Average	
0	1.61	1.60	1.62	1.61	0.00
1	1.30	1.35	1.34	1.33	17.39
3	0.60	0.78	0.79	0.72	55.27
5	0.37	0.23	0.33	0.31	80.74
7	0.16	0.18	0.17	0.17	89.44
10	BDL	BDL	BDL	BDL	100.00
15	BDL	BDL	BDL	BDL	--
20	BDL	BDL	BDL	BDL	--
Regression equation	Y = 3.246 + (- 0.137)X				
R^2	0.973				
Half life	2.09 days				
Safe waiting period	10 days				

Table 11. Dissipation of thiamethoxam in capsicum in poly house conditions

Days after last spray	Residues of thiamethoxam (mg kg^{-1})				Dissipation %
	R1	R2	R3	Average	
0	2.77	2.79	2.76	2.77	0.00
1	2.01	2.04	2.06	2.04	26.35
3	1.75	1.77	1.72	1.75	36.82
5	0.88	0.81	0.83	0.84	69.67
7	0.42	0.40	0.44	0.42	84.83
10	0.09	0.07	0.08	0.08	97.11
15	BDL	BDL	BDL	BDL	100.00
20	BDL	BDL	BDL	BDL	--
Regression equation	Y = 3.444 + (- 0.095)X				
R^2	0.926				
Half-life	2.03 days				
Safe waiting period : 15 days					

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