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Impact of chemical insecticides against chilli thrips (*Scirtothrips dorsalis*) and cost benefit ratio in Allahabad: A review

Pushpendra Singh Sahu, Ashwani Kumar, Hadi Husain Khan and Huma Naz

Abstract
Efficacy of insecticidal management practices using different insecticides were tested against insect pests of chilli thrips (*Scirtothrips dorsalis*) and cost benefit ratio. Intensive cultivation of input responsive high yielding varieties and hybrids and sole reliance on insecticides are the common features of chilli cultivation in Guntur district in Andhra Pradesh. Sanap and Nawale investigated the efficacy of 9 insecticides against *Scirtothrips dorsalis* on chilli (*Capsicum annuum*) (cv. NP-46-A) in Maharashtra. Prasad evaluated the bioassayed against nymphs of *Scirtothrips dorsalis* representing populations from Guntur (GNT), Warangal (WGL) and Vizianagaram (VZM) in Andhra Pradesh, identified as areas of high, medium and low insecticidal use. Varghese and Mathew evaluated the bioefficacy of newer insecticides against the sucking pests of chilli and safety of these insecticides to natural enemy population in chilli ecosystem.

Keywords: insecticide, *Scirtothrips dorsalis*, chilli, pest

Introduction
Chilli (*Capsicum annum* L.) popularly known as 'mirch' in Hindi. It belongs to the family Solanaceae. Chilli is one of the important vegetable and commercial spice crops (Mondal *et al*., 2012) [14]. The red color of chillies is due to the presence of pigment 'Capsanthin' (Choudhary *et al*., 2009) [3] Guntur district in Andhra Pradesh is traditionally a chilli growing district with high input usage under monocropping conditions. Further, intensive cultivation of input responsive high yielding varieties and hybrids and sole reliance on insecticides are the common features of chilli cultivation in Guntur district. The excessive dependence on insecticides, their over use and abuse has accelerated insect control problems through development of insecticide resistance (Reddy *et al.* 1992) [21]. The important chilli growing states in India are Andhra Pradesh, Orissa, Maharashtra, Karnataka and also in a number of other states as a round the year crop. In Andhra Pradesh, chilli is cultivated in an area of 1.89 L hectares with a production of 2.08 L tons. Guntur district in Andhra Pradesh alone contributes to over 35% in the area under chilli crop in India.
Many conventional insecticides are being used to manage these pests with which many folds of resistance was reported in pests like *S. litura* (Prasad *et al*., 2008) [19], Spodoptera exigua (Hubner) (Wang *et al*., 2002) [35], H. armigera (Kranthi *et al*., 2002) [7] etc. The occurrence of insecticide resistance strains can be reduced or delayed by reducing the selection pressure and by adopting insecticide resistance management strategies and alternate insecticides with a novel mode of action. In view of the above constraints in chilli cultivation, it is felt high time to estimate the current status of insecticide resistance so as to corrologate with field control problems besides evaluating newer insecticides with novel mode of action both under laboratory and field conditions so as to have better option on hand that could mitigate the present control failures and residue problems plausing the farming community.

Effect of chemical insecticides against chilli thrips (*Scirtothrips dorsalis*) and cost benefit ratio
Sanap and Nawale (1987) investigated the efficacy of 9 insecticides against *Scirtothrips dorsalis* on chilli (*Capsicum annuum*) (cv. NP-46-A) in Maharashtra, India, in 1982. Four sprays of 0.015% permethrin or 0.05% monocrotophos given at 21-day intervals commencing 45 days after transplantation were the most effective treatments in reducing nymphal populations of the thrips for up to 15 days after application, and in giving the highest yields (864.9 and 837.6 kg/ha, resp).
Prasad *et al*. (1994) [20] evaluated the bioassayed against nymphs of *Scirtothrips dorsalis*

representing populations from Guntur (GNT), Warangal (WGL) and Vizianagaram (VZM) in Andhra Pradesh, identified as areas of high, medium and low insecticidal use. Results indicated that the VZM population of *S. dorsalis* was highly susceptible to all three pyrethroids followed by the WGL and G NT populations. In comparison with the most susceptible VZM population, development of resistance to fenvalerate, cypermethrinand alphamethrin [alpha-cypermethrin], resp., was 3.75, 4.55 and 4.10 times in the GNT population and 2.17, 2.64 and 2.0 times in the WGL population.

Kumar *et al.* (2001) [8] evaluated the bio-efficacy of triazophos (350 or 700 g/ha), acephate (1000 or 1500 g/ha), cypermethrin (150 and 300 g/ha) and imidacloprid (50 or 70 g/ha) against the major pest complex (aphids, *Myzus persicae*; thrips, *Scirtothrips dorsalis*; gram pod borer, *Helicoverpa armigera*; tobacco caterpillar, *Spodoptera litura*; and sunhemp hairy caterpillar, *Utetheisa pulchella*) of chilli (*Capsicum* spp.) in a field experiment conducted in Rajendranagar, Hyderabad, Andhra Pradesh, India during the kharif season of 1997-98. Imidacloprid (70 g/ha) was the best treatment in controlling aphids (99.76% reduction). Acephate (1500 g/ha) was the most effective in controlling thrips (87.22% reduction). Cypermethrin (300 g/ha) was generally the most effective insecticide against borers.

Santharam *et al.* (2003) [23] applied imidacloprid as seed treatment, root dip and foliar spray for the management of thrips on chillies. Seed treatment of imidacloprid 70 WS at 10, 20 and 30g kg-1 protected the seedlings in the nursery upto 45 days. The root dip of the seedlings before transplanting had no effect on the thrips population. Foliar treatment of imidacloprid 200 SL at 250, 375 and 500 ml ha-1 reduced the thrips population significantly and also recorded higher yield of chilli fruits. There was no phytotoxicity in the chilli plants due to the treatment of imidacloprid either as seed treatment, root dip or foliar application. Residue analysis in the chilli fruits collected in the first harvest (7 weeks after last foliar application) revealed that the residue was at below detectable limit.

Laskar and Ghosh (2005) [10] evaluated the efficacy of neem-based and chemical pesticides, alone or alternately with one another, against the thrips (*Scirtothrips dorsalis*) and mite (*Polyphagotarsonemus latus*) infesting chilli. It was observed that alternate application of neem based-chemical, acaricide and insecticide effectively and significantly reduced the pest population without giving them any chance to develop resistance. Minimum number of thrips and mite were found by alternate spraying of Triazophos 40EC (1.5 ml/l), Dicofol 18.5 EC (2.00 ml/l) and Neem Oil 300 ppm (2.5 ml/l), followed by Dicofol 18.5 EC (2.00 ml/l), Neem Oil 300 ppm (2.5 ml/l) and Cypermethrin 25EC (0.5 ml/l).

Singh *et al*. (2005) [29] evaluated the insecticides endosulfan 35EC, indoxacarb 15 SC, methomyl 40 SP, cypermethrin 10 EC, lindane 20 EC and imidacloprid 17.8 SL for their bioefficacy against the different insect pests of chilli (*Capsicum annuum*) cv. Pusa Sadabahar. The results showed that imidacloprid 17.8 SL at 200 ml/ha was the most effective against *Scirtothrips dorsalis* and *Aphis gossypii*, while indoxacarb 15 SC at 50 g ai/ha was most the effective against leaf feeders and fruit borers in chilli. The green chilli yield was highest from the plots applied with imidacloprid followed by plots applied with endosulfan. Both of these insecticides gave significantly higher green chilli yield than the other insecticides. It was observed that those insecticides which controlled sucking pests gave maximum yield of green chilli over the other treatments.

Mallapur and Lingappa (2005) [12] carried out field trials for three years (2000-01 to 2002-03) on the evaluation of indigenous materials against chilli pests at University of Agricultural Sciences, Dharwad. The results revealed that the least leaf curl index was observed in garlic chilli kerosene extract [GCK @ 0.5%] + nimbecidine against both thrips [0.4 LCI] and mites [0.8 LCI]. The next best treatments included turmeric + cow urine [25%] and GCK [1.0%] alone. The untreated plots recorded as high as 1.2 LCI for both the pests. These indigenous materials have also shown a moderate level of efficacy against the fruit borer [27 to 30% damage] as compared to insecticide applied plots [26% damage]. The highest pod yield was obtained in GCK + nimbecidine treatment [10.6q/ha] followed by insecticide application (9.6) and GCK alone. The other materials like nimbecidine alone, parthenium extract and cow urine alone registered their moderate efficacy against chilli pests.

Kadri and Goud (2006) [6] revealed that acetamiprid 20SP @ 0.2g/litre of water was highly effective in reducing the onion thrips population and also in recording highest bulb yield. Among the three neem products tested, they were inferior to all the insecticides molecules including the standard check, dimethoate.

Satpathy *et al.* (2006) [26] studied the efficacy of methomyl against chilli thrips, *Scirtorhrips dorsalis* (Hood) in the farmer's field during 2001-02 and 2002-2003 cropping season. On the basis of post-treatment thrips infestation and yield, application of methomyl @ 300 g ai / ha was found to be most effective compared to the check insecticide, dimethoate and untreated control. Relative infestation in treatments at different intervals after spray indicates that persistent effect is prolonged upto to days after spray. For management of chilli thrips methomyl may be applied @ 300 glha and accordingly the harvest intervals need to be determined on the basis of residue study.

Seal *et al.* (2006) [27] evaluated the efficacy of the following insecticides for their control of this pest *i.e.* spinosad, imidacloprid, chlorfenapyr, novaluron, abamectin, spiromesifen, cyfluthrin, methiocarb, and azadirachtin. Irrespective of the number of applications and use of surfactant, chlorfenapyr was the most effective in reducing the densities of *S. dorsalis* adults and larvae followed by spinosad and imidacloprid. The performance of other insecticides in controlling *S. dorsalis* populations was inconsistent. Nevertheless, all of the above insecticides if applied repeatedly were effective in suppressing of *S. dorsalis* populations. Addition of the surfactant-sticker, Nu-Film 17TM, improved the performance of all insecticides somewhat. Spinosad was slightly harmful and chlorfenapyr was moderately harmful to Cryptolaemus sp. predators.

Gundannavar *et al.* (2007) [4] revealed that among the IPM modules evaluated, M-I comprising organics and safer molecule of insecticide was the most effective module against aphids, thrips, mites and *H. armigera*. Higher chilli yield (5.13 q/ha) was observed in M-I (Marigold trap crop, vermicompost 2.5 t/ha + Neem cake 250kg/ha (without application of recommended dose of fertilizers, *i.e* RDF) superimposed with sprays of Neemazal @ 2 ml/l at 5 week after transplanting(WAT), Diafenthiuron @ 1g/l (8 WAT), profenofos@ 2 ml/l (11 WAT) and Neemazal@ 2ml/l at 14 WAT) followed by M-II (Marigold trap crop, neemcake 500 kg/ha + vermicompost 1.25 t/ha(without application of RDF) superimposed with sprays of NSKE @ 5%(5 WAT), vertimec

@ 0.5 ml/l(8 WAT), *T. chilonis* @ 1,00,000/ha(9 WAT), profenofos@ 2 ml/l(11 WAT) and NPV @250 LE/ha at14 WAT) and M-III (Neemcake 125 kg/ha + vermicompost 625 kg/ha at transplanting (TP) and at 50 DAT (50% N and 100% P&K) superimposed with sprays of Nimbecidine @ 5 ml/l (2 WAT), NSKE @ 5% (5 WAT), Nimbecidine @ 5 ml/l (7 WAT), NSKE @ 5% at 11WAT). Further, highest B:C ratio(5.72) was recorded by M-III followed by M-IV (100 per cent RDF, recommended plant protection (RPP)- two sprays of dimethoate (1.7 ml/l) at 2, 5 WAT and dicofol (2.5 ml/l) + carbaryl (4 g/l) at 7, 11 WAT) and M-I. M-III in comparison with M-I and M-II however appeared to be a quite promising strategy as it did not include any chemical interventions.

Tommasini and Ceredi (2007) [32] carried a study for the control of thrips infestation on nectarines for over a 3- year period in Emilia-Romagna Region (northern Italy). Thrips populations on sprouts were monitored starting from May up until the harvest in July. Over the last two years thrips populations were also sampled on fruit during the harvest. A significant correlation between the density of thrips populations on fruits and fruit damage was found. The thrips species recorded was *Frankliniella occidentalis* (Pergande), along with a variable percentage (0-55%) of other *Thrips* spp. over the 3-year period.A total of five pesticides were evaluated (Acrinathrin, Chlorpyriphos-methyl, Ethofenprox, Phosmet and Spinosad). Acrinathrin and Spinosad proved to be most effective against thrips, particularly when a high relative abundance of thrips was present.

Larral and Ripa (2007) [9] treated the foliage was treated with commercial dosages of: thiamethoxam (Actara 25 WG), mineral oil (Citroliv miscible), imidacloprid (Confidor Forte 200 SL), Thiacloprid (Calipso 480 SC), Spinosad (Success 48), abamectin+mineral oil (Vertimec+Citroliv miscible) and metomil (Lannate 90), the irrigation system was applied with thiamethoxam and a control was maintained with no spraying. Each treatment was replicated 4 times and greenhouse thrips were evaluated in 5 occasions, 1 previous and 4 post spraying. The neonicotinoids showed an effective control of the pest, achieving a nondetection level at the end of the evaluation period. Thiametoxam was likewise effective in both foliar and irrigation system applications. Metomil initially demonstrated (7 days) a significantly greater effect than the other treatments. Spinosad and mineral oil reduced the population of greenhouse thrips in the leaf, but they did not avoid the colonization of the fruit that was damaged to a level comparable to the control.

Mahalingappa *et al*. (2008) [11] bio-efficacy of certain insecticides were studied against chilli thrips and mite. The results indicated that fipronil 0.01 and triazophos 0.08 per cent were most effective against thrips in chillies, which were followed by profenofos 0.10, ethion 0.10 and cypermethrin 0.0012 per cent. Chlorpyriphos 0.0012 per cent was least effective against thrips. Profenofos 0.10 per cent was most effective against mite. The next best treatments were triazophos 0, 08 and ethion 0.1 per cent Cypermethrin 0.0012 was least effective against mite.

Bhede *et al.* (2008) [2] studied the population dynamics and bioefficacy of newer insecticide against chilli *thrips*, *Scirtothrips dorsalis* (Hood) at Vegetable Research Station, MAU, Parbhani during *kharif 2002-03.* The incidence of thrips was highest during 40th meteorological week when the prevailing maximum minimum temperatures, morning-evening relative humidities, rainfall and bright sunshine hours were 35.8°C, 18.0°C, 76%, 34%, 0.00 mm and 11 hrs., respectively. Thrips population exhibited significant negative correlation with evening relative humidity and rainfall and positive correlation with bright sunshine hours. Regression equations worked out indicated that the population decreased by 0.03, 0.04 and increased by 0.303 per unit of evening relative humidity, rainfall and bright sunshine hours, respectively. Application of phosphamidon 40% + imidacloprid 2% SP @ 700 g/ha was most effective for suppression of thrips population and also increased the yield of green chilli.

Shankar *et al.* (2008) [28] conducted a field experiment during different season of 2006 and 2007, in order to evaluate the efficacy of certain insecticides molecules against chilli thrips. Besides, sucking the sap, thrips are responsible to cause leaf curl viral diseases in chilli and thus inflicting considerable losses in its yield and marketable value. It was observed that during both the years, acephate and profenophos 50 EC were effective in reducing the population of chilli thrips compared to their treatment.

Mandi and Senapati (2009) [13] revealed that acetamiprid and thiamithoxam were most effective to minimize the thrips population 93.3% and 89.93% respectively. Neem pesticide (54.2%) and microbial pesticide BT (43.43%) were found moderately effective. However, two sprays of acetamiprid and thiamethoxam followed by two sprays of neem pesticide and BT proved to be effective for management of thrips and it gave highest marketable yield, higher cost benefit ratio and percent reduction in thrips population.

Patel *et al.* (2009) [17] revealed that among the different insecticidal treatments, ethion + cypermethrin (0.045%), methomyl (0.04%) and diafenthiuron (0.05%) proved to be the most effective treatments followed by imidacloprid (0.005%), lufenuron (0.005%) and triazophos (0.04%), whereas both the botanical formulations viz., azadirachtin (0.00075%) and Neem Seed Kernel Suspension (5%) were found to be least effective against the pest. The plots treated with diafenthiuron registered highest (115.75 q/ha) yield which was followed by methomyl (104.67q/ha). The treatments of imidacloprid, lufenuron and triazophos produced satisfactory yield ranging from 69.66 to 82.30 q/ha. Economics of different treatments showed that appreciable Incremental Cost Benefit Ratio (ICBR) were obtained in case of ethion + cypermethrin (1:19.46), methomyl (1:15.18), imidacloprid (1:15.07) and triazophos (1:14).

Reddy and Sreehari (2009) [8] studied the bio efficacy and phytotoxicity of new formulation along with other insecticides against thrips in chilli in three replications. Treatments include the spraying of new formulation Fipronil 80 WG in three doses *i.e.* Fipronil 80 WG @ 30 g a.i/ha, Fipronil 80 WG @ 40 g a.i/ ha, Fipronil 80 WG @ 50 g a.i/ha and Fipronil (Regent) 5% SC @ 40 g a.i/ha, Acephate 75% SP @ 468.75 g a.i/ha, Imidacloprid (confidor) 200 SL @ 30g a.i/ha and untreated control. The results revealed that the Fipronil 80 WG @ 50 g a.i/ha recorded lowest number of thrips and is on par with Fipronil 80 WG @ 40 g a.ilha, Regent 5% SC @ 40g a.i/ha and Acephate 75% sp @ 468.75 g a.i/ha, whereas Confidor 200 SL and foipronil 80 WG @ 30g a.i/ha were found least effective against thrips. None of the treatments had shown any phytotoxicity symptoms on chilli crop.

Moorthy *et al.* (2013) [15] conducted a field experiments at Indian Institute of Horticultural Research, Bengaluru, India to study the bio-efficacy of neem seed powder extract (NSPE) (4%), neem soap (NS) (1%), essential oils of Basil or Tulsi (*Ocimum tenuiflorum* syn. *O. sanctum*), (0.2%) and scented *Geranium*, (*Pelargonium graveolens*), (0.2%) along with

commonly used synthetic insecticides *viz.,* dimethoate (0.06%), acephate (0.075%) and fipronil (0.05%) against onion thrips, *Thrips tabaci* Lind. during summer 2011 and 2012. All the treatments of botanicals, essential oils and insecticides significantly reduced thrips incidence during both the seasons. Fipronil was the most effective treatment in reducing thrips and also in increasing yield during both the seasons. However, *Basil* was at par with fipronil in reducing pest incidence and increasing yield. The NS and NSPE also reduced thrips incidence and were at par with acephate and dimethoate. When yields were considered, plots treated with NSPE, NS, *Basil* and *Geranium* and dimethoate were at par during both seasons. This study clearly illustrated that neem products and essential oils can be used as components of thrips IPM.

Sarkar *et al.* (2013) [25] evaluvated the selectivity of chlorfenapyr 10SC, for two consecutive years *i.e.* 2009-2010 and 2010-2011 in a farmer's field (8.75m above msl) at Gangetic Alluvial plains of West Bengal@ 50, 75, 100 and 125 g a.i. ha-1 along with recommended check fenazaquin 10 EC (@ 100 g a.i. ha-1) and imidacloprid 17.8 SL (@ 20 g a.i). On the basis of post treatment on mite and thrips population, chlorfenapyr @ 100 and 125 g a.i. ha-1 were found to be most effective against the pests. There was significantly less infestation at both the stated concentration (100 and 125 g a.i. ha-1) up to 15 days after treatment. It was also found to be "moderately toxic" to beneficials in chilli including different coleopteran beetles. The molecule did not produce any phytotoxic symptom in chilli.

Vanisree *et al.* (2013) [33] conducted the field experiment during *Kharif* 2008-09 and 2009-10 for evaluating certain new insecticides and indicated that spinosad 0.015 per cent was found to be most effective in reducing the population of *S. dorsalis* as well as in increasing yields. It attains highest cost benefit ratio followed by diafenthiuron 0.045%, pymetrozine 0.02% and fipronil 0.01%. Indoxacarb 0.015 % and flubendiamide 0.012 %. Further flubendiamide recorded the lowest mean per cent reduction over untreated check indicating their poor efficacy against *S. dorsalis* on chillies.

Varghese and Mathew (2013) [34] evaluated the bioefficacy of newer insecticides against the sucking pests of chilli and safety of these insecticides to natural enemy population in chilli ecosystem. Spiromesifen 45 SC at 100 g a.i. ha-1 and propargite 57 EC at 570 g a.i. ha-1 were found to be effective in reducing chilli mite population whereas acetamiprid 20 SP at 20 g a.i. ha-1 along with spiromesifen were found to be effective against chilli thrips. The leaf curling symptom due to the feeding of mites and thrips was least in spiromesifen, propargite and acetamiprid sprayed plants. Spiromesifen was found to be the safest insecticide against natural enemies *viz.* Predatory mites, coccinellid beetles, spiders and neutral insects whereas the organophosphate insecticide dimethoate 30 EC 300 g a.i. ha-1 was found to be unsafe to natural enemies.

Almeida (2013) [1] conducted the field experiment during *Kharif* 2008-09 and 2009-10 for evaluating certain new insecticides indicated that, spinosad 0.015 per cent was found most effective in reducing the population of S. dorsalis as well as in increasing yields. It attains highest cost benefit ratio followed by diafenthiuron 0.045%, pymetrozine 0.02% and fipronil 0.01%. Indoxacarb 0.015 % and flubendiamide 0.012 %. Further flubendiamide recorded the lowest mean per cent reduction over untreated check indicating their poor efficacy against S. dorsalis on chilies.

Hossain *et al.* (2014) [5] reported that alternate spraying of Biopesticide- Spinosad (Tracer 45SC) @ 0.4ml/litre of water and Bioneem (Azadiractin 3EC) @ 2ml/litre of water offered the lowest thrips population (1.92 thrips/ plant and 2.65 thrips /umbel). The highest percentage of thrips population (86.37% in plant and 73.76% in umbel) reduction over control was also obtained from alternate spraying of Biopesticide- Spinosad and Bioneem (Azadiractin 3EC) treated plot followed by Bioneem (Azadiractin 3EC) + White sticky trap treated plot (73.88% and 57.82%). The highest onion seed yield (383.3 kg/ha) and marginal benefit cost ratio (9.55) was also obtained from alternate spraying of Biopesticide- Spinosad and Bioneem (Azadiractin 3EC) treated plot. So, alternate spraying of Biopesticide-Spinosad and Bioneem (Azadiractin 3EC) may be recommended for effective management of thrips in seed onion production.

Sontakke and Mohapatra (2014) [30] evaluvated the two dosages of buprofezin 25 SC *viz.,* 75 g a.i / ha and 150 g a.i. / ha, along with its market samples and treated checks *i.e.*, ethion (225 g a.i./ha) and profenofos (500 g a.i./ha) against mixed population of thrips, S*cirtothrips dorsalis* (Hood) and yellow mite, *Polyphagotarsonemus latus* (Banks) infesting chilli at the Central Farm of Orissa University of Agriculture and Technology, Bhubaneswar during *kharif*2009 and 2010. Buprofezin 25 SC in both the doses (75 and 150 g a.i./ha) was the most effective in checking both thrips and mite. Buprofezin 25 SC in any formulation and even in higher doses was safe to the natural enemies.

Tatagar *et al.* (2014) [31] carried afield experiments during *Kharif* 2007 and 2008 at the Horticulture Research Station, Devihosur, Haveri, Karnataka to find out the bio efficacy of Flubendiamide 24% +Thiacloprid 24% -48% SC against chilli thrips. Different dosages of Flubendiamide 24% + Thiacloprid 24 -48% SC *viz.,* @ 36 + 36, 48 + 48 and 60 + 60 g a.i./ha, were evaluated along with comparative checks. Raised nursery seed beds were prepared with the variety Byadagidabbi. Thirty five days old seedlings were transplanted to main field. Among different dosages, Flubendiamide 24% + Thiacloprid 24% -48% SC @ 48 + 48 g a.i./ha recorded least number of thrips and least leaf curl damage of 0.46 LCI/plant which was significantly superior to comparative checks and recommended insecticide, Profenofos 50 EC @ 500 g a.i./ha and equally good as that of its higher dosage. The dry chilli yield was also better in Flubendiamide 24% + Thiacloprid 24% -48% SC @ 48 + 48 g a.i./ha (7.18 q/ha), which was equally good to its higher dosage and significantly superior to comparative checks and standard check of Profenofos 50 EC @ 500 g a.i/ha (5.77 q/ha)

Naik *et al.* (2015) [16] reported that Abamectin 0.002 per cent, Malathion 0.04 per cent and Dimethoate 0.05 were equally effective in controlling the thrips on green chilli. However, there was variation in the incremental cost benefit ratio among them.

Prabhu *et al.* (2015) [18] evaluated insecticide *i.e.* imidacloprid 17.8% SL during *rabi* and in summer season of 2011 and 2012 against chilli thrips at Agricultural Research Station, Hanumanamatti, Karnataka. The test chemical, imidacloprid 17.8% SL has been found significantly effective for the management of chilli thrips at an appropriate dose of 50 g ai. per ha or 250 ml of formulated product per ha. This treatment recorded 25.07 per cent increase in the green chilli yield with a reduction of 70.47 per cent thrips damage over the untreated control. Management of chilli thrips with this insecticide has recorded significantly lower insect damage and highest grain yield. Hence, the Imidacloprid 17.8% SL may be used for the

management of chilli thrips at a dose of 250 ml of formulated product per ha.

Sarkar *et al*. (2015) [24] evaluated the bio-efficacy of pre-mix insecticide fipronil 15% + emamectin benzoate 5% WDG along with traditional insecticides as foliar spray against chilli thrips, *Scirtothrips dorsalis* and fruit borer, *Helicoverpa armigera* was undertaken at District seed farm (AB block) of BCKV, located at Kalyani, West Bengal and in a farmer's field at Kakdwip (24 Parganas South), West Bengal respectively under irrigated conditions with a HYV chilli cultivar "*Bullet*". The treatment at higher dosages (500, 750 and 1000 ml/ ha) followed by lower dose 400 ml/ha was superior over standard check treatments fipronil 5% SC and emamectin benzoate 5% SG. The highest yield was obtained in case of higher dosages (16.15-18.00 q/ ha). The survival of thrips was minimum in treatments with high dosages with mean ranging from 2.25- 2.87 number of thrips/leaf. It was relatively safe to important natural enemies like *Menochilus* sp. and *Coccinella* sp.

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