**Evaluating efficacy of Novel Insecticides against *Thrips tabaci,* under High Density Planting System on Cotton**

**ABSTRACT**

Background: novel insecticides are the most effective against all stages of sucking pests like aphids, whiteflies, scale insects, thrips and mealybugs. The compatibility of Fipronil commonly used insecticides along with newer insecticides was investigated in this study. Aim: To study the compatibility and toxicity of certain newer insecticides against cottonthrips. Study Design: Randomized Block Design. Methodology: Six different insecticides were evaluated along with untreated control conditions against thrips. The results showed that insecticides, viz., Isocycloseram 9.2% DC, Cyantriniprole 10.6%OD, Chlorfenapyr 240 SC, Flonicamid 50 WG, Tolfenpyrad 15% EC and Fipronil 5% SC against thrips in cotton ecosystem along with these untreated control. . Highest reduction in thrips was recorded with Isocycloseram 9.2% DC with 88.3 per cent reduction of thrips, followed by Fipronil 5% SC with 80.3 per cent and Flonicamid 50 WG with 75.9 per cent and lowest reduction was recorded in Tolfenpyrad 15% EC with 52.7 per cent reduction of thrips after 10 days of all 2 sprayings respectively Conclusion: This study suggests that the most suitable insecticides . Among all the insecticides Isocycloseram 9.2% DC, Fipronil 5% SC and Flonicamid 50 WG are demonstrated to viable in overseeing thrips of cotton in HDPS integrated into pest management programs.

**Key words**: High Density Planting System,Thrips, Insecticides, Efficacy, Cotton, Benefit-cost ratio.

**Introduction**

Cotton holds a coveted role as a major fiber commodity both domestically and internationally. Cotton is regarded as the **"King of Fiber"** and **"White Gold"** because of its **versatility, wide industrial use, economic importance**, and its role as a **major cash crop** that supports the livelihoods of millions from farmers to textile workers especially in countries like India. Cotton, seed-hair fibre of several species of plants of the genus *Gossypium*, belonging to family (Malvaceae). The most important natural fiber crop in the world and the foundation of the global textile industry is farmed cotton (*Gossypium* spp.). Cotton still holds a prominent position in the textile business despite numerous competitors from synthetic fibers. Cotton provides millions of farmers and labourers with a means of livelihood and supports India's cotton textile sector, which produces more than a thousand crore rupees worth of cloth annually (Mayee *et* *al.*, 2004). It is grown in India, in an area of 123.42 lakh hectares with \_production and- productivity. In India, 12687.64 lakh hectares are used for cotton cultivation with production of 32522.02 lakh bales and productivity of 436 kg ha-1 (INDIASTATS 2023-24). Among the several other factors affecting the yield loss of crop, damage by the pest insect pest is considered the one of the major factor causing the sustainable yield loss under field condition. Cotton was infested by 162 species of arthropod pests plant during vegetative and reproductive stages out of which about 12 species are important in India. Generally, cotton insect pests are divided into two categories based on feeding activities i.e., sucking pests and chewing pests. (Nadeem *et al*., 2021). The borers are considered as the main threat to the cotton crop until the introduction of *Bt* cotton, this threat has been shifted to sucking insect pests, especially Aphids (*Aphis gossypii* Glover), leafhoppers (*Amrasca* *biguttula biguttula* Ishida), thrips (*Thrips tabaci* Linn) and whiteflies (*Bemisia tabaci* Gennadius) are among the sap feeders that seriously harm crops. Estimated monetary value of crop losses resulting from insect pests was Rs. 33,966 crores (Srivastava & Dhaliwal 2010). Among sucking pest thrips alone reduce cotton output by 39–50 percent ( Kranthi ,2008). Among these sucking pests, the increased incidence of thrips, noted in recent years. A minor pest, (*Thrips tabaci* Lin), has become a serious pest on *Bt* cotton in India (Sarode *et al.,* 2009). Thrips are generally one of the main early season cotton pests. Thrips are having a wide range of host. Nymphs and adults suck the sap from upper and lower surfaces of the leaves. Margins of affected leaves get slightly curled up and the leaf blades show uneven surface. When the insect attacks in flowering stage, the affected flowers may wither away. Thrips infested fields show rusty appearance from a distance (Sahu and Samal 2020). In extreme cases, around 30-50 percent of lint yield loss has been reported (Cook *et al.,* 2011). The world record indicates the occurrence of 6312 species (ThripsWiki, 2021). Over 1,000 plant species comprising crops, ornamental plants, weeds, shrubs, and trees (Tillekaratne *et al*.,2012) Several species of thrips are known to infest cotton. . In addition to directly harming the crop, they can also act as important vectors of viral diseases. Cotton mosaic disease caused by Tobacco Streak Virus (TSV) is causing concern to the cotton farmers. TSV was reported to be transmitted by different thrips species in various crops (Cook *et al.,* 2003). Thrips have been successfully managed using a number of conventional insecticides. There are a lot of opportunities to handle different pests by applying newer compounds from new pesticide groups with distinct modes of action like **Isocycloseram 9.2% DC** Acts as a Neurotransmission disruptor insecticide. **Cyantraniliprole 10.6% OD** as a **ryanodine receptor modulator** and leads to paralysis. **Chlorfenapyr 240 SC** Disrupts mitochondrial oxidative phosphorylation, causing energy depletion and insect mortality.. **Flonicamid 50 WG** Feeding behavior inhibitor. **Tolfenpyrad 15% EC** Acts on the **mitochondrial electron transport chain**, inhibiting ATP production. **Fipronil 5% SC** Blocks **GABA-gated chloride channels**, resulting in hyperexcitation of the insect nervous system. The majority of modern pesticides are less persistent, have great target specificity, pose little risk to non-target creatures, and are ecologically safe.

**Matierials and methods:**

Field trials was conducted during *kharif*, 2024 at Siddhapur farm of Regional Agricultural Research Station RARS, Warangal to evaluate the efficacy of newer insecticide for the management of thrips. The experiment was laid out in a Randomized Block Design with seven treatments including the untreated control and replicated thrice. The plot size was 5m × 5m with spacing of 90cm between the rows and 15cm between plants. The hybrid RCH 971 was selected for study and sowing was done on 30th July 2024. All the recommended agronomic package of practices were adopted in the managing the crop to maintain a good crop stand. The insecticides were applied according to recommended dose prescribed on the label and they were applied when the pest population crossed the economic threshold level. The insecticides with novel mode of action *viz.,*Isocycloseram 9.2% DC, Cyantriniprole 10.6% OD,Chlorfenapyr 240 SC, Flonicamid 50 WG, Tolfenpyrad 15% EC and Fipronil 5% SC were tested for their efficacy. The data on population of thrips was recorded from randomly selected 3 leaves (1 upper 1 medium 1 lower) from randomly selected five plants per plot and replication wise at pre treatment and 1,3,5,7 and 10 days after first and second application.

**Statistical Analysis**

The data which we obtained was then analysed per cent reduction of thrips population over control was analysed by using standard statistical methods (OPSTAT software) RBD design used and effect of treatments on thrips was recorded.

**Results and discussion**

Population data on thrips following initial insecticidal treatment and spraying The lowest population was recorded by Fipronil 5% SC (13.40), followed by Isocycloseram 9.2% DC (13.50), Flonicamid 50 WG (14.90), Cyantriniprole 10.6%OD (15.60), Chlorfenapyr 240 SC (16.10), and Tolfenpyrad 15% EC (16.20). At one day after spray, all of these treatments are on par with each other and significantly differ from the untreated control (18.23).In comparison to Fipronil 5% SC (8.63), Flonicamid 50 WG (8.80), Chlorfenapyr 240 SC (9.20), and Cyantraniliprole 10.6% OD (10.16), Isocycloseram 9.2% DC had the lowest thrips population (7.93) at 3 DAS. Tolfenpyrsad 15% EC was the moderately successful treatment (11.17). When compared to the untreated control, (18.67). All insecticidal treatments considerably decreased the number of thrips The lowest thrips population was seen at 5 DAS with Fipronil 5% SC (5.20), followed by Isocycloseram 9.2% DC (5.45), and Cyantraniliprole 10.6% OD (7.03); the efficacy of these treatments was statistically comparable. The next best treatments were Tolfenpyrad 15% EC (9.13), Chlorfenapyr 240 SC (8.37), and Flonicamid 50 WG (7.90), all of which were comparable to one another. At 7DAS same trend followed. At 10 DAS revealed that Isocycloseram 9.2% DC (2.76), which was statistically equivalent to Fipronil 5% SC (3.87), was still the most efficacious treatment. Chlorfenapyr 240 SC (6.60) and Tolfenpyrad 15% EC (7.53) were the next most effective, followed by Flonicamid 50 WG (3.87) and Cyantraniliprole 10.6% OD (4.87).In terms of thrips population reduction, all treatments performed noticeably better than the untreated control (15.03).Isocycloseram 9.2% DC had the largest percentage reduction (81.5%) when compared to the untreated control. Fipronil 5% SC (74.2%), Flonicamid 50 WG (68.7%), Cyantraniliprole 10.6% OD (67.6%), Chlorfenapyr 240 SC (56.1%), and Tolfenpyrad 15% EC (49.9%) were next in line.

Data following the second insecticidal spray showed that plants treated with Flonicamid 50 WG had the lowest incidence of thrips (4.96), followed by plants treated with Isocycloseram 9.2% DC (5.06), Fipronil 5% SC (5.40), Cyantriniprole 10.6% OD (6.06), and Chlorfenapyr 240 SC (6.80). These treatments were comparable in their ability to control the thrips population at 1 DAS. There was a substantial difference between the untreated control (14.33) and all of the insecticidal treatments. Isocycloseram 9.2% DC (3.70) was the best treatment, according to the 3DAS observations, followed by Fipronil 5% SC (5.03) and Flonicamid 50 WG (5.86). a similar trend was followed by 5 and 7 DAS spray. According to the results from 10 DAS Isocycloseram 9.2% DC (1.33) was the best treatment, followed by Fipronil 5% SC (2.23) and Flonicamid 50 WG (2.73) and theses treatments are on par with each other. The next best treatments Cyantriniprole 10.6%OD (3.43), Chlorfenapyr 240 SC (4.10), and Tolfenpyrad 15% EC (5.36) When it came to controlling the thrips population in cotton, all of the insecticidal treatments differed considerably from the untreated control (11.36). Isocycloseram 9.2% DC had the largest percentage reduction (88.3%) when compared to the untreated control. Fipronil 5% SC (80.3%), Flonicamid 50 WG (75.9%), Cyantraniliprole 10.6% OD (69.8%), Chlorfenapyr 240 SC (63.9%), and Tolfenpyrad 15% EC (52.7%) were next in line.The efficacy of different insecticidal treatments against per cent reduction of thrips population over untreated control after second spray was found to be in the following order.

 T1>T6>T4>T2>T3>T5>T7

The present findings are in accordance with (Bryant 2024: Pin and Brian, 2023; John, 2022)., who reported that Isocycloseram 9.2% DC significantly reduced the thrips population when compared to other insecticidal treatments It is due to having the plinazolin technology with a novel mode of action. According to Rajashekar et al. (2018), Sathyan et al. (2016), Kumar et al. (2012), and Patil et al. (2009), Fipronil 5% SC was very successful in lowering thrips populations in a variety of cropping systems. These results are in line with those of these studies. Its significant efficacy was demonstrated by Sathyan et al. (2016), who obtained an 83.06% mean reduction over the control.Similarly, the efficacy of Flonicamid 50 WG discovered in this study is consistent with results from China Babu et al. (2017) and Meghana et al. (2018), who found it to be more successful at decreasing thrips populations. Cyantraniliprole 10.6% OD and Flonicamid 50 WG both provided moderate thrip control, according to Srivastava et al. (2014), making them appropriate choices for Integrated Pest Management (IPM) techniques.

The results revealed that all the insecticidal treatments recorded significantly higher cotton yield over untreated control (1263 kg ha-1). Among all the insecticidal Isocycloseram 9.2% DC recorded higher yield (2004 kg ha-1) followed by Fipronil 5% SC (1820 kg ha-1), Flonicamid 50 WG (1750kg ha-1) and Cyantriniprole 10.6%OD (174kg ha-1) and these treatments were on par with each other. The other treatments Chlorfenapyr 240 SC and Tolfenpyrad 15% EC recorded 1516 kg ha-1 and 1496 kg ha-1 Seed cotton yield, respectively. Regarding the benefit cost ratio of different treatments, maximum benefit was from Fipronil 5% SC recorded the highest benefit cost ratio of 5.90:1 followed by Flonicamid 50 WG (5.56:1), Isocycloseram 9.2% DC(4.46:1), Chlorfenapyr 240 SC (3.25:1), Cyantriniprole 10.6%OD (2.05:1) and the least was 1.76:1 in Tolfenpyrad 15% EC.

According to Patil et al. (2009), Fipronil 5% SC at 800 g/ha produced the lowest thrips population (8.47 per 3 leaves) in cotton and outperformed other treatments, yielding 27.23 q/ha in 2007 and 27.50 q/ha in 2008. These results are consistent with their findings. According to Radhika et al. (2018), blackgram sucking pests were successfully controlled by spraying Fipronil 5% SC at weekly intervals at a rate of 50 g a.i./ha. This resulted in a yield saving of 269 kg/ha and an unnecessary yield loss of 26.16%. Shivaramakrishna and Rama Reddy (2020) corroborate these findings by stating that Flonicamid, a more recent insecticide, efficiently suppresses sucking bugs and increases cotton output.

**Conclusion:**

The most successful treatments for cotton thrip infestations in this study were Isocycloseram 9.2% DC, Fipronil 5% SC, and Flonicamid 50 WG. Given their shown effectiveness, financial feasibility, and potential to increase cotton seed output, these insecticides can be suggested for the control of thrips in High-Density Planting Systems (HDPS). Their application enhanced plant health and yield in addition to significantly reducing the thrips population. Furthermore, during the observation periods, these treatments outperformed the untreated control statistically. These insecticides can guarantee effective and long-lasting pest control when used in conjunction with an Integrated Pest Management (IPM) strategy.

**Abbreviations:** DC: Dispersible Concentrate, OD: Oil Dispersion , SC: Suspension Concentrate , WG: Water-dispersible granules ,EC: Emulsifiable Concentrate.

**Disclaimer (Artificial Intelligence)**

Author(s) hereby declare that NO AI technologies such as large language models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript. All the matter that have in the manuscript written and reviewed by the authors.

**Conflict of interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. All authors contributed significantly to the work reported in this paper. The study, designed the work, reviewed and edited the manuscript [Author 1 Hemalatha ] was involved in the conceptualization, methodology, and original draft preparation. [Author 2 and 3 S Omprakash& K Vijayalakshmi ] contributed to data curation, formal analysis, and validation. [Author 4 V.Ramya] participated in the review and editing of the manuscript and provided supervision. All authors have read and approved the final version of the manuscript.

 **Table 1: Efficacy of insecticides against cotton thrips, *Thrips tabaci* after first spray during *kharif*, 2024**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Dosage****(g or ml l-1)** | **Thrips population (No./3leaves)** | **Per cent population reduction over control** |
| **Pre count****(DBS)** | **1 DAS** | **3 DAS** | **5 DAS** | **7 DAS** | **10 DAS** |
| T1:Isocycloseram9.2% DC | 1.2 ml | 18.47(4.40) | 13.50(3.80)a | 7.93(2.98)a | 5.45(2.53)a | 3.63(2.14)a | 2.76(1.92)a | 81.6 |
| T2:Cyantriniprole 10.6%OD  | 1.4 ml | 22.27(4.82) | 15.60(4.06)ab | 10.16(3.33)ab | 7.03(2.83)ab | 6.93(2.81)bc | 4.87(2.41)bc | 67.6 |
| T3:Chlorfenapyr 240% SC | 0.85 ml | 20.60(4.64) | 16.10(4.13)ab | 9.20(3.19)ab | 8.37(3.06)b | 7.40(2.89)bc | 6.60(2.75)cd | 56.1 |
| T4:Flonicamid 50% WG | 0.3 g | 19.00(4.47) | 14.90(3.98)ab | 8.80(3.12)ab | 7.90(2.96)b | 5.93(2.63)b | 4.70(2.38)bc | 68.7 |
| T5:Tolfenpyrad 15% EC | 2 ml | 20.57(4.64) | 16.20(4.14)ab | 11.17(3.47)b | 9.13(3.17)b | 7.90(2.97)c | 7.53(2.91)d | 49.9 |
| T6:Fipronil 5% SC | 2 ml | 19.47(4.51) | 13.40(3.79)a | 8.63(3.09)a | 5.20(2.48)a | 3.60(2.13)a | 3.87(2.18)ab | 74.2 |
| T7:Untreated control | - | 18.23(4.38) | 18.30(4.38)b | 18.67(4.43)c | 18.13(4.37)c | 15.33(4.03)c | 15.03(4.004)e | - |
| SEm(±) |  | 0.13 | 0.11 | 0.11 | 0.12 | 0.10 | 0.12 | - |
| CD (p=0.05) |  | NS | 0.37 | 0.35 | 0.38 | 0.32 | 0.40 | - |
| CV(%) |  | 5.11 | 5.10 | 5.78 | 7.05 | 6.36 | 8.44 | - |

Note: Figures in parenthesis are square root transformed values; **DBS-** Day Before Spray; **DAS**- Day After Spray**; NS**- Non-Significant

Ranking of treatments was done using Duncan’s Multiple Range Test (DMRT) at 5% significance level (p=0.05) )

**Table 2: Efficacy of insecticides against cotton thrips, *Thrips tabaci* after second spray during *kharif*, 2024**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Dosage****(g or ml l-1)** | **Thrips population (No./3leaves)** | **Per cent population reduction over control** |
| **Pre count****(DBS)** | **1 DAS** | **3 DAS** | **5 DAS** | **7 DAS** | **10 DAS** |
| T1:Isocycloseram9.2% DC | 1.2 ml | 6.26(2.68)ab | 5.06(2.46)a | 3.70(2.16)a | 3.30(2.06)a | 2.16(1.77)a | 1.33(1.63)a | 88.3 |
| T2:Cyantriniprole 10.6%OD  | 1.4 ml | 7.37(2.88)ab | 6.06(2.64)a | 6.50(2.73)b | 4.90(2.42)ab | 3.23(2.05)ab | 3.43(2.08)bc | 69.8 |
| T3:Chlorfenapyr 240% SC | 0.85 ml | 7.96(2.98)ab | 6.80(2.79)ab | 6.36(2.69)b | 5.33(2.50)ab | 3.73(2.17)ab | 4.10(2.24)bc | 63.9 |
| T4:Flonicamid 50% WG | 0.3 g | 6.33(2.69)ab | 4.96(2.44)a | 5.86(2.61)ab | 3.73(2.15)a | 2.96(1.98)ab | 2.73(1.93)ab | 75.9 |
| T5:Tolfenpyrad 15% EC | 2 ml | 8.83(3.11)b | 7.90(2.98)b | 7.03(2.83)b | 6.83(2.78)b | 5.20(2.45)b | 5.36(2.52)c | 52.7 |
| T6:Fipronil 5% SC | 2 ml | 5.50(2.54)a | 5.40(2.52)a | 5.03(2.44)ab | 3.93(2.21)a | 2.66(1.90)a | 2.23(1.73)a | 80.3 |
| T7:Untreated control | - | 14.70(3.96)c | 14.33(3.91)c | 14.70(3.95)c | 13.73(3.83)c | 12.33(3.65)c | 11.36(3.45)d | - |
| SEm(±) |  | 0.16 | 0.10 | 0.14 | 0.15 | 0.16 | 0.08 | - |
| CD (p=0.05) |  | 0.50 | 0.32 | 0.44 | 0.48 | 0.50 | 0.24 | - |
| CV(%) |  | 9.41 | 6.31 | 8.98 | 10.57 | 12.38 | 6.11 | - |

Note: Figures in parenthesis are square root transformed values; **DBS-** Day Before Spray; **DAS**- Day After Spray

**Table 3: Effect of different insecticides on cotton yield and incremental benefit cost ratio analysis for insecticidal treatments against *Thrips tabaci* during *kharif* 2024**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Seed cotton yield****(Kg ha-1)** | **Increased yield over control****(Kg ha-1)** | **Cost of treatment****(Insecticide cost+ Labour cost)****(Rs. ha-1)** | **Profit of additional yield****(Rs. 7010 per quintal)** | **Net profit****(Rs ha-1)** | **B:C ratio** |
| T1:Isocycloseram 9.2% DC | 2004 | 741 | 9492 | 51870 | 42378 | 4.46:1 |
| T2:Cyantriniprole 10.6%OD  | 1714 | 451 | 10361 | 31570 | 21209 | 2.05:1 |
| T3:Chlorfenapyr 240% SC | 1516 | 253 | 4163 | 17710 | 13547 | 3.25:1 |
| T4:Flonicamid 50% WG | 1750 | 487 | 5200 | 34139 | 28939 | 5.56:1 |
| T5:Tolfenpyrad 15% EC | 1496 | 233 | 5976 | 16310 | 10334 | 1.76:1 |
| T6:Fipronil 5% SC | 1820 | 557 | 5650 | 38990 | 33340 | 5.90:1 |
| T7: Untreated control | 1263 | - | - | - | - | - |

**References:**

Agale, D. A., Yadav, G. A., Bhosle, B. B. and Bhede, B.V., 2010. Bioefficacy and economics of insecticides against thrips (S*critothrips dorsalis* Hood) on Bt cotton. *Indian Journal of Entomology*, *72*(1), pp.29-32.

Aslam, M., Razaq, M., Shah, S.A. and Ahmad, F., 2004.Comparative efficacy of different insecticides against sucking pests of cotton. *Journal of Scientific Research 15*(1), pp.53-58.

Bharpoda, T.M., Patel, N.B., Thumar, R.K., Bhatt, N.A., Ghetiya, L.V., Patel, H.C. and Borad, P.K., 2014. Evaluation of insecticides against sucking insect pests infesting Bt cotton BG-II. *The bioscan*, *9*(3), pp.977-980.

Broughton, S. and Herron, G.A., 2009. Potential new insecticides for the control of western flower thrips (Thysanoptera: Thripidae) on sweet pepper, tomato, and lettuce. *Journal of Economic Entomology*, *102*(2), pp.646-651.

Bryant, T. and Malone, S., 2025.Efficacy of selected foliar insecticides against thrips in cotton, 2024. *Arthropod Management Tests*, *50*(1), p.tsaf022.

Cook, D., Herbert, A., Akin, D.S. and Reed, J., 2011. Biology, crop injury, and management of thrips (Thysanoptera: Thripidae) infesting cotton seedlings in the United States. *Journal of Integrated Pest Management*, *2*(2), pp.B1-B9.

Cook, D.R., Allen, C.T., Burris, E. Freeman, B. L., Gary B.L., Herzog, A., Lentz, G.L., Leonard, B.R and Reed, J.T. 2003. A Survey of Thrips (Thysanoptera) Species Infesting Cotton Seedlings in Alabama, Arkansas, Georgia, Louisiana, Mississippi, and Tennessee.*Journal Entomological Science*. 38(4): 669-681.

Kranthi, K.R. 2008. Insecticide resistance management in cotton to enhance productivity, Model training course on cultivation of long staple cotton, Central Institute for Cotton Research, Regional station, Coimbatore, December 15-22, pp. 214-231.

Kumar, R., Kranthi, S., Nitharwal, M., Jat, S.L. and Monga, D., 2012. Influence of pesticides and application methods on pest and predatory arthropods associated with cotton. *Phytoparasitica*, *40*, pp.417-424.

Lai, P.C. and Nault, B.A., 2023. Managing a high infestation of onion thrips in onion with insecticides, 2023. *Arthropod Management Tests*, *48*(1), p.tsad119.

Mayee, C.D., Gautam, H.C. and Barik, A., 2004. Cotton scenario in India vis-à-vis world and future need. *Recent Advances in Cotton Research and Development”(MS Chauhan, RK Sain, eds.), Haryana Agricultural University and Cotton Research and Development Association, CCSHAU, Hisar*, pp.245-253

Meghana, H., Jagginavar, S.B. and Sunitha, N.D., 2018. Efficacy of insecticides and bio pesticides against sucking insect pests on Bt cotton. *International Journal of Current Microbiology and Applied Sciences*, *7*(06), pp.2872-2883.

Nadeem, A., Tahir, H.M. and Khan, A.A., 2021. Plant age, crop stage and surrounding habitats: their impact on sucking pests and predators complex in cotton (*Gossypiumhirsutum* L.) field plots in arid climate at district Layyah, Punjab, Pakistan. *Brazilian Journal of Biology*, *82*, p.e236494.

Naik, V.C.B., Kranthi, S. and Viswakarma, R., 2017. Impact of newer pesticides and botanicals on sucking pest management in cotton under high density planting system (HDPS) in India. *Journal of Entomology and Zoology Studies*, *5*(6), pp.1083-1087.

Palumbo, J.C., 2022. Western flower thrips control with isocycloseram on romaine lettuce, spring 2021. *Arthropod Management Tests*, *47*(1), p.tsac037.

Patil S B, Udikeri S S, Matti P V, Guruprasad G S, Hirekurubar R B, Saila H M, Vandal N B. 2009. Bioefficacy of new molecule fipronil 5%SC against sucking pest complex in Bt cotton. Karnataka Journal of Agricultural Sciences 22(5): 1029-1031.

Radhika, M., Reddy, N.C., Anitha, V., Vidhyasagar, B. and Ramesh, S., 2018. Efficacy of insecticides against sucking pest complex in blackgram. *International Journal of Chemical Studies*, *6*(5), pp.1793-1797.

Rajasekhar, N., Prasad, N.V.V.S., Kumar, D.V. and Adinarayana, M., 2018. Incidence and management of cotton thrips (Thripstabaci) in high density planting system (HDPS) under rain fed conditions. *Journal of Entomological Research*, *42*(3), pp.373-376.

Sahu, B.K. and Samal, I., 2020. Pest complex of Cucurbits and their management: A review. *Journal of Entomology and Zoology Studies*, *8*(3), pp.89-96.

Sarode, S.V., Kolhe, A.V. and Sable, V.R. (2009) IPM strategies for cotton in relation to climate change. In: V.V. Ramamurthy, G.P. Gupta and S.N. Puri (eds) Proc. Natn. Symp. IPM Strategies to Combat Emerging Pests in the Current Scenario of Climate Change. January 28-30, 2009, Pasighat, Arunachal Pradesh, pp.181-205.

Sathyan, T., Murugesan, N., Elanchezhyan, K., Raj, A.S. and Ravi, G., 2016.Efficacy of Synthetic Insecticides against sucking insect pests in cotton, Gossypiumhirsutum L. *International Journal of Entomological Research*, *1*(1), pp.16-21.

Shah, Z.H., Sahito, H.A., Kousar, T., Rind, M.M., Jatoi, F.A. and Mangrio, W.M., 2017.Integrated pest management of cotton thrips, Thripstabaci (Lindeman, 1889) through selected pesticides under vitro conditions. *International Journal of Research Studies Zoology*, *3*(4), pp.76-83.

Sivarama Krishna, M and Rama Reddy, Y, 2020. Comparative efficacy of novel insecticide molecules against sucking pests in cotton, J. Ent. Zool. Stu. 8: 2288-92

Srivastava, K.P and Dhaliwal, G.S. 2010, A text book of applied entomology. In: Kalyani publishers, New Delhi, India, pp. 35-41.

Srivastava, M., Funderburk, J., Olson, S., Demirozer, O. and Reitz, S., 2014. Impacts on natural enemies and competitor thrips of insecticides against the western flower thrips (Thysanoptera: Thripidae) in fruiting vegetables. *Florida Entomologist*, pp.337-348

ThripsWiki (2021) ThripsWiki - providing information on the World's thrips. Available from: http://thrips.info/wiki/Main\_Page [accessed 15 August 2021].

Tillekaratne, K., Edirisinghe, J.P., Gunatilleke, C.V.S. and Karunaratne, W.A.I.P., 2012. Survey of thrips in Sri Lanka: a checklist of thrips species, their distribution and host plants. *Ceylon Journal of Science (Biological Sciences)*, *40*(2).

Udikeri, S.S., Patil, S.B., Hirekurubar, R.B., Guruprasad, G.S., Shaila, H.M. and Matti, P.V., 2010. Management of sucking pests in cotton with new insecticides. *Karnataka Journal of Agricultural Sciences*, *22*(4).