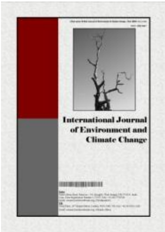

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Efficacy of Newer Insecticides against the Major Sucking Pests of Groundnut (*Arachis hypogea* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiments on the efficacy of newer insecticides on sucking insect pests of groundnut was conducted at Regional Agricultural Research Station, Palem, of Nagarkurnool district, Telangana, India during *rabi*, 2021-22 in a randomized block design with eight treatments *viz*., Tolfenpyard 15% EC at 1.5ml L^{-1} and Tolfenpyard 15% EC at 2 ml L^{-1}, Tolfenpyard 15% EC at 2.5ml L^{-1}, Spinetoram 11.7% SC at 0.5ml L^{-1}, Thiamethoxam 12.6+ Lambdacyhalothrin 9.5% ZC at 0.4ml L^{-1}, Clothianidin 50% WDG at 0.3g L^{-1}, Afidopyropen 50g/IDC at 2ml L^{-1} and Sulfoxaflor 21.89% SC at 0.5ml L^{-1}. Among all the insecticides tested clothianidin @ 0.3g L^{-1} worked very effectively in reducing the population of leafhoppers and thrips. The other effective treatments were afidopyropen at 2ml L^{-1} and tolfenpyard @ 2.5ml L^{-1} followed by tolfenpyard 15 %EC at 2.5ml L^{-1}, tolfenpyard at 2.5ml L^{-1}, thiamethoxam+ lambdacyhalothrin at 0.4ml L^{-1}. The treatment spinetoram at 0.5ml L^{-1} was less effective on the sucking pest. The highest Incremental Cost Benefit Ratio (ICBR) is recorded from the plots sprayed with clothianidin @ 0.3g L^{-1} (1.4.83) followed by afidopyrofen @ 2ml L^{-1} (1:3.94).

Keywords: Bio-efficacy; newer insecticides; groundnut; sucking pests leafhoppers; thrips.

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1. INTRODUCTION

Groundnut (*Arachis hypogea*) L. is a member of the Fabaceae family of legumes. It's also a popular oilseed crop in tropical and subtropical areas around the world [1] and native to South America. The major groundnut-producing countries are China, Nigeria, the USA, Taiwan, Indonesia, Ghana, Argentina, and Brazil. In India it is mainly produced in states like Gujarat, Andhra Pradesh, Karnataka, Telangana Tamil Nadu, Rajasthan, and Maharashtra. China produces the most groundnuts (17.39 million hectares), followed by India (6.70 million tonnes). In India, over 4.76 lakh ha were planted in 2021, with Karnataka leading the way with 1.32 lakh ha, followed by Telangana (0.87 lakh ha) [2]. There are several constraints for the low productivity of groundnut and the biggest threat is due to major insect pests. There are a total of 52 different species that infect groundnut [3] leaf miner (*Aproaerema modicella* Deventer), tobacco caterpillar (*Spodoptera litura* Fabricius), gram caterpillar (*Helicoverpa armigera* Hubner), Termites, *Odontotermes obesus* (Rambur) causing loss of 47.3% [4]. Among them 13 species of sucking insect pests are recorded [5]. The major sucking insect pest complex of groundnut includes thrips, (*Scirtothrips dorsalis* Hood), *(Frankliniella schultzei* Trybom), *(Thrips palmi* Karny), (*Caliothrips indicus* Bagnall), leafhopper, (*Empoasca kerri* Pruthi); aphid, (*Aphis craccivora.* Koch). Aphids are vectors for groundnut rosette virus and peanut mottle virus, resulting in a 40% loss [6] and thrips acts as vectors for peanut bud necrosis. The indiscriminate use of chemicals for control causes resistance, resurgence of the pests, and secondary pest outbreaks [7]. There is a need to use the insecticides at right time and in right doses. Therefore, a study was taken up to evaluate the efficacy of a few newer insecticides having multiple mode of action against sucking pests of groundnut.

2. MATERIALS AND METHODS

The experiment was conducted at Regional Agricultural Research Station, Palem, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Nagarkurnool district during the *rabi,* 2021-22. Groundnut variety K-6 was grown with 22.5×10cm spacing in 3×3m^2 plots. All the standard agronomic practices were followed for raising the crop.

The experiment was laid out with eight treatments and three replications in a randomized block design to investigate the efficacy of different insecticides like tolfenpyard at 1.5ml L^{-1} and tolfenpyard at 2 ml L^{-1}, tolfenpyard at 2.5ml L^{-1}, spinetoram at 0.5ml L^{-1}, thiamethoxam + lambdacyhalothrin at 0.4ml L^{-1}, clothianidin at 0.3g L^{-1}, afidopyropen at 2ml L^{-1} and sulfoxaflor at 0.5ml L^{-1}. Two sprays were given first spray was given after the pest reached Economic Threshold Level (ETL) Generally ETL for leafhopper is 5-10 adults/plant and for thrips, 5 thrips/terminal bud while the second spray was taken up 15 days after the first spray using power operated Knapsack sprayer. Periodic observations were taken on leafhoppers (No. leafhoppers/3 leaves/plant) and thrips (No. thrips/plant). The observations on insect pests population was recorded on one day before the spray and 1, 3, 5 and 7 days after the spray.

The data was analyzed using OPSTAT and the average number of leafhoppers and thrips recorded were square root transformed using the Poisson formula. The percent reduction over control (PRC %) of insect pest population in treatments over control was estimated by using the formula given by Abbott [8].

3. RESULTS AND DISCUSSION

3.1 Efficacy of Different Insecticidal Treatments on Leafhoppers, *Empoasca kerri*

3.1.1 First spray

Initially, the population of leafhoppers was uniformly distributed and found to be non-significant among the treatments (Table 1). The spray of clothianidin at 0.3g L-1 registered the least number of leafhoppers with 0.95 leafhoppers/3 leaves/plant, followed by afidopyropen at 2ml L-1 with 1.06 leafhoppers/3 leaves/plant and tolfenpyard at 2.5ml L-1 with 1.24 leafhoppers/3 leaves/plant. The other effective treatments were tolfenpryad at 2 ml L-1 (1.41 leafhoppers/3 leaves/plant), tolfenpryad at 1.5 ml L-1 (1.56 leafhoppers/3 leaves/plant), sulfoxaflor at 0.5ml L-1 (1.69 leafhoppers/3 leaves/plant), thiamethoxam+ lambdacyhalothrin at 0.4ml L-1 (1.93 leafhoppers/3leaves/plant). There was more survival of the leafhoppers population in the plots sprayed with spinetoram at 0.5g L-1 were observed with 2.09 leafhoppers/3leaves/plant and found to be a minimum reduction as compared to the other treatments according to the pooled mean observation on 1, 3, 5 and 7 days after the spray.

The per cent reduction over the control showed that clothianidin at 0.3g L^{-1} with 77.5% was found to be most effective on leafhoppers and spinetoram at 0.5g L^{-1} (46.6%) was found to be less effective in the controlling leafhoppers (Fig 1).

3.1.2 Second spray

The results from the efficacy of insecticides on the leafhoppers after the second spray indicated that there was no significant difference between the treatments one day before the spray. The treatment clothianidin at 0.3g L-1 was found significantly superior among all the treatments in the suppression of the leafhopper's population with 0.70 leafhoppers/3leaves/plant. The next effective treatments were afidopyropen at 2ml L-1 with 0.82 leafhoppers/3leaves/plant and tolfenpyard at 2.5ml L-1 with 1.03 leafhoppers/3leaves/plant. The treatment spinetoram at 0.5 g L-1 was less effective in controlling leafh1.67 leafhoppers/3 leaves/plant (Table 1).

The per cent reduction over the control revealed that clothianidin at 0.3g L^{-1} was more effective with 85% in controlling leafhoppers population. The next best treatments were afidopyropen at 2ml L^{-1} (82.5%) and tolfenpyard at 2.5ml L^{-1} (77.5%) followed by tolfenpryad at 2 ml L^{-1} (72.5%), tolfenpryad at 1.5 ml L^{-1} (69.2%), sulfoxaflor at 0.5g L^{-1} (65%), thiamethoxam+ lambdacyhalothrin at 0.4ml L^{-1} (63.5%). The effectiveness of spinetoram at 0.5 g L^{-1} was less on the leafhoppers with 58.2%. The results are in accordance with Kadam et al. [9] the spray of clothianidin at 20 g a.i ha^{-1} was found to be the most effective chemical on the suppression of sucking pests on cotton. Robert et al. [10] in their findings reported that the afidopyrofen was effective against sucking pests and it was found to be safer to the natural enemies. Pachundkar et al*.* [11] observed that the spray of clothianidin at (0.025%) showed a maximum efficacy in the reduction of the leafhoppers population on cluster bean. Karabhantanal and Saicharan [12] noticed that spray of tolfenpyrad 20%SC reduced 81.92% of the leafhoppers on pigeon pea. Patel et al. [13] in their findings reported that two sprays of clothianidin 50% WDG at 20 and 25 g a.i./ha were most effective against the sucking pests of cotton and the yield obtained was significantly higher with (11.29 q/ha). According to Vijaya and Ilyas [14] who reported that treatment of clothianidin 50% WDG was found to be most superior in reducing the population of leafhoppers on cotton. Vinothkumar and Karthik [15] reported that bifenthrin 8% +clothianidin showed a maximum effect on the reduction of thrips and leafhoppers on groundnut. Shivani et al. [16] reported that afidopyrofen at 600ml/ha was found to be most effective treatment against leafhoppers followed by afidopyrofen at 750ml/ha in okra. Chen et al observed that afidopyrofen was found to be superior in the controlling of sucking pests.

From both sprays it is evident that a similar trend was noticed on 1, 3, 5 and 7 days after the spray of clothianidin at 0.3g L^{-1} and was superior compared to other treatments. Furthermore, the order of efficacy was afidopyropen at 2ml L^{-1} and tolfenpryad at 2 ml L^{-1}. Followed by tolfenpryad at 2 ml L^{-1}, tolfenpryad at 1.5 ml L^{-1}, sulfoxaflor at 0.5ml L^{-1}, thiamethoxam+ lambdacyhalothrin at 0.4ml L^{-1}. While the efficacy was comparatively less by the spray of spinetoram at 0.5 g L^{-1} on the population of leafhoppers.

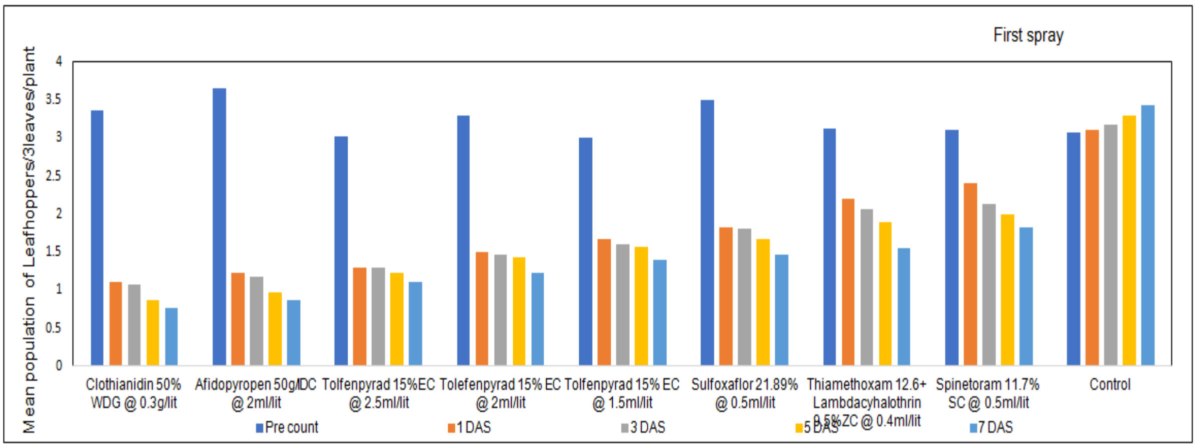

Fig. 1. Efficacy of different insecticides against leafhoppers after first spray

Table 1. Effect of different insecticides on the mean population of leafhoppers on groundnut

Treatments	Dosage	Mean population of leafhoppers/3leaves/plant													
		First spray							Second spray						
		Pre count	1 DAS	3 DAS	5 DAS	7 DAS	Pooled mean	PRC (%)	Pre count	1 DAS	3 DAS	5 DAS	7 DAS	Pooled mean	PRC (%)
Tolfenpyrad 15%EC	1.5 ml L^{-1}	3.00 (1.73)	1.67^{e} (1.31)	1.60^{d} (1.26)	1.57^{c} (1.25)	1.40^{c} (1.18)	1.56	59.1	2.43 (1.56)	1.33^{d} (1.15)	1.30^{d} (1.14)	1.25^{d} (1.13)	1.23^{d} (1.11)	1.28	69.2
Tolfenpyrad 15%EC	2 ml L^{-1}	3.30 (1.81)	1.50^{d} (1.22)	1.47^{c} (1.21)	1.43^{b} (1.19)	1.23^{c} (1.11)	1.41	64.1	2.31 (1.52)	1.25^{c} (1.13)	1.20^{d} (1.10)	1.13^{c} (1.05)	1.10^{c} (1.04)	1.18	72.5
Tolfenpyrad 15%EC	2.5 ml L^{-1}	3.03 (1.74)	1.33^{c} (1.15)	1.30^{b} (1.14)	1.23^{b} (1.11)	1.10^{c} (1.04)	1.24	67.9	2.37 (1.54)	1.13^{bc} (1.06)	1.10^{c} (1.04)	1.00^{b} (1.01)	0.90^{c}(0.94)	1.03	77.5
Spinetoram 11.7%SC	0.5 ml L^{-1}	3.10 (1.76)	2.40^{g} (1.54)	2.13^{f} (1.46)	2.00^{e} (1.41)	1.83^{e} (1.35)	2.09	46.6	2.53 (1.65)	2.26^{g} (1.49)	2.10^{g} (1.45)	1.72^{f} (1.31)	1.67^{g} (1.29)	1.67	58.2
Thiamethoxam 12.6+ Lambdacyhalothrin 9.5%ZC	0.4 ml L^{-1}	3.13 (1.77)	2.20^{f} (1.48)	2.06^{e} (1.43)	1.89^{d} (1.37)	1.55^{d} (1.24)	1.93	54.8	2.35 (1.53)	1.80^{f} (1.34)	1.65^{f} (1.28)	1.62^{e} (1.27)	1.46^{f} (1.21)	1.63	63.5
Clothianidin 50% WDG	0.3 g L^{-1}	3.37 (1.83)	1.10^{a} (1.04)	1.07^{a} (1.03)	0.87^{a} (0.93)	0.77^{a} (0.87)	0.95	77.5	2.43 (1.56)	0.83^{a} (0.91)	0.70^{a} (0.83)	0.67^{a} (0.80)	0.60^{a} (0.81)	0.70	85.0
Afidopyropen 50g/IDC	2 ml L^{-1}	3.67 (1.91)	1.23^{b} (1.12)	1.17^{b} (1.08)	0.97^{b} (0.98)	0.87^{b} (0.93)	1.06	74.6	2.37 (1.54)	0.97^{b} (0.98)	0.83^{b} (0.91)	0.77^{b} (0.87)	0.70^{b} (0.83)	0.82	82.5
Sulfoxaflor 21.89% SC	0.5 ml L^{-1}	3.50 (1.87)	1.83^{f} (1.35)	1.80^{d} (1.34)	1.67^{cd} (1.29)	1.47^{d} (1.21)	1.69	57.1	2.58 (1.68)	1.55^{e} (1.23)	1.50^{e} (1.22)	1.43^{d} (1.19)	1.40^{e} (1.18)	1.47	65.0
Control		3.07 (1.75)	3.10^{h} (1.74)	3.17^{g} (1.77)	3.30^{f} (1.81)	3.43^{f} (1.85)	3.25	-	2.41 (1.55)	2.57^{h} (1.60)	2.73^{h} (1.64)	2.87^{g} (1.68)	4.00^{h} (2.03)	3.04	-
SEm±		0.04	0.03	0.02	0.02	0.04	0.06	-	0.09	0.04	0.02	0.03	0.02	0.02	-
C.D. at 5%		N/S	0.11	0.10	0.10	0.15	0.19	-	N/S	0.15	0.10	0.11	0.10	0.08	-
C.V.		8.54	3.39	3.30	4.75	6.06	6.27	-	4.51	3.72	3.46	3.60	4.37	3.04	-

DAS- Days After Spraying
PRC- Per cent Reduction over Control
** Figures in parenthesis are square root transformed*

Table 2. Effect of different insecticides on the mean population of thrips on groundnut

Treatments	**Dosage**	**Mean population of thrips/plant**													
		First spray							**Second spray**						
		Pre count	**1 DAS**	**3 DAS**	**5 DAS**	**7 DAS**	**Pooled mean**	**PRC (%)**	**Pre count**	**1 DAS**	**3 DAS**	**5 DAS**	**7 DAS**	**Pooled mean**	**PRC (%)**
Tolfenpyrad 15%EC	1.5 ml L^{-1}	5.24 (2.29)	1.70[d] (1.30)	1.55[c] (1.24)	1.50[e] (1.21)	1.30[d] (1.14)	1.51	78.3	4.23 (2.05)	1.83[c] (1.35)	1.80[c] (1.34)	1.73[c] (1.31)	1.60[c] (1.26)	1.74	76.3
Tolfenpyrad 15%EC	2 ml L^{-1}	5.11 (2.25)	1.53[c] (1.23)	1.47[c] (1.21)	1.40[d] (1.18)	1.23[d] (1.33)	1.41	79.5	4.31 (2.07)	1.67[c] (1.29)	1.60[c] (1.26)	1.55[c] (1.23)	1.50[c] (1.22)	1.58	77.8
Tolfenpyrad 15%EC	2.5 ml L^{-1}	5.20 (2.27)	1.40[c] (1.18)	1.37[c] (1.17)	1.33[c] (1.15)	1.11[c] (1.05)	1.30	81.5	4.21 (2.15)	1.60[b] (1.26)	1.45[c] (1.20)	1.43[bc] (1.19)	1.30[c] (1.14)	1.45	80.7
Spinetoram 11.7%SC	0.5 ml L^{-1}	5.10 (2.24)	3.26[g] (1.80)	3.17[e] (1.78)	2.97[g] (1.72)	2.83[f] (1.68)	3.06	52.8	5.25 (2.30)	3.17[e] (1.78)	3.03[f] (1.74)	2.78[f] (1.66)	2.78[e] (1.66)	2.94	58.9
Thiamethoxam 12.6+ Lambdacyhalotrin 9.5%ZC	0.4 ml L^{-1}	5.15 (2.27)	2.80[f] (1.61)	2.70[d] (1.64)	2.54[f] (1.59)	2.27[e] (1.50)	2.58	62.1	4.32 (2.08)	2.80[d] (1.68)	2.77[e] (1.67)	2.60[ef] (1.65)	2.20[de] (1.48)	2.59	67.5
Clothianidin 50% WDG	0.3 g L^{-1}	5.22 (2.28)	1.20[a] (1.10)	1.13[a] (1.12)	1.10[a] (1.04)	0.90[a] (0.94)	1.08	85.0	4.37 (2.08)	1.17[a] (1.09)	1.10[a] (1.04)	1.00[a] (1.01)	0.77[a] (0.87)	1.01	88.6
Afidopyropen 50g/IDC	2 ml L^{-1}	5.24 (2.29)	1.30[b] (1.14)	1.25[b] (1.13)	1.20[b] (1.10)	1.00[b] (1.01)	1.19	83.3	4.37 (2.08)	1.33[b] (1.15)	1.30[b] (1.14)	1.25[b] (1.13)	1.21[b] (1.11)	1.28	82.1
Sulfoxaflor 21.89% SC	0.5 ml L^{-1}	5.20 (2.27)	2.10[e] (1.43)	2.00[d] (1.41)	1.83[e] (1.35)	1.55[e] (1.24)	1.87	74.1	4.83 (2.10)	2.20[d] (1.48)	2.13[d] (1.46)	1.97[cd] (1.41)	1.82[d] (1.35)	1.91	73.1
Control		5.19 (2.27)	5.50[g] (2.34)	5.70[f] (2.38)	5.80[h] (2.40)	6.00[g] (2.44)	5.75	-	4.33 (2.20)	5.03[f] (2.13)	6.33[g] (2.60)	6.60[g] (2.66)	6.77[f] (2.70)	6.18	-
SEm±		0.18	0.10	0.11	0.8	0.7	0.7	-	0.12	0.07	0.05	0.12	0.08	0.05	-
C.D. at 5%		N/S	0.25	0.28	0.16	0.15	0.21	-	N/S	0.23	0.18	0.37	0.27	0.16	-
C.V.		4.21	8.02	6.43	3.73	4.03	5.59	-	2.05	5.39	4.44	8.91	6.95	3.89	-

DAS- Days After Spraying
PRC- Per cent Reduction over Control
** Figures in parenthesis are square root transformed*

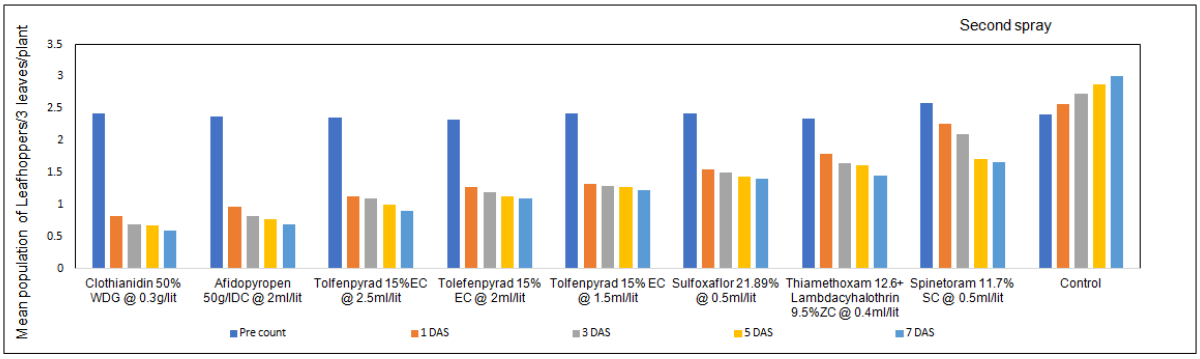

Fig. 2. Efficacy of different insecticides against leafhoppers after second spray

3.2 Efficacy of Different Insecticidal Treatments on Thrips, *Scirtothrips dorsalis*

3.2.1 First spray

The observation on the pre count of thrips population was in the range of 5.11 to 5.24 thrips/plant and found to be non-significant among the treatments (Table 2). The pooled mean estimated after 1, 3, 5, and 7 days of the spray revealed that there was a higher reduction in the population of thrips due to spray of clothianidin at 0.3g L^{-1} with 1.08 thrips/plant and there was a less reduction in the thrips population when spinetoram 0.5 g L^{-1} (3.06 thrips/plant) was sprayed.

The maximum per cent reduction (85%) of thrips over the control was observed in the plots sprayed with clothianidin at 0.3g L-1 and found superior to all other treatments followed by afidopyropen at 2ml L-1 (83.3%), tolfenpyard at 2.5ml L-1 (81.5%) and spinetoram 0.5 g L-1 (52.8%) was less effective in controlling thrips on groundnut.

3.2.2 Second spray

The efficacy of different insecticides on the thrips during the second spray indicated that the population ranged between 4.21 to 5.25 thrips/plant during the pre count and treatments had no significant difference among them. The population of thrips was less in the plots sprayed with clothianidin 0.3g L^{-1} (1.01 thrips/plant) the next effective treatments were afidopyropen 2ml L^{-1} (1.28 thrips/plant) and tolfenpyard @ 2.5ml L^{-1} (1.45 thrips/plant), Whereas spinetoram 0.5 g L^{-1} (2.94 thrips/plant) proved to be the least effective in the suppression of thrips population (Table 2).

The per cent reduction over control after the seventh day indicated that clothianidin 0.3g L^{-1} was most effective among all the treatments with a reduction of 88.6% followed by afidopyropen at 2ml L^{-1} (82.1%), tolfenpyard at 2.5ml L^{-1} (80.7%), tolfenpyard at 2 ml L^{-1} (77.8%). Followed by tolfenpryad at 1.5 ml L^{-1} (76.3%), sulfoxaflor at 0.5ml L^{-1} (72.9%) thiamethoxam+ lambdacyhalothrin at 0.4ml L^{-1} (67.5%). Spinetoram 0.5 g L^{-1} found less effective with 58.9%. The findings are in line with Duraimurugan and Alivelu [17] who reported that the spray of clothianidin 50 WDG reduced the population of thrips on the castor crop. While Sreenivas et al. [18] reported that clothianidin at 60 g a.i. ha^{-1} found to be more effective on the suppression of thrips. Vijayaraghavan and Kavitha [19] observed that spraying of clothianidin 50 WDG was effective in treating sucking pests on the black gram. According to Kalyan et al. [20] reported that tolfenpyrad 15% EC at 125 and 150g a.i. ha^{-1} found promising in controlling sucking pests of cotton. Parmar et al. [21] reported that clothianidin 50% WDG effectively controlled the population of sucking pests of blackgram. Parmar et al. [13], Ambarish et al. [22] in their findings reported that lowest population of thrips (0.77) per leaf were found in the plots treated with sulfoxaflor 30% 108 g a.i./ha.

The overall effect of first and second spray of clothianidin 0.3g L^{-1} was most effective in controlling of thrips. The next effective treatments were afidopyropen at 2ml L^{-1}, tolfenpyard at 2.5ml L^{-1}, tolfenpyard at 2 ml L^{-1}. Followed by tolfenpryad at 1.5 ml L^{-1}, sulfoxaflor at 0.5ml L^{-1}, thiamethoxam+ lambdacyhalothrin at 0.4ml L^{-1}. However, the population of thrips was more in the plots sprayed with spinetoram 0.5 g L^{-1}.

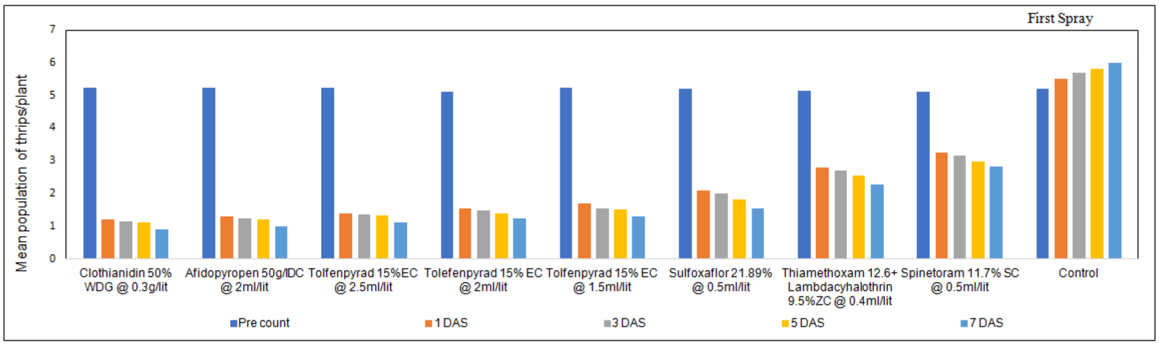

Fig. 3. Efficacy of different insecticides on thrips population after first spray

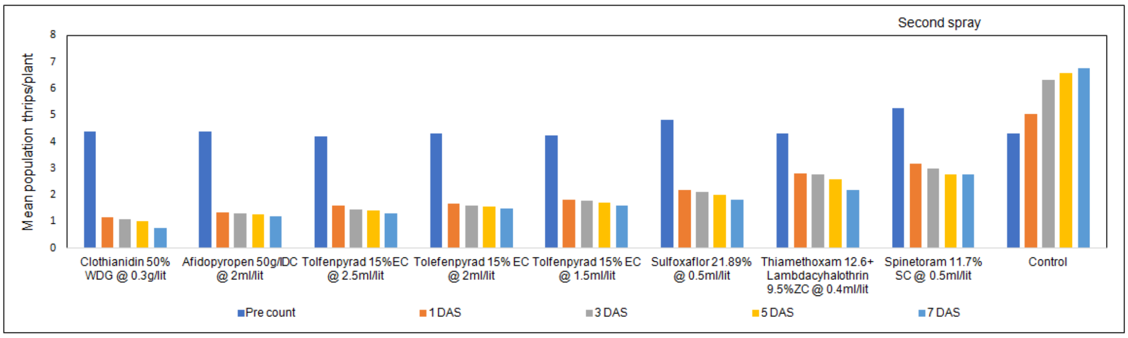

Fig. 4. Efficacy of different insecticides on thrips population after second spray

4. CONCLUSION

From the present study, it is concluded that the best treatment in controlling sucking pests (leafhoppers and thrips) of groundnut was clothianidin @ 0.3g L-1 followed by afidopyropen @ 2ml L-1, tolfenpyard @ 2.5ml L-1 when compared to other insecticides. The per cent reduction of leafhoppers and thrips over control after the seventh day of treatment also indicated that clothianidin 0.3g L-1 was the most effective insecticide among the treatments undertaken in the study. The highest Incremental Cost Benefit Ratio (ICBR) is recorded from the plots sprayed with clothianidin @ 0.3g L-1 (1.4.83) followed by afidopyrofen @ 2ml L-1 (1:3.94)..

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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