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Effect of Aqueous Leaf Extracts on Natural Enemies in Rice Ecosystem

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ABSTRACT

A field experiment was conducted and studied the effect of treatments *viz.,* Neem seed kernel extract (NSKE @ 5%, & 10%), Neem leaf extract (NLE @ 10%), Karanj leaf extract (KLE @ 10%), Custard apple leaf extract (CaLE @ 10%), Chilli pod extract (CPE @10 %), buprofezin 25 SC @ 1.6 ml l^{-1}, flubendiamide 20 WDG @ 0.25 g l^{-1} and untreated control on mirid bugs, spiders and coccinellids of rice ecosystem during *kharif*, 2019. Among the aqueous organic extracts, NSKE @ 5% found to be safer to mirid bugs and spiders while CaLE @ 10% found to be safer to coccinellids when compared to chemicals. The descending order of effect of treatments on mirid bugs was NSKE @ 5% (2.73) > KLE @ 10% (2.71) > CPE @ 10% (2.70) > NLE @ 10% (2.69) > NSKE @ 10% (2.67) > CaLE @ 10% (2.60) > buprofezin 25 SC @ 1.6 ml l^{-1} (1.91) > flubendiamide 20 WDG @ 0.25 g l-1 (1.67). The descending order of effect of treatments on spiders was NSKE @ 5 % (1.10) > NSKE @ 10% (0.93) > CaLE @ 10% (0.80) > NLE @ 10% (0.77) > CPE @ 10% (0.73) > KLE @ 10% (0.67) > flubendiamide 20 WDG @ 0.25 g l^{-1} (0.56) > buprofezin 25 SC @ 1.6 ml l^{-1} (0.52).

Keywords: *Mirid bugs, spiders, coccinellids and aqueous leaf extracts*

Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world population and accounts for more than 50 per cent of the daily calorie intake (Khush, 2005). India is an important centre of rice cultivation with an area of 43.79 M ha, 112.91 M t annual production and 2578 Kg ha^{-1} productivity (Ministry of Agriculture and Farmers Welfare, 2018). In case of Andhra Pradesh, it is grown in an area of 22.18 M ha with 126.91M t production and 5722 Kg ha^{-1} productivity (Directorate of Economics and Statistics, 2018).

The rice crop is subjected to sustain a considerable damage by a number of insect pests. More than 100 insect pests cause significant economic loss to rice crop and among them, brown planthopper (BPH), *Nilaparvata lugens* (Stal.) and white-backed planthopper (WBPH), *Sogatella furcifera* (Horvath) are the principle devastators during *kharif* season in Andhra Pradesh. These two pests are responsible for major economic crop losses and can cause complete destruction of crop in severe cases. On the other hand, Rice leaf folder, *Cnaphalocrocis medinalis* Guenee, is considered as a pest of minor importance have increased in abundance in late 1980's and become a major pest in many parts of world (Ahmed *et al.*, 2010).

The over dependence and excessive use of pesticides may result in development of resistance, induces secondary outbreak of pests, reduce the bio diversity of natural enemies and contamination of the natural ecosystem. Botanical insecticides have long been touted as attractive alternatives to synthetic chemical insecticides for IPM. Natural enemies plays an important role in preventing the insect pest outbreak in the rice (Bambaradeniya and Edirisinghe, 2008). Among the natural enemies, spiders and mirids are important in rice ecosystem. Predation is the common among the insects and some of the predators like spiders and mirids were considered as potential, important and efficient predators of BPH and WBPH (Parasappa *et al*., 2017).

In India, there is sufficient evidence to justify the vital role of natural enemies in suppressing the pest population in rice (Chellaiah *et al*., 1989). Hence, present study was conducted to evaluate the effect of organic extracts against natural enemies in the rice ecosystem. Most of the predators in rice fields seem to evacuate the field after application of chemical insecticides, thus their predatory capacity was suppressed and caused a negative impact on the population densities of rice field predators, whereas the neem formulations were found to be quite safe to them.

MATERIALS AND METHODS

The experiment was conducted at Agricultural College Farm, Bapatla during *kharif*, 2019 in Randomized Block Design (RBD) with nine treatments *viz.*, T1 - Neem seed kernel extract (NSKE @ 5%); T2 - Neem seed kernel Extract (NSKE @ 10%); T3 - Neem leaf extract (NLE @ 10%) ; T4 - Karanj leaf extract (KLE @ 10%); T5 - Custard apple leaf extract (CaLE @ 10%); T6 - Chilli pod extract (CPE @ 10%); T7 - Buprofezin 25 SC @ 1.6 ml l^{-1}; T8- Flubendiamide 20 WDG @ 0.25 g l^{-1} & T9- untreated control and replicated thrice. Nursery of rice variety, BPT-5204 (Samba Mashuri) was sown on 29th July, 2019 and transplanting was done in lines with a spacing of 20×15 cm. Based on the ETL of pest population, two sprayings of all the treatments *viz.*, were done at 40 & 60 DAT. Observations were recorded on number of mirid bugs, spiders and coccinellids from randomly selected 10 hills on one DBS (Day before spraying) and at 1, 3 and 5 DAS (Day after spraying). The data collected was transformed into square root values and subjected to ANOVA and mean values were compared by Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Mirid bugs

The data on the mean population of mirid bugs per hill from table1 ranged from 1.35 (flubendiamide 20 WDG @ 0.25 g l^{-1}) to 2.94 (Untreated control). Among all treatments NSKE @ 5% recorded highest population of mirid bugs (2.81/hill), while @ 10% NSKE, NLE, CPE, KLE and CaLE have recorded 2.72, 2.64, 2.55, 2.51 and 2.44 mirid bugs per hill, respectively when compared to the buprofezin (1.73/hill) & flubendiamide (1.35/hill).

During second spray, the untreated control (3.08/hill) recorded the highest mean population of mirid bugs. Among all treatments, KLE @ 10% recorded the highest population of mirid bugs (2.85/hill), while CPE @ 10%, CaLE @ 10%, NLE @ 10%, NSKE @10% and NSKE @ 5% have recorded 2.83 , 2.75, 2.73 , 2.61 and 2.58 mirid bugs per hill, respectively when compared to buprofezin 25 SC @ 1.6 ml l^{-1} (2.10/hill) & flubendiamide 20 WDG @ 0.25 g l^{-1} (1.99/hill).

The overall cumulative effect (Table.4) of treatments on mirid bugs after two sprays has ranged from 1.67 (flubendiamide 20 WDG @ 0.25 g l^{-1}) to 3.01 (untreated control) per hil. The treatment, NSKE @ 5% recorded the maximum mirid bug population (2.69) per hill. The order of overall efficacy of treatments after two sprays was NSKE @ 5 % (2.73) > KLE @ 10% (2.71) > CPE @ 10% (2.70) > NLE @ 10% (2.69) > NSKE @ 10% (2.67) > CaLE @

10% (2.60) > Buprofezin 25 SC @ 1.6 ml l^{-1} (1.91) > Flubendiamide 20 WDG @ 0.25 g l^{-1} (1.67).

Spiders

The population of spiders ranged from 0.52 (buprofezin) to 1.14 (untreated control) per hill during first spray (Table 2). After the first spray, NSKE @ 5% recorded the highest population of spiders (1.12 no./hill), while CaLE @ 10%, NLE @ 10% , CPE @ 10%, KLE @ 10% and buprofezin have recorded 0.87, 0.83, 0.78, 0.70 and 0.62 no. of spiders, respectively whereas, flubendiamide 20 WDG @ 0.25 g l^{-1} recorded the lowest (0.52/hill) population of spiders. (Table.2)

During second spray, the overall mean population of spiders per hill (Table.4) ranged from 0.51 (buprofezin 25 SC @ 1.6 ml l^{-1}) to 1.36 (untreated control). Among all treatments, NSKE @ 5% recorded the highest population of spiders (1.08/hill) followed by NSKE @ 10% (0.75/hill). The other treatments, CaLE @ 10% , NLE @ 10%, CPE @ 10%, KLE @ 10% and Buprofezin 25 SC @ 1.6 ml l^{-1} recorded 0.73, 0.71, 0.68 and 0.63 number of spiders per hill, respectively whereas, flubendiamide 20 WDG @ 0.25 g l^{-1} has recorded the lowest population of spiders (0.49/hill). After two sprays, NSKE @ 5% recorded the maximum spider number of spiders per hill (1.10).

Coccinellids

The overall mean population of coccinellids per hill ranged from 0.24 (buprofezin 25 SC @ 1.6 ml l^{-1}) to 0.55 (untreated control) after first spray. Among all treatments CaLE @ 10% recorded highest population with 0.53 no./hill followed by KLE @10% with popuation of 0.45 no./hill. The other treatments CPE @ 10% , NLE @ 10% , NSKE @ 5%, and NSKE @ 10% recorded (0.40 no./hill), (0.38 no./hill), (0.31 no./hill) and (0.30 no./hill) population of coccinellids respectively and all were on par with each other. Flubendiamide 20 WDG @ 0.25 g l^{-1} recorded (0.26 no./hill) and on par with buprofezin 25 SC @ 1.6 ml l^{-1} recorded lowest population of coccinellids with (0.24 no./hill). (Table.3)

After second spray, the overall mean population of coccinellids per hill ranged from 0.27 (buprofezin 25 SC @ 1.6 ml l^{-1}) to 0.87 (untreated control). Among all treatments CaLE @ 10% recorded highest mean population with 0.74/hill followed by NLE @10% with popuation of 0.67 no./hill and on par with each other. The other treatments KLE @ 10%, CPE @ 10%, NSKE @ 10% and NSKE @ 5% recorded 0.57, 0.54, 0.48 and 0.47 coccinellids no./hill respectively and all treatmants were on par with each other. Flubendiamide 20 WDG @ 0.25 g l^{-1} recorded 0.30 coccinellids/hill and Buprofezin 25 SC @ 1.6 ml l^{-1} recorded lowest population of coccinellids (0.27 no./hill) and both treatments were on par with each other.

The overall cumulative effect of treatments on coccinellids after two sprays (ranged from 0.26 (buprofezin 25 SC @ 1.6 ml l^{-1}) to 0.71 (untreated control). The treatments CaLE @ 10% recorded the maximum coccinellids population of 0.64 per hill. The order of overall efficacy of treatments after two spraying were CaLE @ 10% (0.64) > NLE @ 10% (0.53) > KLE @ 10% (0.51) > CPE @ 10% (0.46) > NSKE @ 5% (0.42) > NSKE @ 10% (0.39) > flubendiamide 20 WDG @ 0.25 g l^{-1} (0.28) > buprofezin 25 SC @ 1.6 ml l^{-1} (0.26). (Table.4)

Present findings are in agreement with Ravichandra *et al.* (2014) who reported that on seven DAS of buprofezin 25% SC @ 1.0 ml/l recorded lower population of 13.10 mirid bugs per hill and pongamia aqueous extract recorded 15.11 mirid bugs per hill when compared to control with 19.69 mirid bugs per hill at 14 DAS. Joseph *et al.* 2010 who reported that neem oil and NSKE were safe to the

Table 1. Effect of treatments on mirid bug population in rice crop after two sprays during *kharif*, 2019

T. No	Treatments	Mean population of mirid bugs per hill*									
		First spray					Second spray				
		DBS	1DAS	3DAS	5 DAS	Mean	DBS	1DAS	3DAS	5 DAS	Mean
1	NSKE @10%	2.63 (1.88)	2.67 (1.91)	2.59 $(1.89)^{abc}$	2.51 $(1.87)^{b}$	2.72 $(1.93)^{a}$	2.90 (1.97)	2.73 (1.93)	2.74 $(1.95)^{b}$	2.19 $(1.79)^{c}$	2.61 $(1.90)^{a}$
2	Neem leaf extract @10%	2.73 (1.93)	2.63 (1.90)	2.55 $(1.88)^{abc}$	2.67 $(1.91)^{ab}$	2.64 $(1.90)^{a}$	3.00 (1.99)	2.77 (1.93)	2.70 $(1.92)^{b}$	2.47 $(1.86)^{b}$	2.73 $(1.93)^{a}$
3	Karanj leaf extract @10%	2.63 (1.90)	2.57 (1.89)	2.54 $(1.88)^{abc}$	2.47 $(1.86)^{b}$	2.51 $(1.87)^{a}$	3.08 (2.01)	2.73 (1.93)	2.60 $(1.90)^{b}$	3.13 $(2.03)^{a}$	2.85 $(1.96)^{a}$
4	Custard apple leaf extract	2.72 (1.93)	2.50 (1.86)	2.62 $(1.89)^{abc}$	2.68 $(1.91)^{ab}$	2.44 $(1.85)^{a}$	2.93 (1.90)	2.47 (1.85)	2.73 $(1.93)^{b}$	2.53 $(1.88)^{ab}$	2.75 $(1.93)^{a}$
5	Chilli pod extract	2.73 (1.93)	2.57 (1.89)	2.54 $(1.88)^{abc}$	2.60 $(1.90)^{ab}$	2.55 $(1.88)^{a}$	3.07 (2.01)	2.83 (1.95)	2.67 $(1.91)^{b}$	2.77 $(1.94)^{ab}$	2.83 $(1.95)^{a}$
6	Buprofezin 25 SC @ 1.6 ml l^{-1}	2.80 (1.94)	2.43 (1.84)	2.23 $(1.79)^{c}$	1.67 $(1.62)^{c}$	1.73 $(1.64)^{b}$	2.87 (1.96)	2.60 (1.88)	2.00 $(1.72)^{c}$	1.67 $(1.63)^{c}$	2.10 $(1.75)^{a}$
7	Flubendiamide 20 WDG @ 0.25 g l^{-1}	2.63 (1.90)	2.40 (1.83)	2.17 $(1.77)^{c}$	1.53 $(1.59)^{c}$	1.35 $(1.53)^{b}$	2.98 (1.98)	2.07 (1.74)	1.93 $(1.71)^{c}$	0.83 $(1.34)^{d}$	1.99 $(1.71)^{b}$
	NSKE @ 5%	2.77 (1.94)	2.87 (1.96)	2.67 $(1.97)^{ab}$	2.64 $(1.90)^{ab}$	2.81 $(1.95)^{a}$	3.03 (2.01)	2.93 (1.98)	2.75 $(1.99)^{b}$	2.17 $(1.78)^{c}$	2.58 $(1.89)^{a}$
9	Untreated control	2.73 (1.93)	2.90 (1.97)	3.03 $(2.00)^{a}$	3.11 $(2.02)^{a}$	2.94 $(1.98)^{a}$	2.96 (1.99)	3.00 (1.99)	3.20 $(2.05)^{a}$	3.17 $(2.04)^{a}$	3.08 $(2.02)^{a}$
	SEm±	0.08	0.07	0.07	0.06	0.06	0.11	0.09	0.07	0.09	0.08
	CD (0.05)	N.S	0.2	0.12	0.14	0.17	0.34	0.27	0.14	0.17	0.13
	CV(%)	7.21	5.96	6.68	5.98	5.2	9.84	8.11	6.22	8.19	6.86

Values in the parenthesis are square root transformations; DBS-day before spraying; DAS; day after spraying; NS= Non significant

Table 2. Effect of treatments on spiders population in rice crop after two sprays during *kharif*, 2019

T. No	Treatments	Mean population of spiders per hill*									
		First spray					Second spray				
		DBS	1DAS	3DAS	5 DAS	Mean	DBS	1DAS	3DAS	5 DAS	Mean
1	NSKE @10%	0.97	0.80	0.83	0.81	1.10	0.83	0.70	0.53	0.93	0.75
		(1.40)	(1.34)	(1.35)^{c}	(1.36)^{bc}	(1.45)^{a}	(1.35)	(1.30)	(1.24)^{b}	(1.39)^{a}	(1.32)^{abc}
2	Neem leaf extract @10%	0.98	0.87	0.98	0.88	0.83	0.93	0.80	0.43	0.80	0.71
		(1.41)	(1.37)	(1.41)^{c}	(1.37)^{bc}	(1.35)^{a}	(1.39)	(1.34)	(1.20)^{b}	(1.34)^{a}	(1.31)^{bc}
3	Karanj leaf extract @10%	0.90	1.13	0.77	0.82	0.70	1.07	0.80	0.63	0.77	0.63
		(1.38)	(1.46)	(1.33)^{c}	(1.35)^{bc}	(1.30)^{b}	(1.44)	(1.34)	(1.28)^{ab}	(1.33)^{a}	(1.28)^{c}
4	Custard apple leaf extract	0.93	0.73	0.83	0.88	0.87	0.93	0.68	0.53	0.87	0.73
		(1.39)	(1.32)	(1.39)^{c}	(1.37)^{bc}	(1.36)^{b}	(1.39)	(1.29)	(1.24)^{b}	(1.36)^{a}	(1.32)^{abc}
5	Chilli pod extract	1.10	0.70	0.83	0.80	0.78	0.97	0.65	0.67	0.80	0.68
		(1.45)	(1.30)	(1.35)^{c}	(1.34)^{bc}	(1.33)^{b}	(1.40)	(1.28)	(1.29)^{ab}	(1.34)^{a}	(1.29)^{c}
6	Buprofezin 25 SC @ 1.6 ml l^{-1}	1.00	0.75	0.47	0.58	0.62	0.81	0.60	0.53	0.30	0.51
		(1.41)	(1.32)	(1.21)^{d}	(1.26)^{cd}	(1.26)^{c}	(1.34)	(1.26)	(1.24)^{b}	(1.14)^{b}	(1.22)^{c}
7	Flubendiamide 20 WDG @ 0.25 g l^{-1}	0.93	0.77	0.67	0.50	0.52	0.87	0.67	0.57	0.23	0.49
		(1.39)	(1.33)	(1.29)^{cd}	(1.22)^{d}	(1.24)^{c}	(1.36)	(1.29)	(1.25)^{b}	(1.11)^{a}	(1.21)^{c}
8	NSKE @ 5%	1.03	0.89	1.04	0.90	1.12	1.13	0.77	0.70	0.87	1.08
		(1.42)	(1.37)	(1.42)^{b}	(1.38)^{b}	(1.46)^{a}	(1.44)	(1.33)	(1.30)^{ab}	(1.36)^{a}	(1.44)^{a}
9	Untreated control	0.98	1.33	1.43	1.26	1.14	0.88	0.93	1.03	1.23	1.36
		(1.41)	(1.52)	(1.55)^{a}	(1.50)^{a}	(1.53)^{a}	(1.37)	(1.39)	(1.42)^{a}	(1.48)^{a}	(1.57)^{a}
	SEm±	0.04	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.04
	CD (0.05)	N.S	0.15	0.12	0.11	0.14	NS	0.16	0.14	0.17	0.12
	CV(%)	5.10	6.20	6.76	6.03	5.96	8.05	6.02	6.54	7.53	5.34

Values in the parenthesis are square root transformations; DBS-day before spraying; DAS; day after spraying; NS= Non significant

Table 3. Effect of treatments on coccinellid population in rice crop after two sprays during *kharif*, 2019

T. No	Treatments	Mean population of coccinellids per hill*									
		First spray					Second spray				
		DBS	1DAS	3DAS	5 DAS	Mean	DBS	1DAS	3DAS	5 DAS	Mean
1	NSKE @10%	0.40	0.34	0.28	0.26	0.30	0.60	0.54	0.63	0.57	0.48
		(1.18)	(1.15)	(1.13)^{b}	(1.12)^{b}	(1.14)^{ab}	(1.26)	(1.24)	(1.27)^{abc}	(1.25)^{abc}	(1.21)^{bcd}
2	Neem leaf extract @10%	0.50	0.37	0.42	0.42	0.38	0.77	0.72	0.67	0.70	0.67
		(1.22)	(1.17)	(1.18)^{ab}	(1.19)^{ab}	(1.17)^{ab}	(1.33)	(1.31)	(1.29)^{abc}	(1.30)^{a}	(1.29)^{ab}
3	Karanj leaf extract @10%	0.37	0.43	0.40	0.40	0.45	0.70	0.57	0.72	0.63	0.57
		(1.17)	(1.19)	(1.18)^{ab}	(1.18)^{ab}	(1.20)^{ab}	(1.30)	(1.25)	(1.31)^{ab}	(1.28)^{ab}	(1.25)^{abc}
4	Custard apple leaf extract	0.53	0.33	0.44	0.42	0.53	0.67	0.55	0.60	0.65	0.74
		(1.24)	(1.15)	(1.20)^{ab}	(1.19)^{ab}	(1.23)^{a}	(1.29)	(1.24)	(1.26)^{abc}	(1.29)^{ab}	(1.32)^{ab}
5	Chilli pod extract	0.40	0.48	0.45	0.43	0.40	0.73	0.58	0.63	0.57	0.53
		(1.18)	(1.22)	(1.21)^{ab}	(1.20)^{ab}	(1.18)^{ab}	(1.32)	(1.25)	(1.28)^{abc}	(1.25)^{abc}	(1.24)^{abcd}
6	Buprofezin 25 SC @ 1.6 ml l^{-1}	0.30	0.40	0.27	0.23	0.24	0.53	0.58	0.48	0.28	0.27
		(1.14)	(1.18)	(1.12)^{b}	(1.11)^{b}	(1.11)^{b}	(1.23)	(1.25)	(1.22)^{c}	(1.13)^{c}	(1.12)^{d}
7	Flubendiamide 20 WDG @ 0.25 g l^{-1}	0.33	0.37	0.30	0.25	0.26	0.57	0.53	0.43	0.33	0.30
		(1.15)	(1.17)	(1.14)^{b}	(1.12)^{b}	(1.12)^{b}	(1.25)	(1.24)	(1.20)^{c}	(1.15)^{c}	(1.14)^{cd}
8	NSKE @ 5%	0.63	0.70	0.74	0.59	0.47	0.63	0.70	0.74	0.59	0.47
		(1.27)	(1.29)	(1.30)^{abc}	(1.26)^{abc}	(1.21)^{bcd}	(1.27)	(1.29)	(1.30)^{abc}	(1.26)^{abc}	(1.21)^{bcd}
9	Untreated control	0.67	0.73	0.77	0.85	0.87	0.67	0.73	0.77	0.85	0.87
		(1.29)	(1.31)	(1.33)^{a}	(1.36)^{a}	(1.37)^{a}	(1.29)	(1.31)	(1.33)^{a}	(1.36)^{a}	(1.37)^{a}
	SEm±	0.05	0.05	0.04	0.04	0.03	0.07	0.08	0.07	0.04	0.04
	CD (0.05)	NS	0.16	0.11	0.12	0.10	NS	0.16	0.10	0.13	0.12
	CV(%)	7.82	6.90	5.32	5.92	5.14	9.44	10.41	10.07	6.07	5.79

Values in the parenthesis are square root transformations; DBS-day before spraying; DAS; day after spraying; NS= Non significant

Table 4. Cumulative effect of treatments on mirid bugs, spiders, and coccinellids in rice crop after two sprays during *kharif*, 2019

T. No	Treatments	Mean number per hill*								
		Mirid bugs			Spiders			Coccinellids		
		First spray	Second spray	Mean	First spray	Second spray	Mean	First spray	Second spray	Mean
1	NSKE @10%	2.72 (1.93)^{a}	2.61 (1.90)^{a}	2.67 (1.91)^{a}	1.1 (1.45)^{a}	0.75 (1.32)^{abc}	0.93 (1.39)^{bc}	0.3 (1.14)^{ab}	0.48 (1.21)^{bcd}	0.39 (1.18)^{bcd}
2	Neem leaf extract @10%	2.64 (1.90)^{a}	2.73 (1.93)^{a}	2.69 (1.92)^{a}	0.83 (1.35)^{a}	0.71 (1.31)^{bc}	0.77 (1.33)^{bcd}	0.38 (1.17)^{ab}	0.67 (1.29)^{ab}	0.53 (1.23)^{abc}
3	Karanj leaf extract @10%	2.51 (1.87)^{a}	2.85 (1.96)^{a}	2.71 (1.93)^{a}	0.7 (1.30)^{b}	0.63 (1.28)^{c}	0.67 (1.29)^{cd}	0.45 (1.20)^{ab}	0.57 (1.25)^{abc}	0.51 (1.23)^{abc}
4	Custard apple leaf extract	2.44 (1.85)^{a}	2.75 (1.93)^{a}	2.6 (1.89)^{a}	0.87 (1.36)^{b}	0.73 (1.32)^{abc}	0.8 (1.34)^{bcd}	0.53 (1.23)^{a}	0.74 (1.32)^{ab}	0.64 (1.28)^{ab}
5	Chilli pod extract	2.55 (1.88)^{a}	2.83 (1.95)^{a}	2.7 (1.93)^{a}	0.78 (1.33)^{b}	0.68 (1.29)^{c}	0.73 (1.31)^{cd}	0.4 (1.18)^{ab}	0.53 (1.24)^{abcd}	0.46 (1.21)^{abc}
6	Buprofezin 25 SC @ 1.6 ml l^{-1}	1.73 (1.64)^{b}	2.1 (1.75)^{a}	1.91 (1.70)^{b}	0.52 (1.24)^{c}	0.51 (1.22)^{c}	0.52 (1.23)^{d}	0.24 (1.11)^{b}	0.27 (1.12)^{d}	0.26 (1.11)^{d}
7	Flubendiamide 20 WDG @ 0.25 g l^{-1}	1.35 (1.53)^{b}	1.99 (1.71)^{b}	1.67 (1.62)^{b}	0.62 (1.26)^{c}	0.49 (1.21)^{c}	0.56 (1.24)^{d}	0.26 (1.12)^{b}	0.3 (1.14)^{cd}	0.28 (1.12)^{d}
8	NSKE @ 5%	2.81 (1.95)^{a}	2.58 (1.89)^{a}	2.73 (1.93)^{a}	1.12 (1.46)^{a}	1.08 (1.44)^{a}	1.1 (1.45)^{ab}	0.31 (1.15)^{ab}	0.47 (1.21)^{bcd}	0.42 (1.18)^{bcd}
9	Untreated control	2.94 (1.98)^{a}	3.08 (2.02)^{a}	3.01 (2.00)^{a}	1.34 (1.53)^{a}	1.36 (1.57)^{a}	1.35 (1.55)^{a}	0.55 (1.24)^{a}	0.87 (1.37)^{a}	0.71 (1.31)^{a}
	SEm±	0.06	0.08	0.06	0.05	0.04	0.04	0.03	0.04	0.04
	CD (0.05)	0.17	0.13	0.17	0.14	0.12	0.13	0.1	0.12	0.1
	CV (%)	5.2	6.86	5.21	6.03	5.45	5.44	5.14	5.79	6.45

Values in the parenthesis are square root transformations; DBS-day before spraying; DAS; day after spraying; NS= Non significant

spiders. Ravichandra *et al.* (2014) also reported that pongamia aqueous extract recorded 4.00 spiders per hill when compared with control with 5.8 spiders per hill at 14 DAS. Choudhary *et al.* (2017) also reported that chemical insecticide was more fatal to natural enemies, than the neem products and were found safer and less toxic for different natural enemies. Rosaiah (2001) recorded that coccinellids were most predominant and there were no significant difference between the populations of these predators in plants sprayed with different plant products.

CONCLUSION

All organic extracts were safer to the natural enemies *viz.*, green mirid bugs, spiders and coccinellids, when compared to chemical treatments. NSKE @ 5%, KLE and CPE @ 10% found to be safer by recording the highest number of mirid bugs, while CaLE @ 10% recorded the higher no. of spiders.

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