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Eco-friendly Management of Rice Bug *Leptocorisa acuta* F. under Upland Rice Ecosystem

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A B S T R A C T

A study on eco friendly management of Rice bug, *Leptocorisa acuta*under upland rice by using organic pesticide was taken inOnattukara Regional Agricultural Research Station, Kayamkulam. Randomized block design with seven treatments and three replications were chosen which include 3 botanicals (1% azadirachtin 0.003%, cashew nut shell liquid 0.1% and dasagavya 3%), one microbial agent (chitin based Pseudomonas 2.5 kg ha^{-1}), one animal origin pesticide (fish jaggery extract 0.6%) and one check insecticide (Malathion 50 EC 0.1%) and untreated control plot. The treatment dasagavya 3% showed the significant effect on reducing rice bug population as well as grain infestation throughout the reproductive stage of the crop. It recorded lowest grain damage of 8.75% significantly over other treatments. The mean population of rice bug was less and varies from 0.33-13 from treatment dasagavya 3%. As greater biodiversity present in upland rice, it showed non-toxic effect to natural enemies *viz.,* predators, spiders and parasitoids. Untreated plot also recorded with more population of natural enemies. Malathion 50 EC 0.1% recorded least population of natural enemies and found to be toxic. Cashew nut shell liquid and Fish jaggery extract are also found to be effective and on par with Dasagavya. So, organic pesticides are safer and efficient in rice bug control under upland rice cultivation.

Introduction

Rice field is rapidly changing dynamic ecosystem with plenty of biodiversity of pest and natural enemies. From sowing to harvesting rice is liable to pest attack. There are reports of more than 128 insect pests infesting rice crop (Kalode, 2005). Rice bug *Leptocorisa acuta* F. (Alydidae: Hemiptera) is one among them. It may cause 30% annihilation of crop at milky or soft dough stage to harvesting under upland rice cultivation (Tiwari *et al.,* 2014).

As rice is a commercial crop, farmers depend on chemical insecticides for the control of the insect pests. However, continuous use of the chemicals is causing ecological imbalance (Tuan, 2014) and greater negative impingement on living things represented by

4 R's, i.e. Residue, Resurgence, Resistance and Risk. To overcome this, best way is to go for ecofriendly tactics by utilization of bio pesticides in rice bug management. This is economically viable and beneficial in sustainable pest management.

Materials and Methods

A field experiment was conducted to draw out the management strategy by utilization of bio pesticides against rice bug under upland rice. Bhagya, a short duration variety was selected for experiment.

The field experiment was taken in Onattukara Regional Agricultural Research Station, Kayamkulam. Place located at 9^0 11' N latitude, 76^0 30' E longitude and at an altitude of 6 m above mean sea level. Direct sowing of crop was done by using two days old sprouted seeds with 10 cm×10 cm spacing. All agronomical practices *viz.*, weeding (45 DAS) and fertigation (70:35:35 Kg ha^{-1})have been takento maintain the good plant stand till the crop harvest.

Design and layout

A randomized block design with seven treatments and three replications have been taken. Of seven treatments, 3 botanicals (1% Azadirachtin 0.003%, Cashew nut shell liquid 0.1% and Dasagavya 3%), one microbial agent (Chitin based Pseudomonas 2.5 kg ha^{-1}), one animal origin pesticide (Fish jaggery extract 0.6%) and one check insecticide (Malathion 50 EC 0.1%) and untreated control plot have been chosen. Layout of experiment is given in Plate1.

Observations of percentage damage and population of rice bug

Post treatment observations at 5, 7 and 10 days after application were recorded at two crop growth stages (50 and 70 DAS). Both the observations of percentage infestation and population were recorded. Percentage infestation was taken from 10 randomly selected hills from each plot. The bug infestation was recorded by counting the number of grains infected from total number of grains in a panicle from ten hills. The population of rice bug and natural enemies was recorded by counting number of individuals caught per 10 sweeps.

Yield

The crop was harvested at 90 days after sowing. Dry weight of straw and grain was taken and expressed in kg ha^{-1}.

Analysis and assessment of results

The data generated through field experiment were transformed and statistically dealt out by analysis of variance. The treatment effects were distinguished.

Results and Discussion

Regarding the effect of bio pesticides against rice bug, observations at 5, 7 and10 DAT at 2 treatments *viz.*, 50 and 70 DAS were recorded. The observations of percentage grain infestation and population of rice bug were recorded and the data analyzed is represented below (Plate 2).

Mean percentage infestation of rice bug (Table 1)

Rice bug, commonly start infestation from milky stage of crop. At 70 DAS, significant reduction in grain damage was observed in the treatment dasagavya 3% (14.75%) compared to control (29.23%) at 5 days after treatment. This was on par with the treatments cashew nut shell liquid 0.1% and fish jaggery extract 0.6% with incidence of 15.02 and 20.79% respectively. The treatments *viz.*, azadirachtin 0.003% (21.77), chitin based

Pseudomonas 2.5 kg ha^{-1}(21.92) and malathion 50 EC 0.1% (25.00) were on par with the control (29.23%).

At seven days after treatment, rice bug infestation on grains reduced significantly in the treatment dasagavya 3% (14.37%) compared to all other treatments and control (26.63%). This was on par with the treatments azadirachtin 0.003% (19.99%) fish jaggery extract 0.6% (21.05%), cashew nut shell liquid 0.1% (23.72%), chitin based Pseudomonas 2.5 kg ha^{-1} (25.98%) and malathion 50 EC 0.1% (27.18%).

Significant reduction grain damage was recorded in the treatment dasagavya 3% (8.97%) compared to all other treatments and control at ten days after treatment, The treatments *viz*., fish jaggery extract 0.6% (14.09%). chitin based Pseudomonas 2.5 kg ha^{-1} (15.75%), cashew nut shell liquid 0.1% (19.10%) and malathion 50 EC 0.1% (20.63%) were on par. Azadirachtin 0.003% (23.45%) was found to be on par with control (26.99%).

Mean population of Rice bug (Table 2)

At 50 DAS, there was no significant difference in rice bug population between treatments and control (5 DAT). However, the lowest population was recorded from the treatment dasagavya 3% (0.33) followed by chitin based Pseudomonas 2.5 kg ha^{-1} (0.67) and cashew nut shell liquid 0.1% (0.67).The same trend was observed at 7 DAT also. The lowest population was observed in the treatment dasagavya 3% (0.33) which was on par with cashew nut shell liquid 0.1% (0.67), fish jaggery extract 0.6% (1.00), malathion 50 EC 0.1% (1.00), azadirachtin 0.003% (1.33) and chitin based Pseudomonas 2.5 kg ha^{-1} (1.67). At 10 DAT, significant reduction in population was recorded from the treatment dasagavya 3% (0.67) and on par with cashew nut shell liquid 0.1% (1.67), chitin based Pseudomonas 2.5kg ha^{-1} (2.33), fish jaggery extract 0.6% (2.33), malathion 50 EC 0.1% (2.67) and azadirachtin 0.003% (3.33). The untreated control plot recorded the highest population of 7.33.

At 70 DAS, significant reduction in population was noticed in the treatment dasagavya 3% (4.00) which recorded the lowest population (5 DAT). This was on par with the treatments fish jaggery extract 0.6% (6.00), azadirachtin 0.003% (7.00), cashew nut shell liquid 0.1% (7.67) and chitin based Pseudomonas 2.5 kg ha^{-1} (8.67). The highest population of 16.00 was recorded in control which was on par with malathion 50 EC 0.1% (10.00). All the treatments recorded significantly low population of rice bug compared to control (16.67) at 7 DAT. The lowest population was observed in the treatment malathion 50 EC 0.1% (7.33) which was on par with dasagavya 3% (7.67), fish jaggery extract 0.6% (8.00), chitin based Pseudomonas 2.5 kg ha^{-1} (8.00), cashew nut shell liquid 0.1%(8.67) and azadirachtin 0.003% (10.00). At 10 DAT, the lowest population was recorded from dasagavya 3% (13.00) and on par with fish jaggery extract 0.6% (14.67), malathion 50 EC 0.1% (14.67) and cashew nut shell liquid 0.1% (16.33). The treatments *viz.*, azadirachtin 0.003%, chitin based Pseudomonas 2.5 kg ha^{-1}and control were on par with a population of 19.67, 21.67 and 26.0 respectively.

Effect of bio pesticides on overall population of natural enemies in upland rice ecosystem

The natural enemies recorded from rice field includes predators (*Micraspis discolor*, dragon flies, damsel flies, gryllids, *Ophionea nigrofasciata* and *Paederus fuscipes*), spiders (*Tetragnatha* sp.and *Argiope* sp.) and parasitoids (*Goniozus nephantidis* and *Cotesia* sp.) (Plate 3).

Predators

At 50 DAS, significant effect was noticed with maximum population was reported from dasagavya 3% (17.00) found to be on par with control and fish jaggery extract 0.6% with population of 14.33 and 13.67 respectively. The treatments *viz.*, cashew nut shell liquid 0.1%, chitin based Pseudomonas 2.5 kg ha^{-1}, malathion 50 EC 0.1% and azadirachtin 0.003% were on par with population of 9.67, 7.67, 6.67 and 6.33 respectively (5 DAT).Similarly at 7 DAT, non significant effect on predator population was noted. However, the highest population noted from control plot which was preceded by dasagavya 3%, fish jaggery extract 0.6%, chitin based Pseudomonas 2.5 kg ha^{-1}, cashew nut shell liquid 0.1%, malathion 50 EC 0.1% and azadirachtin 0.003% with population of 11.00, 8.67, 8.00, 7.67, 6.33, 5.00 and 4.00 respectively. At 10 DAT highest population of predators was recorded from dasagavya 3% (14.33) and control (12.00) followed by cashew nut shell liquid 0.1% (13.67), fish jaggery extract 0.6% (11.67), chitin based Pseudomonas 2.5 kg ha^{-1}(8.67), malathion 50 EC 0.1% (8.00) and Azadirachtin 0.003% (6.67).

At 70 DAS, control plot recorded the highest population of 18.00 on par with dasagavya 3% (17.666), fish jaggery extract 0.6% (14.33), cashew nut shell liquid 0.1% (13.33). Treatments *viz.*, azadirachtin 0.003%, chitin based Pseudomonas 2.5 kg ha^{-1} and malathion 50 EC 0.1% were on par with predator count of 10.33, 9.33 and 9.00 respectively (5 DAT). Same trend was followed at 7 DAT with untreated control plot noted the highest predators with 21.00 significantly. This was on par with dasagavya 3%, cashew nut shell liquid 0.1%, chitin based Pseudomonas 2.5 kg ha^{-1}, fish jaggery extract 0.6%, with predator count of 16.00, 15.33, 13.00 and 13.00 respectively. Azadirachtin 0.003% and malathion 50 EC 0.1% recorded the lowest population of 9.00 and 7.00 respectively. At 10 DAT, significant effect was observed with control plot recorded the maximum population of 25.33 on par with dasagavya 3% with population of 20.67. treatments *viz.*, fish jaggery extract 0.6%, chitin based Pseudomonas 2.5 kg ha^{-1}, cashew nut shell liquid 0.1%, azadirachtin 0.003% and malathion 50 EC 0.1% were on par with population of 16.666, 15.33, 13.67, 11.666 and 11.33 respectively (Table 3).

Parasitoids

At 50 DAS, significantly higher population of parasitoids recorded from control (29.0). This was on par with the treatments dasagavya 3% (23.67) and fish jaggery extract 0.6% (22.67). The treatments *viz.*, azadirachtin 0.003% (17.67), cashew nut shell liquid 0.1% (16.67) and chitin based Pseudomonas 2.5 kg ha^{-1}(16.33) were found to be on par. The lowest population was recorded from malathion 50 EC 0.1% (6.33) (5 DAT). At seven days after treatment, significantly high population of parasitoids was recorded with control (26.00). This was on par with dasagavya 3%, fish jaggery extract 0.6% and chitin based Pseudomonas 2.5 kg ha^{-1}, with population of 18.00, 17.33 and 17.00 respectively. The lowest population of 9.67 was reported from azadirachtin 0.003% and on par with cashew nut shell liquid 0.1% and malathion 50 EC 0.1% with mean population of 12.0. Similarly at 10 DAT, the highest population was recorded in control (25.33) and on par with dasagavya 3% (21.67), cashew nut shell liquid 0.1% (19.0), and fish jaggery extract 0.6% (18.33). The other treatments *viz.*, chitin based Pseudomonas 2.5 kg ha^{-1}(16.00), azadirachtin 0.003% (15.33) and malathion 50 EC 0.1% (11.33) were found to be on par. At 70 DAS, control plot noted the superior population of parasitoids (26.33) succeeded by dasagavya 3% (18.33) on par with azadirachtin 0.003% (17.666), chitin based

Pseudomonas 2.5 kg ha^{-1} (16.67), fish jaggery extract 0.6% (16.33), malathion 50 EC 0.1% (14.67) and cashew nut shell liquid 0.1%(14.00) (5 DAT). Seven days after treatment, control plot recorded 25.33 parasitoids, on par with dasagavya 3% (24.67), cashew nut shell liquid 0.1% and malathion 50 EC 0.1% with 21.00 and fish jaggery extract 0.6% with 19.00. The lowest population recorded from chitin based Pseudomonas 2.5 kg ha^{-1} about 12.33 followed by azadirachtin 0.003% about 16.00. Ten days after treatment, significant effect on parasitoids population was noticed with maximum record from control (26.67) was on par with dasagavya 3%, fish jaggery extract 0.6%, chitin based Pseudomonas 2.5 kg ha^{-1}, azadirachtin 0.003% and cashew nut shell liquid 0.1% with population of 25.00, 22.33, 22.00, 21.67 and 18.67 respectively. Malathion 50 EC 0.1% recorded with lowest population of 15.00 (Table 4).

Spiders

Non significant population of spiders was noted from both the cropping period (50 and 70 DAS). Only significant effect was noticed at 7 DAT (70 DAS) with superior population recorded from control plot noted with 2.038 on par with Dasagavya 3% and Cashew nut shell liquid 0.1% with population of 2.0 (Table 5).

Yield

The average highest yield of grain 3266.66 Kg ha^{-1} recorded from Cashew nut shell liquid 0.1% significantly with highest B: C ratio of 2.8. This was succeeded by Dasagavya 3% (2983.33 kg ha^{-1}) with B: C ratio of 2.6. The average straw yield of 3358.33 kg ha^{-1} recorded from Cashew nut shell liquid 0.1% on par with Dasagavya 3% (3300.00 kg ha^{-1}) (Table 6).

Table.1 Effect of organic pesticides on rice bug infestation at 70 days after sowing of upland rice

Treatments	**Grain damage (%)- 70 DAS**		
	5 DAT	7 DAT	10 DAT
Azadirachtin	21.77^{ab} (4.66)	19.99^{a} (4.51)	23.45^{a} (4.83)
Chitin based pseudomonas	21.92^{ab} (4.68)	25.98^{a} (5.14)	15.75^{a} (3.94)
Cashew nut shell liquid	15.02^{bc} (3.87)	23.72^{a} (4.92)	19.10^{a} (4.37)
Fish jaggery extract	20.79^{abc} (4.55)	21.05^{a} (4.61)	14.09^{a} (3.74)
Dasagavya	14.75^{c} (3.64)	14.37^{b} (3.79)	8.97^{b} (2.99)
Malathion	25.00^{a} (4.98)	27.18^{a} (5.27)	20.63^{a} (4.51)
Control	29.23^{a} (5.41)	26.63^{a} (5.20)	26.99^{a} (5.20)
CD (0.05)	0.995	0.697	0.636

Figures in parenthesis are $\sqrt{x+1}$ transformed values, DAS: Days after sowing, DAT: Days after treatment, DAS: Days after sowing

Table.2 Effect of organic pesticides on mean population of rice bug at different crop growth stages of upland rice

Treatments	Mean population of rice bug 10 sweeeps^{-1}					
	50DAS			70 DAS		
	5 DAT	7 DAT	10 DAT	5 DAT	7 DAT	10 DAT
Azadirachtin	1.00 (1.18)	1.33^{b} (1.27)	3.33^{b} (1.95)	7.00^{bc} (2.62)	10.00^{ab} (3.16)	19.67^{ab} (4.657)
Chitin based pseudomonas	0.67 (1.00)	1.70^{b} (1.38)	2.33^{b} (1.54)	8.67^{abc} (2.95)	8.00^{b} (2.83)	21.67^{ab} (4.69)
Cashew nut shell liquid	0.67 (1.05)	0.67^{b} (1.05)	1.67^{b} (1.46)	7.67^{bc} (2.65)	8.67^{b} (2.95)	16.33^{bc} (4.03)
Fish jaggery extract	1.00 (1.18)	1.00^{b} (1.18)	2.33^{b} (1.54)	6.00^{bc} (2.38)	8.00^{b} (2.73)	14.67^{bc} (3.79)
Dasagavya	0.33 (0.88)	0.33^{b} (0.88)	0.67^{b} (1.0)	4.00^{c} (1.98)	7.67^{b} (2.62)	13.00^{c} (3.58)
Malathion	1.00 (1.18)	1.00^{b} (1.18)	2.66^{b} (1.76)	10.00^{ab} (3.09)	7.33^{b} (2.46)	14.67^{bc} (3.79)
Control	2.33 (1.68)	5.00^{a} (2.34)	7.33^{a} (2.8)	16.00^{a} (3.98)	16.67^{ab} (4.08)	26.00^{a} (5.09)
CD (0.05)	NS	0.790	0.899	1.089	0.941	0.940

Figures in parenthesis are $\sqrt{x+1}$ transformed values, DAS: Days after sowing, DAT: Days after treatment, DAS: Days after sowing

Table.3 Effect of organic pesticides on mean population of predators recorded by sweeping at different crop growth stages of upland rice

Treatments	Mean population of predators10 sweeps^{-1}					
	50 DAS			70 DAS		
	5 DAT	7 DAT	10DAT	5 DAT	7 DAT	10 DAT
Azadirachtin	6.33^{c} (2.46)	4.00^{c} (1.94)	6.67^{c} (2.55)	9.33^{b} (3.05)	9.00^{bc} (2.95)	11.67^{c} (3.42)
Chitin based pseudomonas	7.67^{c} (2.72)	7.67^{b} (2.77)	8.67^{abc} (2.93)	10.33^{b} (3.20)	13.00^{abc} (3.6)	15.33^{bc} (3.9)
Cashew nut shell liquid	9.67^{c} (3.046)	6.33^{b} (2.51)	13.67^{ab} (3.7)	13.33^{ab} (3.58)	15.33^{ab} (3.88)	13.67^{c} (3.65)
Fish jaggery extract	13.67^{b} (3.66)	8.0^{b} (2.83)	11.67^{abc} (3.25)	14.33^{ab} (3.76)	13.00^{bc} (3.52)	16.67^{c} (3.65)
Dasagavya	17.00^{a} (4.11)	8.67^{b} (2.95)	14.33^{a} (3.77)	17.67^{a} (4.20)	16.0^{ab} (3.99)	20.67^{ab} (4.54)
Malathion	6.67^{c} (2.47)	5.0^{c} (2.21)	8.00^{bc} (2.83)	9.00^{b} (3.0)	7.00^{c} (2.64)	11.33^{c} (3.36)
Control	14.33^{b} (3.78)	11.00^{a} (3.31)	14.33^{a} (3.77)	18.00^{a} (4.25)	21.00^{a} (4.57)	25.33^{a} (5.04)
CD (0.05)	1.156	0.573	0.875	0.820	1.049	0.795

Figures in parenthesis are $\sqrt{x+1}$ transformed values, DAS: Days after sowing, DAT: Days after treatment, DAS: Days after sowing

Table.4 Effect of organic pesticides on mean population of parasitoids recorded by sweeping at differentcrop growth stages of upland rice

Treatments	Mean population of parasitoids 10 sweeps^{-1}					
	50 DAS			70 DAS		
	5 DAT	7 DAT	10 DAT	5 DAT	7 DAT	10 DAT
Azadirachtin	17.67^{abc} (4.20)	9.67^{b} (3.09)	15.33^{bc} (3.83)	17.67^{b} (4.2)	16.00^{bc} (3.98)	21.67^{ab} (4.66)
Chitin based pseudomonas	16.33^{abc} (4.04)	17.00^{ab} (4.11)	16.00^{bc} (4.00)	16.67^{b} (4.04)	12.33^{c} (3.50)	22.00^{ab} (4.69)
Cashew nut shell liquid	16.67^{abc} (4.06)	12.00^{b} (3.32)	19.00^{ab} (4.33)	14.00^{b} (3.72)	21.00^{ab} (4.58)	18.67^{bc} (4.31)
Fish jaggery extract	22.67^{ab} (4.77)	17.33^{ab} (4.17)	18.33^{ab} (4.27)	16.33^{b} (4.0)	19.00^{ab} (4.32)	22.33^{ab} (4.69)
Dasagavya	23.67^{ab} (4.87)	18.00^{ab} (4.21)	21.67^{ab} (4.64)	18.33^{b} (4.28)	24.66^{a} (4.95)	25.00^{a} (4.98)
Malathion	6.33^{c} (2.46)	12.00^{b} (3.42)	11.33^{c} (3.35)	14.67^{b} (3.82)	21.00^{ab} (4.59)	15.00^{c} (3.86)
Control	29.00^{a} (5.38)	26.00^{a} (5.1)	25.33^{a} (5.02)	26.33^{a} (5.14)	25.33^{a} (5.03)	26.67^{a} (5.17)
CD(0.05)	0.667	1.128	0.831	0.819	0.750	0.574

Figures in parenthesis are $\sqrt{x+1}$ transformed values, DAS: Days after sowing, DAT: Days after treatment, DAS: Days after sowing

Table.4 Effect of organic pesticides on mean population of spiders recorded by sweeping at different crop growth stages of upland rice

Treatments	Mean population of spiders per 10 sweeps					
	50 DAS			70 DAS		
	5 DAT	7 DAT	10 DAT	5 DAT	7 DAT	10 DAT
Azadirachtin	0.33 (0.88)	0.33 (0.88)	0.33 (0.88)	0.67 (1.00)	0.33^{b} (1.05)	0.67 (1.05)
Chitin based pseudomonas	0.33 (0.88)	0.33 (0.88)	1.00 (1.09)	0.67 (1.00)	0.33^{b} (1.18)	0.67 (1.00)
Cashew nut shell liquid	0.67 (1.00)	0.33 (0.88)	1.00 (1.23)	2.00 (1.56)	2.00^{a} (0.88)	1.67 (1.45)
Fish jaggery extract	0.33 (0.88)	0.67 (1.00)	0.67 (1.00)	0.67 (1.0)	0.67^{b} (0.88)	1.33 (1.35)
Dasagavya	1.00 (1.18)	1.00 (1.18)	1.33 (1.35)	2.00 (1.58)	2.00^{b} (0.88)	1.67 (1.46)
Malathion	0.33 (0.88)	0.33 (0.88)	0.0 (0.70)	0.67 (1.0)	0.33^{b} (1.46)	1.00 (1.09)
Control	1.00 (1.18)	1.33 (1.35)	2.33 (1.68)	2.33 (1.68)	3.33^{a} (2.04)	2.00 (1.56)
CD (0.05)	NS	NS	NS	NS	0.532	NS

Figures in parenthesis are $\sqrt{x+1}$ transformed values, DAS: Days after sowing, DAT: Days after treatment, DAS: Days after sowing

Table.6 Effect of organic pesticides on yield

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Marginal B:C ratio
1% Azadirachtin 0.003%	2458.33	2541.66	2.1
Chitin based Pseudomonas 2.5 Kg ha^{-1}	2375.00	2550.00	2.4
Cashew nut shell liquid 0.1%	3266.66	3358.33	2.8
Fish jaggery extract 0.6%	2854.00	2733.33	1.8
Dasagavya 3%	2983.33	3300.00	2.6
Malathion 50EC 0.1%	2810.83	2275.00	2.5
Untreated control	1883.33	1351.66	-
CD (0.05)	781.564	909.503	-

Rice bug is a major threat to rice. Because, it attack the crop during reproductive stage. From the results of 3.1. Rice bugs are susceptible to dasagavya 3% at 70 DAS and effective at reducing the damage (Fig 1). The lowest population from dasagavya 3% was noted and found to be effective at 50 and 70 DAS. Secondary metabolites and minerals and organic acids found in plant extracts used in dasagavya imparts them insecticidal property (Das *et al.*, 2004). The other botanicals *viz.*, azadirachtin 0.003%, cashew nut shell liquid 0.1% and Fish jaggery extract 0.6% are found to be effective by showing higher mortality next to Dasagavya 3%). Dasagavya is effective in controlling sucking pests like aphids, white flies, thrips and mites and some foliage feeders (Prabhu, 2006). Dasagavya 3 per cent was found to be effectively controlling the pests and diseases in floral crops (Package of practices, KAU, 2009).

Untreated control plot built more population of natural enemies *viz.*, Predators, parasitoids and spiders. This was succeeded by dasagavya 3% found to be safer to predators, parasitoids and spiders. Next to that, Fish jaggery extract 0.6% safer to predators and parasitoids. Cashew nut shell liquid 0.1% is safer to spiders. Overall population of predators and parasitoids was reaches maximum during later crop stage. Spiders were increased gradually and reaches maximum at 70 DAS (Premila, 2003) but non significant with treatment effect. Though malathion 50 EC 0.1% showed some effect on rice bug, however the population of natural enemies *viz.*, predators, parasitoids and spiders recorded was least from entire crop period (Fig 3, 4 and 5). There was a significant higher yield of grain and straw was obtained from Cashew nut shell liquid 0.1% and dasagavya 3%. Lowest yield recorded from control plot (Fig 6).

In conclusion, up to certain stage, rice can resist the pest incidence due to residence of defenders in the ecosystem with moderate population without use of insecticides (Nalinakumari *et al.*, 1996). So that, the conservation of carnivorous arthropods in situ for suppressing pest population is seems to be best instead of using toxic chemicals (Lekha, 2003). Bio pesticides especially dasagavya, cashew nut shell liquid and fish jaggery extract have putatively great role in controlling rice bug, safety and conservation of natural enemies in order to manage rich biodiversity by balancing pests and natural enemies. This statement is supported by Gangwar *et al.*, (2015) by saying biological control should be preferable over chemical as biocontrol contributes 60% mortality of rice pests. Malathion is not safer to natural enemies present in ecosystem. So, utilization of bio pesticides dedicate ample scope for pest control by keep away dangerous pesticides and conserving natural enemies under upland cultivation.

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Abbreviations

DAT: Days after treatment, DAS: Days after sowing, NS: Non significant

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