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"Management of Green Leaf Hopper (*Nephotettix virescens*) and Brown Plant Hopper (*Nilaparvata lugens*)throughEco-friendly approaches"

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ABSTRACT
A field experiment was conducted to study the effect of various Eco-friendly insecticides*viz.,* Camphor oil @ 1000 ml/ha, Cedarwood oil @ 1000 ml/ha, Eucalyptusoil @ 1000 ml/ha, Lemongrass oil @ 1000 ml/ha, Neemazal @ 1000 ml/ha, Dinotefuran20SG@ 200 ml/ha and Rynaxypyr20SC@ 100 ml/haagainst the population of Green LeafHopper (*Nephotettix virescens*) and Brown Plant Hopper (*Nilaparvata lugens*). The results revealed that all the plots treated with Eco-friendly insecticides had significant influence on the population of the insect pest.The lowest population of *N. lugens*and *N. virescens*was recorded in the plot treated with Rynaxypyr 100 ml/ha with a lowest mean population of 7.79% and 8.03% respectively as compared to 18.19% and 17.05% recorded in the control plot.The percent reduction of *N. lugens* and *N. virescens*population over control recorded was 57.17 and 52.90 respectively. The lowest mean population was also recorded in the plot treated with Dinotefuran 20SG@ 200 ml/ha with a mean population of 8.69% and 9.03% respectively. The plot treated with Cedarwood oil @ 1000 ml/ha recorded the highest mean population of *N. lugens* and *N. virescens*of 11.00% and 11.79%respectively. The highest grain yield of 5.9 ton/ha was recorded in the plot treat with Rynaxypyr 20SC@ 100 ml/ha which was at par withDinotefuran 20SG@ 200 ml/ha with a yield of 5.68 tons/ha as compared to 3.27 tons/ha in control plot.
Key words: *Nephotettix virescens*, *Nilaparvata lugens*, Rynaxypyr,Dinotefuran

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INTRODUCTION

Rice (*Oryzasativa*) belongs to the family Graminae, is one of the most important food crops not only in India but the world too. More than two billion people in Asia and hundred million in Africa and Latin America depends upon rice as staple food. Rice is grown in all the continents except Antarctica. Rice is India's pre-eminent crop and is the staple food of the people of the Eastern and Southern parts of the country where about 44.1 million hectare of land is under rice cultivation with a production of 110.15 million tonnes [1]. Introduction and wide adoption of high yielding varieties, improper application of fertilizers etc. has led to sever incidence of different insect pests. The insect pests are amajor constraint in rice production in which yield losses due to their infestation of rice ranges from 25-51 per cent [2]. Nearly 300 species of insect pests attack the rice crop at different stages and among them only 23 species cause notable damage [3]. Homopterous insect Green Leaf Hopper (*Nephotettix virescens*) and Brown Plant Hopper (*Nilaparvata lugens*) are important pests of rice in southeast and Far East Asia, because it causes both direct and

indirect damages to the rice crop. Direct damages are accomplished by sucking plants sap which often results in the complete withering of the plants known as hopper burn and indirect damage results in transmission of viral diseasessuch as vector of Rice Grassy Stunt and Ragged Stunt Viruses.Generally the yield losses due to hoppers ranges from 10-90 percent but if timely control measures are not taken up, there may be possibility of total crop loss within a very short period[4]. Several resistant varieties of rice were released but populations of the insect pest were reported to show resistance. On the other hand they have also developed resistance to most organophosphates, carbamates and synthetic pyrethroids insecticides [5]. So there is a need for alternate approach, which is most effective against BPH, less toxic to mammals and effective at lower quantity substituting to older chemicals in integrated pest management. Therefore, several insecticides derived from plant origin and new molecular insecticides with different mode of action were under taken to test its efficacy against the population of Green Leaf Hopper (*Nephotettix virescens*) and Brown Plant Hopper (*Nilaparvatalugens*).

MATERIAL AND METHODS

A field experiment was conducted at Research farm, RPCAU, Pusa, Samastipur, Bihar in *Kharif*, 2018. The size of each plot measured 20–25 m² with Spacing 20 x 15 cm.The experimental design incorporated was Random Block Design(RBD) with 8 treatments and 3 replications. The seedlings were transplanted at 3½ - 4 weeks after sowing. Two insecticidal sprays were initiated 15DAT.Observations on insect pest populations were recorded from randomly selected ten hills from each replication at one day before and seven days after each spray in all the treatments. The percentage of leaf damage was calculated as follows

$$\text{Per cent incidence (\%)} = \frac{\text{Number of damaged leaves/hill}}{\text{Total number of leaves/hill}} \times 100$$

The avoidable loss and increase in yield over control were calculated for each treatment by the following formula given by Pradhan, 1964:

$$\text{Avoidable loss (\%)} = \frac{\text{Highest yield in treated plot} - \text{Yield in the treatment}}{\text{Highest yield in treated plot}} \text{ X } 100$$

$$\text{Increase in yield (\%)} = \frac{\text{Yield in treatment} - \text{Yield in control}}{\text{Yield in control}} \text{ X } 100$$

To determine the most effective and economical treatment, the net profit and benefit-cost ratio were worked out by taking the expenditure on the individual insecticidal treatment and the corresponding yield into account.

RESULTS AND DISCUSSION:

Comparative efficacy of different Eco-friendly insecticides against population of Green Leaf Hopper (*Nephotettix virescens*) and Brown Plant Hopper (*Nilaparvata lugens*) during *Kharif* 2018are presented in Table 1 and 2.The results indicates that during first spray 7 DAA the mean population of *N. lugens* varied from 5.47-23.97% and after second spray 7DAA the mean population of *N. lugens* varied from 5.10-20.31. The mean data indicates that the lowest populations of *N. lugens* was recorded in the plot treated with Rynaxypyr 100 ml/ha with a lowest mean population of 7.79% as compared to 18.19% mean population of *N. lugens* in control plot. The plot treated with Dinotefuran 20SG@ 200 ml/haexhibited the second most effective treatment in managing the population of *N. lugens*with a mean population of 8.69%. The other treatments viz., Eucalyptus oil @ 1000 ml/ha, Camphor oil @ 1000 ml/ha, Neemazal @ 1000 ml/ha, Lemongrass oil @ 1000 ml/ha and Cedarwood oil @ 1000 ml/ha also showed significant reduction in the population of the pest with a mean population of 9.89%, 10.15%, 10.33%, 10.91 and 11.00% respectively. On the other hand, the population of *Nephotettixvirescens* at 7 DAA after first spray varied from 5.10-16.03 whereas on the second spray 7DAA the population varied from 4.05-16.64. The mean data represented on the table indicates that the lowest mean population of 8.03% was recorded in the plot treated withRynaxypyr 100 ml/ha as compared to 17.05% in the control plot. This was followed by the plot treated with Dinotefuran 20SG@ 200 ml/ha with a mean population of 9.03% which was at par withNeemazal @ 1000 ml/ha and Cedarwood oil @

1000 ml/ha with a mean population of 9.92% and 9.78% respectively. The plot treated with Camphor oil @ 1000 ml/ha, Lemongrass oil @ 1000 ml/ha and Cedarwood oil @ 1000 ml/ha also showed significant reduction of the population of *Nephotettix virescens* with a mean population of 10.94%, 11.19% and 11.79% respectively. The present finding is in agreement with the with Balamurugan*et al.*, [2] who reported that the efficacy of Rynaxypyr in the population of *Nephotettixvirescens* and *Nilaparvata lugens* showed a significant reduction of insect pest population with a mean population of 6.83% and 5.99% respectively. Seni and Naik [9] also observed the effectiveness of Rynaxypyr 20 SC for suppression of plant hoppers population in rice.Konchada et al., [4] studied the efficacy of Dinotefuran 20 SG against *Nilaparvata lugens* and reported a mean population of 7.60% as against 20.60% in the control plot.

Economics:

It was found that in Table 3, that Rynaxypyr 20 SC @ 30 g a.i/ha treated plot recorded highest yield of 5.90 t/ha (>80% yield increase over control) followed by Dinotefuran 20SG@ 200 ml/ha with a yield of 5.68 t/ha. The yield obtained from other treatments also recorded significantly higher yield as compared to control plot. the plot treated with Lemongrass oil @ 1000 ml/ha, Eucalyptus oil @ 1000 ml/ha, Neemazal @ 1000 ml/ha,Camphor oil @ 1000 ml/ha, Cedarwood oil @ 1000 ml/ha recorded a yield of 5.14 t/ha, 4.88 t/ha, 4.57 t/ha, 4.32 t/ha and 3.89 t/ha respectively. The highest cost benefit ratio of was recorded in the plot treated with Dinotefuran 20SG@ 200 ml/ha which was followed by Camphor oil @ 1000 ml/ha, Cedarwood oil @ 1000 ml/ha, Lemongrass oil @ 1000 ml/ha, Rynaxypyr 20 SC @ 30 g a.i/ha, Eucalyptus oil @ 1000 ml/ha and Neemazal @ 1000 ml/ha.The present finding is in agreement with Seni and Naik (2017) who reported that rynaxypyr 20 SC @ 30 g a.i/ha treated plot recorded highest yield of 4.61 t/ha (>34% yield increase over control) as compared to rest of the other insecticidal treatments.

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Table 1: Efficacy of botanicals against *Nilaparvata lugens* population during *Kharif*, 2018

Treatment	Dose (ml/ha)	During 1st spray		During 2nd spray		Mean	% reduction of population over control
		1 DBA	7 DAA	1 DBA	7 DAA		
T_1= Camphor oil	1000	11.03 (3.40)	10.81 (3.36)	9.91 (3.23)	8.83 (3.05)	10.15	44.20
T_2= Cedar wood oil	1000	13.04 (3.68)	9.57 (3.17)	11.53 (3.47)	9.87 (3.22)	11.00	39.52
T_3= Eucalyptus oil	1000	12.29 (3.58)	9.86 (3.22)	9.22 (3.12)	8.20 (2.95)	9.89	45.62
T_4= Lemongrass oil	1000	13.62 (3.76)	9.45 (3.15)	10.78 (3.36)	9.79 (3.21)	10.91	40.10
T_5= Neemazal	1000	14.68 (3.90)	8.65 (3.02)	11.05 (3.40)	6.93 (2.73)	10.33	43.21
T_6= Dinotefuran	200	12.71 (3.63)	6.84 (2.71)	9.12 (3.10)	6.08 (2.57)	8.69	52.22
T_7= Rynaxypyr	150	12.24 (3.57)	5.47 (2.44)	8.34 (2.97)	5.10 (2.37)	7.79	57.17
T_8= Water spray	-	11.80 (3.51)	23.97 (4.94)	16.68 (4.14)	20.31 (4.59)	18.19	
S.Ed(±)		1.15	2.94	3.85	0.85		
CD(0.05)		2.46	6.30	8.26	1.81		

Figures in the parenthesis are of square root transformation values (√(x+0.5))

Table 2: Efficacy of botanicals against *Nephotettix virescens* population during *Kharif*, 2018

Treatment	Dose (ml/ha)	During 1st spray		During 2nd spray		Mean	% reduction of population over control
		1 DBA	7 DAA	1 DBA	7 DAA		
T_1= Camphor oil	1000	16.64 (4.14)	8.60 (3.02)	10.97 (3.39)	7.54 (2.84)	10.94	35.83
T_2= Cedarwood oil	1000	15.76 (4.03)	9.87 (3.22)	12.72 (3.64)	8.82 (3.05)	11.79	30.85
T_3= Cedarwood oil	1000	13.98 (3.81)	8.20 (2.95)	9.89 (3.22)	7.03 (2.74)	9.78	42.63
T_4= Lemongrass oil	1000	15.81 (4.04)	9.02 (3.09)	11.56 (3.47)	8.37 (2.98)	11.19	34.36
T_5= Neemazal	1000	14.86 (3.92)	6.93 (2.73)	12.13 (3.55)	5.77 (2.50)	9.92	41.81

T_6= Dinotefuran	200	15.04 (3.94)	6.08 (2.57)	10.13 (3.26)	4.86 (2.32)	9.03	47.03
T_7= Rynaxypyr	150	13.86 (3.79)	5.10 (2.37)	9.09 (3.10)	4.05 (2.13)	8.03	52.90
T_8= Water spray	-	16.94 (4.18)	16.03 (4.07)	18.62 (4.37)	16.64 (4.14)	17.05	
S.Ed(±)		1.85	1.88	3.39	1.35		
CD(0.05)		3.96	4.04	7.27	2.90		

Figures in the parenthesis are of square root transformation values ($\sqrt{x + 0.5}$)

Tbale 3: Economical Yield after treatment of different botanicals

Treatment	Dose (ml/ha)	**Yield (t/ha)**	**Increased yield over control (%)**	**Gross return (₹ /ha)**	**Cost of management (₹ /ha)**	**Net return (₹ /ha)**	**Cost-benefit ratio**
T_1= Camphor oil	1000	4.32	32.11	15577.5	650	14927.5	1:22.96
T_2= Cedar wood oil	1000	3.89	18.96	9610	425	9185	1:21.61
T_3= Eucalyptus oil	1000	4.88	49.23	24955	2800	22155	1:7.91
T_4= Lemongrass oil	1000	5.14	57.18	28985	1650	27335	1:16.56
T_5= Neemazal	1000	4.57	39.75	20150	6600	13550	1:2.05
T_6= Dinotefuran	200	5.68	73.70	37355	1471.2	35883.80	1:24.39
T_7= Rynaxypyr	150	5.90	80.42	40765	2425	38340	1:15.81
T_8= Water spray	-	3.27	-				

Cost-benefit ratio of the different treatments on Rice

Cost of Rice =.₹ 15.50/kg

Labour charge for two times insecticides application = ₹ 150 X 2 = 300

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