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Research Article

Impact of certain essential oils and insecticides against major insect pests and natural enemies in rice

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Abstract

The present experiment was carried out during *kharif,* 2017 & 2018 to determine the efficacy of some selected botanicals (essential oils) and insecticides against major insect pests like stem borer; *Scirpophaga incertulas* (Walk.), plant hoppers; both brown plant hopper (BPH), *Nilaparvata lugens* (Stål), white backed plant hopper (WBPH), *Sogatella furcifera* (Horvath), gall midge; *Orseolia oryzae* (Wood-Mason) and natural enemies in rice. The treatments were; Camphor oil, Cedar wood oil, Eucalyptus oil and Lemon grass oil @ 1000 ml ha^{-1}, Neemazal 1EC @ 1000 ml ha^{-1}, Rynaxypyr 20 SC @ 150 ml ha^{-1} and Dinotefuran 20 SG @ 200 g ha^{-1}. Among the different treatments, chemical insecticide Rynaxypyr 20 SC @ 150 ml ha^{-1} was most effective to manage the infestation of stem borer and Dinotefuran 20 SG @ 200 g ha^{-1} against plant hoppers in both the years. Among botanicals, Eucalyptus oil @ 1000 ml ha^{-1} was found effective to suppress the incidence of yellow stem borer and plant hoppers as well as highest yield was recorded from same treatment. Whereas, Cedar wood oil @ 1000 ml ha^{-1} was found effective to reduce the incidence of gall midge. All the botanicals were safe to natural enemies. For this reason, these botanicals may provide an effective and eco-friendly alternate to conventional synthetic insecticides and can be incorporated in the integrated pest management programme of rice pests.

Keywords: Botanicals, gall midge, natural enemies, plant hoppers, stem borer

1. Introduction

Rice (*Oryza sativa* L.) is one of the important cereal foods in the world and half of the global population depends on it for fulfillment of their nutritional requirement (FAO, 2004). In India, it is the most important cereal crop covering about one-fourth of the total cropped area and providing food to about more than half of the Indian population. It thrives well under varying topographic and hydrologic conditions ranging from rain fed upland to rain fed lowland as well as in deep water conditions (Adhya *et al.,* 2009). Introduction and wide cultivation of high yielding varieties has led to severe incidence of different insect pests. It is infested with large number of insect pests. Among them, yellow stem borer (YSB), *Scirpophaga incertulas* (Walk.), plant hoppers; both brown plant hopper (BPH), *Nilaparvata lugens* (Stål), white backed plant hopper (WBPH), *Sogatella furcifera* (Horvath), are the major insect pests for causing huge economic crop losses to rice (Seni and Naik, 2018). Yield losses due to yellow stem borer are estimated 1-19% in early transplanted and 38-80% in late transplanted rice crops (Catinding and Heong, 2003). Plant hoppers causes almost 10 to 90 per cent yield losses in rice but if timely control measures are not taken up; there may be possibility of total crop loss within a very short time (Seni and Naik, 2017a). Gall midge; *Orseolia oryzae* (Wood-Mason) is another important insect which causes an annual yield loss of 0.8% of the total production (Seni and Naik, 2018). The damage symptom caused by gall midge is the production of a silvery-white, tubular leaf sheath gall called a *silver shoot* or *onion shoot* (Seni and Naik, 2017). This causes the tiller sterile and do not bear panicle. Synthetic chemical treatments are still reliable tool to tackle the major insect pest's problem in rice. But the overuse and untimely application of those have created a number of unwanted side effects such as the development of resistant mechanism in insects, environmental pollution and health hazards to farmers as well as consumers (Hassall, 1990; Satpathi *et al.,* 2005). For this, now-a-days emphasis has been given to botanical pesticides as they are considered as environmentally friendly; besides, this method does not only reduce application of synthetic insecticides, but also reduce the cost of pest management programme. Some essential oils already tested and recommended for use on plants to minimize the various insect pests infestation as they have multiple mode of action, i.e. larvicidal, repellent and ovicidal activities (Sarwar and Salman, 2015; Murray, 2000). Keeping this in mind, the study was undertaken to evaluate the efficacy of some commercially available botanical formulations against stem borer, gall midge, plant hoppers and natural enemies in rice under field condition.

2. Materials and methods

The experiment was conducted at the experimental farm of Regional Research and Technology Transfer Station (OUAT), Chiplima, Sambalpur, Odisha, in randomized block design (RBD). There were eight treatments which were replicated thrice in a net experimental area of 5 m x 4 m during each *kharif* 2017 and 2018 seasons. The experimental farm is situated at $20^{0}21'$ N latitude and $80^{0}55'$ E longitude in Dhankauda block of Sambalpur district at an altitude of 178.8 m above mene seac lavel. The climate of the area is warm sub humid. Nursery of rice variety Swarna was sown in the first week of July and transplanting was done after 25 days of sowing at 20 cm x 15 cm hill spacing. All the agronomic practices were followed during crop growth period. The treatments were: Four botanicals-essential oils i.e. camphor oil, cedar wood oil, eucalyptus oil and lemon grass oil @ 1000 ml ha^{-1} were compared with neem formulation, Neemazal 1EC @ 1000 ml ha^{-1} and commonly recommended insecticides rynaxypyr 20 SC @ 150 ml ha^{-1} and dinotefuran 20 SG @ 200 g ha^{-1}. Adjuvant dhanuvit was added to oil spray @ 0.05% to form an emulsion. All the pesticides were provided by ICAR-Indian Institute of Rice Research, Hyderabad. Both the botanicals and chemical insecticides were applied at 20, 45 and 65 days after transplanting (DAT) except untreated control. The insecticides were applied as high volume sprays @ 500 litres of spray water per hectare. Observations on the incidence of dead heart (DH), silver shoot (SS) were recorded from 10 randomly selected hills per plot from each replication at 55 and 75 days after transplanting. The white ear head (WEH) was counted on 10 randomly selected hills from each plot just before harvest. Then percentage of dead hearts, silver shoots and white ear heads were worked out. The hopper population per 10 hills was recorded at 72 DAT. The population of two natural enemies viz., spiders and green mirid bug per 10 hills was recorded at 75 days after transplanting. The mean value of data obtained from field experiments were analyzed statistically by ANOVA after transformation. Finally the grain yield was recorded on plot basis in each treatment and expressed as tonnes per hactare.

3. Results and discussion

3.1 Effect on stem borer

The results showed that stem borer infestation during vegetative stage ranged from 1.68 to 8.66% dead hearts (DH) in the treatments in *Kharif* 2017 (Table 1), whereas, it was 0.50 to 6.94% DH in *Kharif* 2018 during 50 to 75 DAT (Table 2). There were significant differences in stem borer damage among the botanical and insecticide treatments. Rynaxypyr @ 150 ml ha^{-1} treatment recorded the lowest mean damage of 1.68% while botanical treatments showed mean DH infestation between 4.56-6.30% compared to 8.66% in untreated control in *Kharif* 2017. While in *Kharif* 2018 season, it is observed that rynaxypyr treatment was again best treatment for stem borer management and recorded the mean damage of 0.50% while botanical treatments showed mean DH infestation between 1.71-2.53% compared to 6.94% in untreated control. Botanical insecticide treatments were significantly superior to control in 2018. White ears (WE) at heading stage in various treatments ranged from 2.24 to 8.67% and 0.60 to 3.85% against 13.25 to 7.98% in control in *kharif* 2017 and 2018, respectively. There were significant differences among botanical and insecticide treatments in white ear damage. Mean WE infestation ranged from 6.13 to 9.32% and 2.35 to 4.54% in botanical treatments as compared to 2.24-4.05% and 0.60-2.34% in insecticide treatments in *Kharif* 2017 and 2018 respectively. Overall, eucalyptus oil @ 1000 ml ha^{-1} was found to be superior in reducing stem borer infestation compared to other botanical treatments along with insecticide, rynaxypyr at both vegetative and reproductive phases. It was also observed that the infestation of stem borer was higher in *kharif* 2017 in comparison to *Kharif* 2018. Our results are in conformity with the findings of Karthikeyan and Christy (2014), who observed that chlorantraniliprole 18.5 EC @ 150 ml ha^{-1} significantly reduce the stem borer infestation in treated plot than untreated check. Seni and Naik (2017) also observed that the rynaxypyr 20 SC @ 30 g a.i ha^{-1} treated plot recorded significantly lower per-cent of dead heart (0.42%) and white ear head (1.24%) caused by stem borer and produced higher grain yield than the other tested insecticides. Regarding essential oil, different studies also showed that eucalyptus oil was effective against different insect pests e.g. *Sitophilus oryzae, Rhyzopertha*

Table 1: Efficacy of botanicals and insecticides against stem borer in rice during *Kharif* 2017.

Treatment	Stem borer (DH%)			WEH%
	55 DAT*	75 DAT	Mean	
Camphor oil @ 1000 ml ha^{-1}	5.45 (2.44)	4.92 (2.32)	5.19 (2.38)	7.78 (2.87)
Cedarwood oil @ 1000 ml ha^{-1}	6.11 (2.56)	6.49 (2.64)	6.30 (2.61)	8.67 (3.03)
Eucalyptus oil @ 1000 ml ha^{-1}	5.15 (2.38)	4.32 (2.19)	4.74 (2.29)	6.13 (2.57)
Lemongrass oil @ 1000 ml ha^{-1}	4.89 (2.32)	4.23 (2.17)	4.56 (2.25)	6.66 (2.67)
Azadirachtin 1 EC @ 1000 ml ha^{-1}	6.57 (2.66)	6.36 (2.62)	6.47 (2.64)	9.32 (3.13)
Dinotefuran 20 SG @ 200 g ha^{-1}	3.65 (2.03)	3.60 (2.02)	3.63 (2.03)	4.05 (2.12)
Rynaxypyr 20 SC @ 150 ml ha^{-1}	1.77 (1.50)	1.58 (1.44)	1.68 (1.47)	2.24 (1.65)
Control	7.64 (2.85)	9.69 (3.19)	8.66 (3.03)	13.25 (3.70)
S.Em	0.10	0.11	0.08	0.13
CD (5%)	0.31	0.32	0.25	0.39

DAT: Date after transplanting.

Figures in parentheses are square root transformed values

dominica, Tribolium castaneum, Amrasca devastans, Musca domestica etc. (Lee *et al.,* 2004; Regnault-roger, 1997). Chakraborty (2011) observed that bio formulations based on neem were found effective in minimizing the incidence of yellow stem borer, *S. incertulas* in rice.

3.2 Gall midge management

From the experimental results, it is observed that all the chemicals both botanical and synthetic insecticides were effective in minimizing the infestation of gall midge (GM) and thus, reducing the formation of silver shoot as compared to the untreated control (Table 3). From the table, it was also observed that infestation of gall midge in terms of silver shoot was higher in *kharif* 2018 in comparison to *Kharif* 2017. In insecticide treated plots, in 2017 the gall midge infestation recorded as silver shoot ranged from 5.55 to 6.09% as against 10.76% in control. Whereas, in 2018 the silver shoot ranged from 15.03 to 20.42% as against 34.22% in untreated control. All botanical treatments also reduced gall midge (7.42-9.13% and 15.62-24.19% in *kharif* 2017 and 2018, respectively) and among them Cedarwood oil @ 1000 ml ha^{-1} showed better efficacy than other treatments (7.42% and 15.62% in *kharif* 2017 and 2018, respectively).

3.3 Effect on plant hoppers

From the experimental results (Table 3), it is observed that the treatment containing dinotefuran 20 SG @ 200 g ha^{-1} was found to be the most effective treatment with mean population of 36.00 and 27.00 numbers per 10 hills in *kharif* 2017 and 2018, respectively and was significantly superior to control (145.67 per 10 hills and 98.67 per 10 hills in 2017 and 2018, respectively). All botanical treatments also significantly reduced plant hoppers populations (64.67-77.67 per 10 hills and 44.00-56.33 per 10 hills in *kharif* 2017 and 2018 respectively) and among them eucalyptus oil @ 1000 ml ha^{-1} and Camphor oil @ 1000 ml ha^{-1} showed better efficacy but they were at par with each other. Seni and Naik (2017a) also observed the effectiveness of dinotefuran 20 SG for minimizing the plant hoppers population in rice. Jena (2005) observed that antifeedant and oviposition deterrent activities were more common in leaf hoppers and plant hoppers than the knock down effects after feeding on plants treated with crude or commercial neem formulations.

3.4 Effect on natural enemies (spider and green mirid bugs)

The results on the presence of spiders in different treatments (Table 4) showed that highest number of spiders was found in the un-treated control (11.67 and 7.67 per 10 hills in *kharif* 2017 and 2018, respectively) than the number of spiders recorded in other treated plots. Among different insecticide treatments it is found that minimum spider population was present in dinotefuran 20 SG (2.67 and 1.67 per 10 hills in *kharif* 2017 and 2018, respectively) at 75 DAT. Maximum population of the spiders were noticed in botanical treatments (7.67-9.33 and 4.67-5.33 per 10 hills in *kharif* 2017and 2018, respectively) in both the years indicating that all botanicals are safe to the spiders. Among botanicals, highest spider population of (9.33 and 5.67 per 10 hills in *kharif* 2017 and 2018,

Table 2: Efficacy of botanicals and insecticides against stem borer in rice during *Kharif* 2018.

Treatment	Stem borer (DH%)			WEH%
	55 DAT	75 DAT	Mean	
Camphor oil @ 1000 ml ha^{-1}	2.32 (1.67)	2.17 (1.63)	2.25 (1.65)	3.44 (1.98)
Cedarwood oil @ 1000 ml ha^{-1}	2.64 (1.75)	2.42 (1.70)	2.53 (1.73)	3.85 (2.08)
Eucalyptus oil @ 1000 ml ha^{-1}	1.59 (1.43)	1.83 (1.52)	1.71 (1.48)	2.35 (1.68)
Lemongrass oil @ 1000 ml ha^{-1}	2.11 (1.61)	2.45 (1.71)	2.28 (1.67)	3.24 (1.92)
Azadirachtin 1 EC @ 1000 ml ha^{-1}	2.52 (1.73)	2.38 (1.70)	2.45 (1.72)	4.54 (2.24)
Dinotefuran 20 SG @ 200 g ha^{-1}	1.78 (1.51)	1.80 (1.51)	1.79 (1.51)	2.34 (1.68)
Rynaxypyr 20 SC @ 150 ml ha^{-1}	0.50 (0.98)	0.51 (0.98)	0.50 (1.00)	0.60 (1.02)
Control	6.18 (2.58)	7.69 (2.86)	6.94 (2.73)	7.98 (2.91)
S.Em	0.11	0.11	0.08	0.12
CD (5%)	0.34	0.34	0.23	0.35

DAT: Date after transplanting

Figures in parentheses are square root transformed values

Table 3: Efficacy of botanicals and insecticides against gall midge (SS%) and plant hoppers in rice during *Kharif* 2017 and 2018.

Treatment	SS%*		No. of Plant hoppers 10 hills^{-1}	
	2017	2018	2017	2018
Camphor oil @ 1000 ml ha^{-1}	8.60 (3.02)	21.39 (4.67)	65.67	48.00
Cedarwood oil @ 1000 ml ha^{-1}	7.42 (2.81)	15.62 (4.01)	77.67	53.67
Eucalyptus oil @ 1000 ml ha^{-1}	9.08 (3.09)	22.39 (4.78)	64.67	44.00
Lemongrass oil @ 1000 ml ha^{-1}	6.53 (2.65)	22.84 (4.83)	72.33	56.33
Azadirachtin 1 EC @ 1000 ml ha^{-1}	9.13 (3.10)	24.19 (4.97)	67.67	49.33
Dinotefuran 20 SG @ 200 g ha^{-1}	6.09 (2.56)	20.42 (4.57)	36.00	27.00
Rynaxypyr 20 SC @ 150 ml ha^{-1}	5.55 (2.45)	15.03 (3.94)	57.00	38.00
Control	10.76 (3.35)	34.22 (5.89)	145.67	98.67
S.Em	2.59	0.14	3.20	3.56
CD (5%)	7.85	0.43	9.71	10.80

*Figures in parentheses are square root transformed values

Table 4: Impact of botanicals and insecticides against green mirid bug and spiders in rice during *kharif* 2017 and 2018.

Treatment	No. mirid bugs 10 hills^{-1}		No. spiders/10 hills	
	2017	2018	2017	2018
Camphor oil @ 1000 ml ha^{-1}	33.67	19.33	8.33	5.00
Cedarwood oil @ 1000 ml ha^{-1}	29.00	18.67	7.67	4.67
Eucalyptus oil @ 1000 ml ha^{-1}	28.00	18.33	9.33	5.67
Lemongrass oil @ 1000 ml ha^{-1}	23.00	16.67	7.67	5.00
Azadirachtin 1 EC @ 1000 ml ha^{-1}	31.00	20.33	8.00	5.33
Dinotefuran 20 SG @ 200 g ha^{-1}	14.33	8.67	2.67	1.67
Rynaxypyr 20 SC @ 150 ml ha^{-1}	22.33	14.33	6.00	4.33
Control	41.33	25.00	11.67	7.67
S.Em	1.52	1.36	0.69	0.48
CD (5%)	4.62	4.14	2.09	1.45

respectively) was noticed in eucalyptus oil treatment. Whereas, in case of green mirid bug, it is observed that highest numbers were present in the un-treated control (41.33 and 25.00 per 10 hills in *kharif* 2017 and 2018, respectively) than the other treated plots. Among different insecticide treatments it is found that low population of mirid bugs was recorded in dinotefuran treatment (14.33 and 8.67 per 10 hills in *kharif* 2017 and 2018, respectively) at 75 DAT. Higher population of the mirid bugs were also noticed in botanical treatments (23.00-33.67 and 16.67-20.33 per 10 hills in *kharif* 2017 and 2018, respectively) indicating that all botanicals were safe to the mirid bug. It was also observed that the maximum population of spiders and mirid bugs were found in *kharif* 2017 in comparison to *Kharif* 2018, and this might be due to the higher plant hopper population in 2017. The present findings are corroborated by the findings of others (Shanwei *et al.,* 2009; Jafar *et al.,* 2013; Seni and Naik, 2017) who reported that the rynaxypyr was safer to beneficial arthropods in rice field. It is also reported that the commercial neem formulations such as Neemax, Rakshak, and Fortune Aza were safer to mirid bug, *C. lividipennis* and stem borer egg parasitoid, *Trichogramma japonicum* in rice (Katti, 2013).

3.5 Effect on yield

Significant differences were observed in grain yield among the treatments and control in both the seasons (Table 5). Based on yield, rynaxypyr treated plot recorded the highest mean grain yield of 5.03 t ha^{-1}, followed by dinotefuran with 4.51 t ha^{-1} when compared to 3.23 t ha^{-1} in control. Among

Table 5: Effect of different treatments on grain yield of rice during *Kharif* 2017 and 2018.

Treatment	Grain yield (t ha^{-1})		Pooled
	2017	2018	
Camphor oil @ 1000 ml ha^{-1}	4.19	4.39	4.29
Cedarwood oil @ 1000 ml ha^{-1}	4.31	4.48	4.40
Eucalyptus oil @ 1000 ml ha^{-1}	4.35	4.56	4.46
Lemongrass oil @ 1000 ml ha^{-1}	4.27	4.35	4.31
Azadirachtin 1 EC @ 1000 ml ha^{-1}	4.21	4.17	4.19
Dinotefuran 20 SG @ 200 g ha^{-1}	4.45	4.56	4.51
Rynaxypyr 20 SC @ 150 ml ha^{-1}	4.86	5.19	5.03
Control	3.04	3.43	3.23
S.Em	0.05	0.05	0.04
CD (5%)	0.15	0.15	0.13

the botanicals, eucalyptus oil treated plot recorded highest yield of 4.46 t ha^{-1} and others were at par with each others with a range of 4.19-4.31 t ha^{-1}.

From the present study, it can be concluded that the infestation of yellow stem borer, and plant hoppers can be minimized by using eucalyptus oil @ 1000 ml ha^{-1} whereas, gall midge by cedarwood oil @ 1000 ml ha^{-1}. Since essential oils are a mixture of components (unlike chemical insecticides which are mainly based on a single component), they act together and it is unlikely that insects will develop resistant against them. By this, they may provide an effective and eco-friendly alternative to conventional synthetic insecticides and can be incorporated in the integrated pest management of rice pests especially under organic as well as conventional rice farming system.

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