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Ganeshwari
Department of Entomology,
College of Agriculture I.G.K.V.
Raipur, Chhattisgarh, India

Sada Kumar
Department of Agrometeorology,
College of Agriculture I.G.K.V.
Raipur, Chhattisgarh, India

Sonali Deole
Department of Entomology,
College of Agriculture I.G.K.V.
Raipur, Chhattisgarh, India

Correspondence
Ganeshwari
Department of Entomology,
College of Agriculture I.G.K.V.
Raipur, Chhattisgarh, India

Biosafety evaluation of essential oils and chemical insecticides on population of coccinellids in rice field

Ganeshwari, Sada Kumar and Sonali Deole

Abstract
The investigation entitled "Biosafety evaluation of essential oils and chemical insecticides on population of coccinellids in rice field" was carried out at Research cum Instructional Farm of IGKV, Raipur (C.G.) during Kharif, 2017-18 and the field study was carried out to evaluate the safety of essential oils *i.e*., Camphor oil, Cedarwood oil, Eucalyptus oil, lemongrass oil, Neemazal and chemical insecticides *i.e*., Dinotefuran and Rynaxypyr to coccinellids (*Ladybird beetles*) in the rice fields brought out that all essential oils were found less toxic to coccinellids population and among them the safest one is Neemazal @ 2.0ml/l with highest coccinellids population *i.e*.,1.72 per hill. The Chemical insecticide *i.e*., Dinotefuran @ 0.50g/l was more fatal to Coccinellids with the lowest mean population i.e., 0.39 whereas maximum coccinellids population was found in the untreated control (1.98).

Keywords: Evaluation of essential oils, population, coccinellids in rice

Introduction
Rice is the important food crop of the developing world and the staple food of more than half of the world's population. It an excellent source of complex carbohydrates. Nine out of every ten people in the world who eat rice are Asian. Globally, about 90 percent of the rice cultivable land is in Asia. "Rice is Life" this has become a worldwide mantra since the International Year of Rice in 2004. About 90 percent of world rice is utilized in Asia (Anonymous, 2004) [5]. The hot and humid environment in which rice is grown is very conducive for the proliferation of insects. The rice plant is attacked by more than 128 species of insects, 20 of them can cause major economic loss (Kalode, 2005) [2]. Insecticides are used widely to control the insect pests of rice because of the easy adoption, effectiveness and easily control. Indiscriminate use of chemical insecticides at higher dosages results in pest resurgence, resistance in insect pests, and residual problems in soil water and the human body. Therefore, it has now become necessary to search for the alternative means of pest control, which can minimize the use of synthetic pesticides. Essential oils derived from natural plant products are easy to extract, biodegradable and do not persist in soil and it possesses a wide range of desirable properties for pest management and is regarded as non-toxic and safe (Batish *et al*., 2008) [6]. So based on environment safety the essential oils are eco-friendly and non-toxic and have no residual problems towards human health. The aim of the study is that to evaluate the neem products, essential oils, and insecticides against the ladybird beetle so that we can find the comparative result that which one is safer and which one is fatal for ladybird beetle. Natural enemies play an important role in preventing the insect pest outbreak in a rice field. (Bambaradeniya and Edirisinghe, 2008) [4]. It is eco-friendly and plays an important role in integrated pest management (IPM). Most of the predators in rice fields harmed and affected after the application of chemical insecticides, thus their predatory capacity was suppressed and harmed the population densities of rice field predators (Lee *et al*., 1993) [3].

Materials and Methods
To determine biosafety evaluation of essential oils and chemical insecticides on the population of coccinellids in rice field the field experiment was conducted during Kharif 2017-18 in a randomized block design with eight treatments and three replications. The seedling of variety Swarna was transplanted in a plot size of 20 m^2 with a spacing of 20x15 cm and normal agronomical practices were adopted. The knapsack sprayer and spray volume @ 500 l/ha were used with a hollow cone nozzle to impose the spray treatments. Teepol at the rate of 1ml/liter of water was added in the solution of essential oils to make the oil mixed with water.

Treatment details

Table 1: Treatment which is used in the field experiment

S. No.	Treatments	Dose/l	Dose/ ha
1.	Camphor oil	2.0 ml	1000 ml
2.	Cedar wood oil	2.0 ml	1000 ml
3.	Eucalyptus oil	2.0 ml	1000 ml
4.	Lemongrass oil	2.0 ml	1000 ml
5.	Neemazal (1.0%Azadirachtin)	2.0 ml	1000 ml
6.	Dinotefuran 20SG	0.50 g	250 g
7.	Rynaxypyr 20SC	0.3 ml	150 g
8.	Untreated control	Water spray	-

Method of observation

Different essential oils and chemical insecticides were evaluated for the safety of natural enemies (coccinellids) of insect pests of rice. Pretreatment observations were recorded on 5 randomly selected plants a day before the application of essential oils while post-treatment observations were recorded at 5 and 10 days after spraying.

Statistical analysis

The data were analyzed statistically using appropriate transformation. The data were analyzed by using square root transformation. Wherever necessary. The standard statistical procedure was followed as per Gomez and Gomez (1985) [1].

Results

The nontarget effect of different oil and neem extracts and insecticidal treatment was assessed for population fluctuation of ladybird beetle at periodic intervals under different treatment. In the pre-treatment observation, the average ladybird beetle population ranged from 1.33 to 1.56 per hill which differs non significantly among all the treatments including untreated control. In post-treatment observations recorded at 5 and 10 days after 1st, 2nd, 3rd, and 4th spraying indicated that the chemical insecticide is more fatal to the ladybird beetle than the oils and neem products**.**

At 5th day after the first spray among the different oils and neem product maximum population of ladybird beetle i.e., 1.52 per hill was recorded in eucalyptus oil @ 2.0 ml/l that was at par with Neemazal @ 2.0 ml/l (1.46 per hill), lemongrass oil @ 2.0 ml/l (1.43 per hill), camphor oil @ 2.0 ml/l (1.41 per hill) and cedarwood oil @ 2.0 ml/l (1.18 per hill). All essential oils and neem products are safer treatment against the ladybird beetle whereas, the highest population was recorded in the untreated plot with the average number of 1.72 and lowest population recorded in Rynaxypyr @ 0.3 ml/l with 0.53 ladybird beetle per hill. At 10 day after first spray results showed that Minimum population of ladybird beetle is recorded from plot treated with dinotefuran @ 0.50g/l with 0.48 ladybird beetle per hill whereas maximum population was recorded in the untreated plot with the average number of 1.84. Among essential oils and neem product, eucalyptus oil @ 2.0 ml/l was safest with 1.64 ladybird beetle per hill which was at par with Neemazal @ 2.0 ml/l 1.58 per hill, lemongrass oil @ 2ml/l (1.55 per hill), camphor oil @ 2.0 ml/l (1.59 per hill), cedarwood oil @ 2.0 ml/l (1.51 per hill).

On the 5th day after second spray results showed that the Minimum population of spiders was recorded from plot treated with dinotefuran @ 0.50g/l with 0.44 ladybird beetles per hill which found at par with Rynaxypyr @ 0.3ml/l with 0.46 ladybird beetles per hill. The maximum population was recorded in the untreated plot with an average number of 1.78. Among oils and Neem products Neemazal @ 2.0ml/l with (1.61 per hill), eucalyptus oil @ 2.0 ml/l (1.50 per hill), camphor oil @ 2.0 ml/l (1.48 per hill), lemongrass oil @ 2ml/l (1.39 per hill) and cedarwood oil @ 2.0 ml/l (1.08 per hill). At 10 day after the second spray Among the different essential oils and neem maximum population of ladybird beetle *i.e.*, 1.73 per hill was recorded in Neemazal @ 2.0ml/l that is at par with eucalyptus oil @ 2.0 ml/l (1.62 per hill), camphor oil @ 2.0 ml/l (1.60 per hill), lemongrass oil @ 2ml/l (1.51 per hill), cedarwood oil @ 2.0 ml/l (1.20 per hill). All essential oils and neem are safer treatment against the ladybird beetle whereas the highest population was recorded in an untreated plot with the average number of 1.90 and lowest population recorded in the plot treated with dinotefuran @ 0.50g/l with 0.41 ladybird beetle per hill.

On the 5th day after third spray results showed that the Minimum population of spiders was recorded from plot treated with dinotefuran @ 0.50g/l with 0.39 ladybird beetles per hill which found at par with Rynaxypyr @ 0.3ml/l with 0.40 ladybird beetles per hill. Maximum population was recorded in untreated plot with the average number of 1.98 ladybird beetle per hill which was found at par with Neemazal @ 2.0ml/l with (1.87 per hill), eucalyptus oil @ 2.0 ml/l (1.60 per hill), lemongrass oil @ 2ml/l (1.58 per hill), camphor oil @ 2.0 ml/l (1.46 per hill), cedarwood oil @ 2.0 ml/l (1.42 per hill). At 10 day after 3rd spray results showed that Minimum population of ladybird beetle is recorded from plot treated with dinotefuran @ 0.50g/l with 0.36 ladybird beetle per hill whereas maximum population was recorded in an untreated plot with the average number of 2.10. Among essential oils and neem maximum population of ladybird beetle *i.e.*; 1.99 per hill was recorded in Neemazal @ 2.0ml/l that is at par with eucalyptus oil @ 2.0 ml/l (1.72 per hill), lemongrass oil @ 2ml/l (1.70 per hill), camphor oil @ 2.0 ml/l (1.58 per hill), cedarwood oil @ 2.0 ml/l (1.54 per hill).

On the 5th day after 4th spray results showed that the Minimum population of spiders was recorded from plot treated with dinotefuran @ 0.50g/l with 0.28 ladybird beetles per hill which found at par with rynaxypyr @ 0.3ml/l with 0.31 ladybird beetles per hill. The maximum population was recorded in an untreated plot with the average number of 2.22 ladybird beetle per hill. Among oils and neem product neemazal @ 2.0ml/l with (1.73 per hill), eucalyptus oil @ 2.0 ml/l (1.59 per hill), lemongrass oil @ 2ml/l (1.54 per hill), camphor oil @ 2.0 ml/l (1.43 per hill), cedarwood oil @ 2.0 ml/l (1.43 per hill).

At 10 days after 4th spray results indicated that all essential oils and neem products are safer treatment against the ladybird beetle. Highest population was recorded in untreated plot with the average number of 2.34 which is significantly at par with all other oils and neem products *i.e.*, neemazal @ 2.0ml/l (1.85 per hill), eucalyptus oil @ 2.0 ml/l (1.71 per hill), lemongrass oil @ 2ml/l (1.66 per hill), camphor oil @ 2.0 ml/l (1.55 per hill), cedarwood oil @ 2.0 ml/l (1.33 per hill). The minimum population of ladybird beetle is recorded from plot treated with Dinotefuran @ 0.50g/l with 0.24 ladybird beetles per hill. Which was found at par with Rynaxypyr @ 0.3 ml/l with 0.29 ladybird beetles per hill.

Table 2: Effects of essential oils and chemical insecticides on ladybird beetles population

S. No.	Treatments	Dose/ha	Mean ladybird beetle population per hill									
			Pre-treatments	5 days after the 1st spray	10 Days after the 1st spray	5 days after 2nd spray	10 Days after 2nd spray	5 days after 3rd spray	10 Days after 3rd spray	5 days after 4th spray	10 Days after 4th spray	Overall Mean
T1	Camphor oil	1000 ml	1.40 (1.54)*	1.41^{b} (1.55)*	1.53^{b} (1.59)*	1.48^{b} (1.57)*	1.60^{b} (1.61)*	1.46^{b} (1.56)*	1.58^{b} (1.60)*	1.43^{b} (1.56)*	1.55^{b} (1.59)*	1.50 (1.57)
T2	Cedarwood oil	1000 ml	1.38 (1.54)	1.18^{b} (1.47)	1.30^{b} (1.51)	1.08^{b} (1.44)	1.20^{b} (1.48)	1.42^{b} (1.53)	1.54^{b} (1.57)	1.21^{b} (1.48)	1.33^{b} (1.52)	1.28 (1.50)
T3	Eucalyptus oil	1000 ml	1.56 (1.58)	1.52^{bc} (1.58)	1.64^{b} (1.62)	1.5^{b} (1.58)	1.62^{b} (1.61)	1.60^{b} (1.61)	1.72^{b} (1.64)	1.59^{b} (1.61)	1.71^{b} (1.64)	1.61 (1.61)
T4	Lemongrass oil	1000 ml	1.33 (1.52)	1.43^{b} (1.55)	1.55^{b} (1.59)	1.39^{b} (1.54)	1.51^{b} (1.58)	1.58^{b} (1.60)	1.70^{b} (1.64)	1.54^{b} (1.59)	1.66^{b} (1.63)	1.54 (1.59)
T5	Neemazal (1.0% Azadirachtin)	1000 ml	1.53 (1.59)	1.46^{b} (1.57)	1.58^{b} (1.60)	1.61^{b} (1.61)	1.73^{bc} (1.65)	1.87^{b} (1.69)	1.99^{b} (1.72)	1.73^{b} (1.64)	1.85^{b} (1.68)	1.72 (1.64)
T6	Dinotefuran 20SG	250 g	1.44 (1.56)	0.57^{a} (1.25)	0.48^{a} (1.21)	0.44^{a} (1.20)	0.41^{a} (1.18)	0.39^{a} (1.18)	0.36^{a} (1.16)	0.28^{a} (1.13)	0.24^{a} (1.11)	0.39 (1.17)
T7	Rynaxypyr20SC	150 g	1.36 (1.53)	0.53^{a} (1.24)	0.49^{a} (1.21)	0.46^{a} (1.21)	0.42^{a} (1.19)	0.40^{a} (1.18)	0.38^{a} (1.17)	0.31^{a} (1.14)	0.29^{a} (1.13)	0.41 (1.18)
T8	Untreated Control	Water spray	1.47 (1.57)	1.72^{bc} (1.65)	1.84^{bc} (1.68)	1.78^{bc} (1.66)	1.90^{bc} (1.70)	1.98^{b} (1.72)	2.10^{c} (1.75)	2.22^{bc} (1.78)	2.34^{bc} (1.82)	1.98 (1.72)
SE(m)±			0.069	0.035	0.043	0.073	0.048	0.066	0.064	0.065	0.054	-
C.D.			NS	0.10	0.132	0.21	0.146	0.20	0.198	0.18	0.165	-

*Figures in parentheses are square root transformed value

Discussion

The results are closely confirmed with the finding of Katole and Patil (2000) [14] the neem products, like Neemazal, neem was found safer to the natural enemies. Karthikeyan *et al.*, (2008) [7] reported that the botanical treatments support a higher population of coccinellid beetle and other natural enemies, such as damselflies *(Agriocnemis* sp.), green mirid bugs (*Cyrtorhinus lividipennis*) and larval parasitoids (*Stenobracon* sp.) differed significantly with the insecticide-treated plot. Joseph *et al*., (2010) [13] indicated that the chemical pesticides are more fatal to the spiders and coccinellids than the neem products. Tiwari and Prasad (2011) [15] found Neemazal was safer than chemical insecticides having low mortality of predatory spider (16.61%) after 14 days of spray. Islam (2012) [12] evaluated the botanical extracts and insecticides for their side effects on the natural enemies in the rice ecosystem. The botanicals were found less harmful than those of insecticides. Natural enemies like Lady Bird Beetle and rove beetles Broad-spectrum insecticide applications alter the arthropod fauna in the agroecosystem. Ahmad *et al.*, (2015) [11] concluded that the spider's population was significantly resistant to *A. indica* and *E. globulus* based products than Spinosad. Muddasir *et al.*, (2015) [8] stated that the reduction in spider's population was 42.18%, 36.68% and 33.38% with Spinosad, *A. indica*, and *E. globulus* respectively. Pandey (2016) [9] the most lethal effect on the ladybird beetle was observed in plot T_7 *i.e*., the insecticide-treated plot with the highest percent reduction over control (79.25%). Choudhary (2017) [10] indicated that all Neem based insecticides are safer treatment against the ladybird beetle Minimum population of ladybird beetle is recorded from plot treated with dinotefuran @ 0.5g/l with 0.16 ladybird beetles per hill.

Conclusion

Bio-safety evaluation of essential oils and chemical insecticides on a population of coccinellids in rice field revealed that chemical insecticide was more fatal to coccinellids. All essential oils and Neemazal were found safer and less toxic for different coccinellid beetle. Among essential oils and chemical insecticides, Neemazal @ 2.0 ml/l was found safest for ladybird beetle.

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