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EFFECT OF INSECTICIDES ON SOIL ARTHROPODS AND EARTH WORMS IN ARECA NUT ECOSYSTEM

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Abstract- Soil arthropods and earth worms were exposed to the different insecticides under field conditions for about 105 days. The observed taxa of soil arthropods consists mites, collembola symphylla, millipede, centipede, pseudoscorpion, diplura and ants in areca garden ecosystem. The aim of the study was on effects of insecticides on selected beneficial non targeted soil arthropods and earthworms. The results revealed that Chlorpyriphos 20 EC 10 l/ha were found to have negative effect on soil arthropods. Whereas, Phorate 10G 25Kg/ha and fipronil 5 SC 2.5 l/ha were cause toxic effect on earth worms. By using various chemical for controlling of areca nut root grub will cause toxic effect on the soil arthropods and earth worms in both the location Harakere and Gulukoppa. Although the application of Chlorpyriphos and Fipronil was efficient in controlling populations of areca nut white grub (*Leucopholis lepidophora* Bl.), as we expected, they negatively affected non-target arthropods and earth worms in the soil surface. Hence, areca growers go for integrated pest management practices.

Keywords- insecticides, earth worms, soil arthropods, areca garden, phorate

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Introduction

Soil arthropods and earth worms are important part of soil environments. Arthropods are involved in organic matter decomposition, partial regulation of microbial activities and nutrient cycles. Depending on the diet (saprophagous, phytophagous or predation), soil fauna are closely linked to each other and to microorganisms, plants and soil [1]. Soil arthropods are sensitive bioindicators of environmental change because of their small size, rapid reproductive rates and short generation times.

Earthworms are an essential part of the soil food functioning. Without them, all the organic matter would build up on the soil surface. The capability of changing the soil structure by preferential feeding on organic material by earthworms was the basis for vermiculturing of organic matter rich waste materials. Earthworms provide key soil functions that favour many positive ecosystem services. Because of their living habits, earthworms are exposed to chemicals present in their terrestrial environment [2]. Areca nut is one of the important commercial crop grown in India. It is mainly infested by root grubs, for controlling of root grubs various chemicals were applied by the farmers. Chemicals are applied for controlling of root grubs in areca garden, it may affect on the soil arthropods. Some chemicals like Chlorpyriphos 20 EC, Phorate 10G and imidacloprid 17.8 SL were commonly used by the farmers for the control of root grub [3]. These chemicals may show negative effect on the soil arthropods density. In order to save the soil arthropods need to use chemicals which were safer and effectiveness to manage the root grub, so in this regard need to evaluate effectiveness of the chemicals. Hence, the present study was focussed on to find out the effect of insecticides on earthworms and other soil arthropods.

Materials and Method

Field experiments were conducted in two locations *viz*,. Harakere (Shivamogga taluk) (N13º53; E075º33) and Gulukoppa (Hosanagara taluk) (N13º52'.02"; E075º12'.76") villages of Shivamogga district. The experiment was initiated with eight treatments by adopting randomized block design (RBD) with three replications. Each treatment consist 45 palms in which 15 palms were selected for sampling of soil arthropods and earth worms. First spray was taken up during August-2013 (Spraying throughout the field) and second spray (drenching the insecticide per tree basis) was given 60 days after first treatment i.e., during November-2013.

Observations were recorded by digging the soil in between the palms in an area of 0.5 X 0.5 m and at base of the palms in randomly selected 15 palms per treatment. Number of earthworm's counts were taken in between and around the palm and in second spray observation was taken only around the palm at day before and 60 days after treatment and 45 DAT respectively. During each observation three samples of 500 gram soil per treatment were collected randomly in a polyethylene cover and brought into laboratory for extraction of other soil arthropods using berlese funnel and arthropods were collected in 75 per cent ethyl alcohol. These arthropods were identified and their diversity was recorded. Data on effect of insecticides on soil arthropods and earth worms was sub-

jected to Square root transformation. % reduction of Soil arthropods and earth worms were calculated by using following formula:

$$\% \text{ Reduction} = \frac{\text{Control - Treatment}}{\text{Control}} \times 100$$

Result and Discussion

Effect of Newer Insecticides Against Soil Arthropods

The soil arthropods encountered were mites, collembola symphylla, millipede, centipede, pseudoscorpion, diplura and ants in areca garden ecosystem.

Table 1- Effect of insecticide molecules against soil arthropods on areca nut under field conditions at Gulukoppa, Hosanagara taluk*

Insecticides	Mean number of soil arthropods** (3 samples per treatment)					
	I treatment			II treatment		
	DBT	60DAT	Reduction (%)	DBT	105 DAT	Reduction (%)
Chlorpyriphos 20EC 5 l/ha	1.19 (1.29)	1.22 (1.25)	18.85	1.22 (1.25)	0.56[a] (1.00)	57.99
Chlorpyriphos 20EC 10 l/ha	1.33 (1.35)	0.89 (1.16)	47.54	0.89 (1.16)	0.26[a] (0.86)	73.04
Fipronil 5SC 2.5 l/ha	0.89 (1.18)	1.11 (1.26)	1.64	1.11 (1.26)	1.07[a] (1.21)	10.66
Imidacloprid 17.8SL 1l/ha	1.30 (1.29)	1.37 (1.33)	16.81	1.37 (1.33)	1.11[ab] (1.25)	25.06
Emamectin benzoate 5%SG 250g/ha	1.67 (1.46)	0.78 (1.12)	63.28	0.78 (1.12)	0.37[a] (0.93)	55.99
Phorate 10G 25Kg/ha	1.59 (1.44)	1.59 (1.39)	21.31	1.59 (1.39)	0.59[a] (1.04)	65.61
Chlorantraniliprole 18.5%SC 658ml/ha	1.07 (1.24)	1.04 (1.24)	24.02	1.04 (1.24)	0.78[a] (1.08)	30.68
Untreated check	1.78 (1.48)	2.26 (1.63)	0.00	2.26 (1.63)	2.44[b] (1.71)	0.00
CD(p=0.05)	0.43	0.45		0.45	0.49	
CV%	18.40	20.01		20.01	24.63	
SEm±	0.14	0.15		0.15	0.16	

DBT- Day before treatment, DAT- Days after treatment; Figures in the parentheses are√X+0.5 transformed value.
*I treatment is a spray to entire area and II treatment is given 60 days after I treatment;
** Area sampled in each replication (0.5m (L) x0.5m (B) x60cm depth); 3 replications per treatment

Table 2- Effect of insecticide molecules against soil arthropods on areca nut under field conditions at Harakere, Shivamogga taluk*

Insecticides	Mean number of soil arthropods** (3 samples per treatment)					
	I treatment			II treatment		
	DBT	60DAT	Reduction (%)	DBT	105 DAT	Reduction (%)
Chlorpyriphos 20EC 5 l/ha	10.78 (3.25)	4.00 (2.11)	25.05	4.00 (2.11)	2.00[a] (1.57)	43.33
Chlorpyriphos 20EC 10 l/ha	3.78 (2.06)	1.33 (1.26)	28.72	1.33 (1.26)	0.67[a] (1.07)	43.33
Fipronil 5SC 2.5 l/ha	3.78 (2.06)	1.22 (1.26)	34.66	1.22 (1.26)	1.00[a] (1.21)	7.27
Imidacloprid 17.8SL 1l/ha	7.33 (2.61)	2.56 (1.75)	29.62	2.56 (1.75)	1.11[a] (1.22)	50.72
Emamectin benzoate 5%SG 250g/ha	9.56 (3.06)	1.78 (1.43)	62.43	1.78 (1.43)	1.44[a] (1.36)	7.92
Phorate 10G 25Kg/ha	7.67 (2.78)	2.22 (1.63)	41.46	2.22 (1.63)	1.78[a] (1.49)	9.33
Chlorantraniliprole 18.5%SC 658ml/ha	6.78 (2.69)	2.11 (1.60)	37.09	2.11 (1.60)	0.67[a] (1.08)	64.21
Untreated check	11.44 (3.05)	5.67 (2.43)	0.00	5.67 (2.43)	5.00[b] (2.34)	0.00
CD(p=0.05)	1.84	0.82		0.82	0.48	
CV%	38.95	27.98		27.98	19.18	
SEm±	0.61	0.27		0.27	0.16	

DBT- Day before treatment, DAT- Days after treatment; Figures in the parentheses are√X+0.5 transformed value.
*I treatment is a spray to entire area and II treatment is given 60 days after I treatment
** Area sampled in each replication (0.5m (L) x0.5m (B) x60cm depth); 3 replications per treatment

In the first treatment, observations recorded at Gulukoppa, Hosanagara taluk (Location 1), after 60 days of imposition of treatment the fipronil 5 SC 2.5 l/ha (1.64%) had showed minimum per cent reduction of soil arthropod followed by imidacloprid 17.8 SL 1 l/ha (16.81%). Whereas, Highest per cent of reduction was observed in emamectin benzoate 5% SG 250g/ha (63.28%) over untreated check followed by chloropyriphos 20 EC 10 l/ha (47.54%). These chemicals had higher effect on the soil arthropods. In second treatment at 105 days after first treatment, the least per cent reduction was observed in fipronil 5 SC 2.5 l/ha (10.66%) followed by imidacloprid 17.8 SL 1 l/ha (25.06%). Whereas, maximum per cent of reduction was observed in chloropyriphos 20 EC 10 l/ha (73.04%) followed by Phorate 10G 25Kg/ha (65.61%), these chemicals have higher effect on the soil arthropods [Table-1]. There was inconsistency in effect of chemicals on soil arthropod in first treatment Emamectin benzoate 5% SG 250g/ha gave negative effect on soil arthropod but in second treatment chloropyriphos 20 EC 10 l/ha showed highest reduction.

In Harakere, Shivamogga taluk (Location 2), least per cent reduction was observed in chlorpyriphos 20 EC 5 l/ha (25.05%) followed by chloropyriphos 20 EC 10 l/ha (28.72%) at 60 days of treatment. Whereas, highest soil arthropod population reduction was noticed in emamectin benzoate 5% SG 250g/ha (62.43%) followed by Phorate 10G 25Kg/ha (41.46%). At 105 days after treatment the minimum per cent of soil arthropod reduction was observed in fipronil 5 SC 2.5 l/ha (7.27%) followed by Emamectin benzoate 5% SG 250g/ha (7.92%). Maximum per cent reduction was observed in chlorantraniliprole 18.5% SC 658ml/ha (64.21%) over untreated check followed by imidacloprid 17.8 SL 1 l/ha (43.33%) [Table-2].

There was a lot of variation in effect of chemicals on soil arthropod at two different locations due to variation in climatic condition, soil moisture and chemical properties of the soil. The present findings were confirmation with Ahmad & Gurkan [4] where they reported collembola populations were more affected by imidacloprid. Rashmi [5] reported, soil application of chlorpyriphos was found to be significantly more toxic to collembolan population in litter sample. Sarath & Gupta [6] showed similar results, where, phorate proved to be more toxic to Collembola than aldicarb. Jehan [7] seed treatment with imidacloprid and thiomethoxam in cotton resulting in decreased Psocoptera, Oribatida, Actinedia and Gamasida population density in the soil. Chemicals used to control root grubs reduce the population of most of the soil arthropods in young age areca nut gardens [8].

Effect of Selected Newer Chemicals on Earthworms under Field Condition

In location I (Gulukoppa, Hosanagara taluk), observations were recorded in between the palms at 60 days after the treatment imposition. Phorate 10G 25Kg/ha (1.64%) had minimum effect on earthworm population followed by chlorpyriphos 20 EC 5 l/ha (4.89%). Maximum per cent reduction was observed on chlorantraniliprole 18.5% SC 658ml/ha (56.38%). Observations around the palm were taken at 60 days after the treatment imposition. Phorate 10G 25Kg/ha (1.99%) found to have minimum effect on earthworm population followed by fipronil 5 SC 2.5 l/ha (8.12%). Maximum per cent of reduction was observed on chlorpyriphos 20 EC 10 l/ha (23.56%) followed by chlorantraniliprole 18.5% SC 658ml/ha (22.65%). At 105 days after the first treatment around the palm, chlorpyriphos 20 EC 5 l/ha (1.56%) found that minimum effect on earthworm population followed by emamectin benzoate 5% SG 250g/ha (2.50%). Maximum per cent of reduction was observed on Phorate 10G 25Kg/ha (22.65%) followed by chlorantraniliprole 18.5% SC 658ml/ha (20.59%) [Table-3].

Table 3- Effect of insecticide molecules against earthworms on areca nut under field conditions at Gulukoppa, Hosanagara taluk*

Insecticides	Mean number of earthworms** (15 samples per treatment)							
	I treatment (in between the palm)			I treatment (around the palm)			II treatment (around the palm)	
	DBT	60DAT	Reduction (%)	DBT	60 DAT	Reduction (%)	105 DAT	Reduction (%)
Chlorpyriphos 20EC 5 l/ha	DBT	60DAT	Reduction (%)	DBT	60 DAT	Reduction (%)	105 DAT	Reduction (%)
Chlorpyriphos 20EC 10 l/ha	0.93 (1.19)	0.80 (1.14)	4.89	2.13 (1.56)	1.07 (1.21)	20.37	0.93 (1.19)	1.56
Fipronil 5SC 2.5 l/ha	1.00 (1.22)	0.73 (1.11)	11.23	1.67 (1.47)	0.80 1.13)	23.56	0.67 (1.06)	6.25
Imidacloprid 17.8SL 1l/ha	1.00 (1.21)	0.67 (1.07)	19.30	1.73 (1.47)	1.00 (1.22)	8.12	0.80 (1.13)	10.00
Emamectin benzoate 5%SG 250g/ha	1.20 (1.28)	0.93 (1.20)	5.85	2.13 (1.57)	1.13 (1.28)	15.39	0.87 (1.16)	13.97
Phorate 10G 25Kg/ha	1.53 (1.42)	1.00 (1.20)	21.05	1.93 (1.54)	1.00 (1.19)	17.62	0.87 (1.17)	2.50
Chlorantraniliprole 18.5%SC 658ml/ha	1.07 (1.22)	0.87 (1.17)	1.64	1.73 (1.46)	1.07 (1.21)	1.99	0.73 (1.10)	22.66
Untreated check	1.27 (1.33)	0.67 (1.07)	36.29	2.33 (1.68)	1.13 (1.26)	22.65	0.80 (1.12)	20.59
CD(p=0.05)	2.87 (1.83)	1.27 (1.32)	0.00	2.87 (1.83)	1.80 (1.51)	0.00	1.60 (1.37)	0.00
CV%	0.41	0.30		0.53	0.43		0.44	
SEm±	17.32	14.81		19.15	19.45		21.37	
	0.13	0.10		0.17	0.14		0.14	

DBT- Day before treatment, DAT- Days after treatment; Figures in the parentheses are√X+0.5 transformed value.

*I treatment is a spray to entire area and II treatment is given 60 days after I treatment

** Area sampled in each replication (0.5m (L) x0.5m (B) x60cm depth); 3 replications per treatment

Table 4- Effect of insecticide molecules against earthworms on areca nut under field conditions at Harakere, Shivamogga taluk*

Insecticides	Mean number of earthworms** (15 samples per treatment)							
	I treatment (in between the palm)			I treatment (around the palm)			II treatment (around the palm)	
	DBT	60DAT	Reduction (%)	DBT	60 DAT	Reduction (%)	105 DAT	Reduction (%)
Chlorpyriphos 20EC 5 l/ha	1.73 (1.41)	1.33 (1.35)	19.87	3.93 (2.09)	2.00 (1.55)	24.61	0.67[a] (1.07)	39.58
Chlorpyriphos 20EC 10 l/ha	1.40 (1.37)	1.00 (1.22)	25.60	4.00 (2.09)	1.67 (1.46)	38.22	0.47[a] (0.98)	49.25
Fipronil 5SC 2.5 l/ha	1.27 (1.32)	1.07 (1.25)	12.28	2.93 (1.85)	1.93 (1.55)	2.27	0.40[a] (0.95)	62.50
Imidacloprid 17.8SL 1l/ha	1.60 (1.43)	1.33 (1.35)	13.19	4.13 (2.15)	1.33 (1.34)	52.17	0.33[a] (0.90)	54.69
Emamectin benzoate 5%SG 250g/ha	1.53 (1.40)	1.27 (1.29)	13.95	4.20 (2.16)	2.00 (1.56)	29.39	0.53[a] (1.02)	51.67
Phorate 10G 25Kg/ha	1.07 (1.24)	1.00 (1.19)	2.34	3.27 (1.81)	1.40 (1.37)	36.45	0.53[a] (1.01	30.95
Chlorantraniliprole18.5%SC658ml/ha	1.33 (1.35)	1.27 (1.31)	1.04	3.87 (1.95)	1.60 (1.44)	38.64	0.67[a] (1.07)	24.48
Untreated check	1.67 (1.44)	1.60 (1.43)	0.00	2.87 (1.77)	1.93 (1.56)	0.00	1.07[b] (1.24)	0.00
CD(p=0.05)	0.60	0.43		0.80	0.43		0.18	
CV%	24.93	18.91		23.05	16.78		9.96	
SEm±	0.20	0.14		0.26	0.14		0.06	

DBT- Day before treatment, DAT- Days after treatment; Figures in the parentheses are√X+0.5 transformed value.
*I treatment is a spray to entire area and II treatment is given 60 days after I treatment
** Area sampled in each replication (0.5m (L) x0.5m (B) x60cm depth); 3 replications per treatment

The results regarding Phorate were different in 60 and 105 days after treatment observation periods. This was due to application method followed. In the first treatment, Phorate was applied by broadcasting, and hence minimum quantity of insecticide was reached per unit area. This leads to reduced effect of Phorate which reflected on the reduced toxic effect on earthworm. However, in the second treatment, Phorate was applied around the base of the palm and this leads to negative effect on the population of earthworms.In first treatment, observations were recorded in between and around the palm at Harkere, Shivamogga taluk(Location 2). At 60 days after the treatment imposition, the data revealed that chlorantraniliprole 18.5% SC 658ml/ha (1.04%) had minimum effect on earthworm population followed by Phorate 10G 25Kg/ha (2.34%). Maximum per cent of reduction was observed on chlorpyriphos 20 EC 10 l/ha (25.60%) followed by chlorpyriphos 20 EC 5 l/ha (19.87%). The least earthworm reduction was observed in fipronil 5 SC 2.5 l/ha (2.27%) treated plot at 60 days after the first treatment imposition around the palm and followed by chlorpyriphos 20 EC 5 l/ha (24.61%). Maximum per cent of reduction was observed on imidacloprid 17.8 SL 1 l/ha (52.17%) followed by chlorantraniliprole 18.5% SC 658ml/ha (38.64%). In second treatment around the palm at 105 days after the first treatment imposition, chlorantraniliprole 18.5% SC 658ml/ha (24.48%) found to have minimum effect on earthworm population followed by Phorate 10G 25Kg/ha (30.95%). Maximum per cent of reduction was observed on fipronil 5 SC 2.5 l/ha (62.50%) followed by imidacloprid 17.8 SL 1 l/ha (54.69%) [Table-4].

Conclusion

Based on the results, it can be concluded that fipronil 5 SC 2.5 l/ha followed by imidacloprid 17.8 SL 1 l/ha causes higher toxic effect to the earthworm population compared to the other chemicals. The present results were in conformity with Mostert [9] Dittbrenner [10] & Kreutzweiser [11]. The following chemicals, viz., Imidacloprid 17.8 SL1 l/ha and Chlorpyriphos 20 EC 10 l/ha which were found to be effective against root grubs, showed negative effect on earth worm and other arthropod populations in areca nut ecosystem. Fipronil 5 SC had showed non toxic to the soil arthropods. chlorpyriphos 20 EC 5L/ha shows less toxic to the earth worms.

Conflicts of Interest : None declared.

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