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Field efficacy of selected insecticide molecules against finger millet [*Eleusine coracana* (L.) Gaertn.,] earhead caterpillars

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Abstract
To study the bio-efficacy of selected insecticides against earhead caterpillars in finger millet (variety KMR-204) under field conditions an experiment was conducted at Zonal Agricultural Research Station Vishweshwaraiah Canal, Farm, Mandya, during *kharif* 2018 and 2019, University of Agricultural Sciences, Bangalore. The results revealed that, two sprays at dough stage of the crop, all the insecticides *viz.*, thiodicarb 76 WP (1.0 g L^{-1}), acephate 75 SP (1.5 g L^{-1}), profenphos 50 EC (2.0 mL L^{-1}), quinalphos 25 EC (2.0 mL L^{-1}), lambda cyhalothrin 5 EC (0.6 mL L^{-1}), novuluron 10 EC (1.5 mL L^{-1}), fenvelarate 0.4D (25 kg ha^{-1}), chlorpyriphos 1.5D (25 kg ha^{-1}) and chlorpyriphos 20 EC (2.0 mL L^{-1}) were found to be effective in reducing different species of earhead caterpillars *viz.*, *Archips micaceana, Somena scintillans, Cryptoblabes angustipennella, Nola analis, Cydia* sp., *Helicoverpa armigera, Pyrausta phoenicealis, Corcyra cephalonica, Stathmopoda* sp. and *Spodoptera frugiperda, Eublemma* sp., *Conogethes punctiferalis, Euproctis similis, Mythimna separate* and *Ataboruza* sp., over untreated control. However, thiodicarb 75 WP @ 1.0 g L^{-1} and lambda cyhalothrin 5 EC at 0.6 mL L^{-1} were found to be more effective in reducing the mean larval population and registered higher percentage of recovery with least larval population compared to rest of the insecticides.

Keywords: finger millet, earhead caterpillars, thiodicarb 75 WP and lambda cyhalothrin 5 EC

Introduction

Finger millet, *Eleusine coracana* (L.) Gaertn is important climate resilient small millet, forms staple nourishment for many African and Asian countries of the world including India, wherever it is cultivated. It is also known as bird's foot, mandua, maruva, madua, nagli and nachni in different regions of the country and as "ragi" in south India and African millet and red millet in English [17] belongs to family 'Poaceae'. *Eleusine*, the generic name, which is a Greek word meaning 'Goddess of Cereals" [6], The earliest archeological proof of its cultivation is from Ethiopia, circa 3000 B.C. Finger millet arose in Uganda and neighboring parts of Africa thousands of years ago and spread over to India by 1000 B.C [16]

In India major finger millet growing states are Karnataka, Uttarakhand, Tamil Nadu, Maharashtra, Odisha, Andhra Pradesh and Gujarat and cultivated over an area of 11.94 lakh ha with total production of about 19.85 lakh tonnes and with productivity of 1662 Kg ha^{-1} during the year 2017-18 [4]. Karnataka is the major contributor nearly 65 % of finger millet both in area and production in the country and Tamil Nadu has the highest productivity (3714 Kg ha^{-1}), followed by Puducherry (2889 Kg ha^{-1}). Finger millet is tropical and subtropical climate crop. It can be cultivated up to 2100m an altitude, minimum temperature of 8-10 °C for its better germination and maximum temperature of 26-29 °C congenial for better growth and yield of the crop. It can be grown in different soils from poor to fertile with a wider adaptability. Alluvial, loamy and sandy soil with good drainage facility is suitable for growing in different parts of the country during all the cropping seasons. This crop being cultivated in rainfed as well as irrigated situation.

The crop is being attacked by over 57 insect species [18] of which, shoot fly (*Atherigona miliaceae* Malloch), stem borer (*Sesamia inferens* Wlk.), white stem borer (*Saluria inficita* (Wlk.)), flea beetle (*Chaetocnema* sp), red headed hairy caterpillar (*Amsacta albistriga* Walk.), Bihar hairy caterpillar (*Spilarctia obliqua* Walk.), oriental armyworm (*Mythimna separata*

Walk.), aphids, *Histeronura setariae*, ragi root aphid *Tetraneura nigriabdominalis* were considered as important. During earhead stages mainly attacked by two hemipteran earhead bugs *viz.*, mirid bug (*Calocoris angstatus* Leth.) and rice bug, *Leptocorisa acuta* (Thunb), and several species of lepidopteran earhead caterpillars *viz*., *Cryptoblabes angustipennella* Hamps, *C. gnidiella* (Mill), *Eublemma (Autoba) silicula* Swinh, *Helicoverpa armigera* (Hub.), *Cacoecia epicyrta* Meur, *Stathmopoda theoris* Meyr, *Archips micaceanus* (Wlk.) and *Sitotroga cerealella* (Oliv.) are occasionally becomes serious [5]. These, lepidopteran earhead caterpillars are becoming important insect species and major production constraints in all regions, especially southern parts of India [10].

In southern parts of Karnataka, the farmers are facing serious problem of finger millet earhead caterpillars since from decades [3] especially in both *kharif* and *rabi* seasons regularly. Among the different insect pests of finger millet, the earhead caterpillars *viz*., *Cryptoblabes angustipennella* (Hampson), *Archips micaceana* (Walker), *Euproctis subnotata* (Walker), *Helicoverpa armigera* (Hubner) are important species. As these caterpillars damage the crop during earhead stage. Since a large number of high yielding varieties of finger millet are now being introduced for enhancing grain production. In view of the growing need for the improvement in yield and due to the fact that finger millet earhead caterpillars are one of the major constraints for yield reduction, hence the investigation was initiated at Zonal Agricultural Research Station, Vishweshwaraiah Canal, Farm, Mandya during 2018 and 2019 to know the efficacy of selected insecticides molecules against finger millet earhead caterpillars.

Materials and Methods

To know the bio-efficacy of selected new and conventional insecticides against earhead caterpillars in finger millet, a field experiment was laid out in Randomized Completely Block Design (RCBD) with 10 treatments *viz.*, thiodicarb 76 WP (1.0 g L^{-1}), acephate 75 SP (1.5 g L^{-1}), profenphos 50 EC (2.0 mL L^{-1}), quinalphos 25 EC (2.0 mL L^{-1}), lambda cyhalothrin 5 EC (0.6 mL L^{-1}), novuluron 10 EC (1.5 mL L^{-1}), fenvelarate 0.4D (25 kg ha^{-1}), chlorpyriphos 1.5D (25 kg ha^{-1}) and chlorpyriphos 20 EC (2.0 mL L^{-1}) with untreated check replicated thrice. A popular and susceptible variety KMR-204 was selected for sowing in *kharif* 2018 and 2019 with a spacing of 30 × 10 cm, between rows and plants, respectively. For each replication, a plot size of 3.0 × 4.0 m was maintained. All packages of practice were followed except plant protection measures. All nine insecticides were applied at the dough stage of the finger millet crop.

In each treatment, the larval population was recorded one day before spray on ten randomly selected ears. The post-treatment count was made at 1, 5, 7, and 14 days after spray. The observations on total earhead caterpillar species complex recorded during *kharif* 2018 and 2019 and were subjected to $\sqrt{x+0.5}$ transformation. The data of each treatment was subjected to ANOVA [8, 9] and means were separated by Tukey's HSD [20]. The harvesting was made at physiological maturity. Reduction in larval population over the control was calculated by using following formula [1].

$$\text{Larval per cent reduction} = \frac{C - T}{C} \times 100$$

Where, C: larval population in control

T: larval population in treatments

Results and Discussions

During *kharif* 2018, the mean larval population of earhead caterpillar species before imposition of treatments varied between 2.98 to 4.02 larvae per earhead, were statistically non-significant with each other. After a day of first spray, treatments *viz.*, thiodicarb 75 WP @ 1.0 g L^{-1} (1.86 larvae/earhead), lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (1.80 larvae/earhead) and profenophos 50 EC @ 2.0 mL L^{-1} (1.71 larvae/earhead) were found significantly more effective in reducing the larval population over the control (3.30 larvae/earhead) and were on par with other treatments *viz.*, quinalphos 25 EC @ 2.0 mL L^{-1} (2.10 larvae/earhead), novaluron 10 EC @ 1.5 mL L^{-1} (2.07 larvae/earhead), fenvelarate 0.4 D @ 25kg ha^{-1} (1.96 larvae/earhead), chlorpyriphos 1.5 D @ 25kg ha^{-1} (2.03 larvae/earhead) and chlorpyriphos 20 EC @ 2.0 mL L^{-1} (2.16 larvae/earhead). Similarly, at 5 days after the first spray the treatments, thiodicarb 75 WP @ 1.0 g L^{-1} (1.98 larvae/earhead) and lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (2.0 larvae/earhead) registered significantly least larval population over the control (3.23 larvae/earhead), were statistically on par with rest of the treatments *viz.*, profenophos 50 EC @ 2.0 mL L^{-1} (2.16 larvae/earhead), quinalphos 25 EC @ 2.0 mL L^{-1} (2.37 larvae/earhead), novaluron 10 EC @ 1.5 mL L^{-1} (2.23 larvae/earhead), fenvalerate 0.4 DP @ 25 kg ha^{-1} (2.31 larvae/earhead), chlorpyriphos 1.5 D @ 25kg ha^{-1} (2.53 larvae/earhead) and chlorpyriphos 20 EC @ 2.0 mL L^{-1} (2.49 larvae/earhead) in reducing the larval population. However, at 7 days after first spray, all the treatments imposed were significantly superior in reducing the larval populations (varied between 0.97 to 1.53 larvae/earhead) over the untreated check (3.67 larvae/earhead). Further at 14 days after first spray, spray with thiodicarb 75 WP @ 1.0 g L^{-1} (1.11 larvae/earhead) and lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (1.13 larvae/earhead) were significantly superior over the control (3.86 larvae/earhead), both these treatments were on par with rest of the molecules evaluated *viz.*, profenophos 50 EC @ 2.0 mL L^{-1} (1.37 larvae/earhead), novaluron 10 EC @ 1.5 mL L^{-1} (1.34 larvae/earhead), fenvelarate 0.4 D @ 25kg ha^{-1} (1.43 larvae/earhead), chlorpyriphos 1.5 D @ 25kg ha^{-1} (1.50 larvae/earhead) and chlorpyriphos 20 EC @ 2.0 mL L^{-1} (1.44 larvae/earhead) (Table 1).

Later, observations recorded at a day after imposition of second spray, revealed that spray with, thiodicarb 75 WP @ 1.0 g L^{-1} (0.71 larvae/earhead) was found to be effective in reducing the mean larval population over the untreated check (3.06 larvae/earhead), which was on par with the treatments *viz.*, lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (0.78 larvae/earhead) and novaluron 10 EC @ 1.5 mL L^{-1} (0.96 larvae/earhead). Similarly, at 5 days after second spray application of thiodicarb 75 WP @ 1.0 g L^{-1} was found to be most effective and significantly superior over all other treatments in reducing the incidence to 0.46 larvae per earhead and was on par with lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (0.49 larvae per earhead). However, at 7 and 14 days after second spray, application of thiodicarb 75 WP @ 1.0 g L^{-1} (0.26 and 0.21 larvae/earhead, respectively) and lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (0.29 and 0.24 larvae/earhead, respectively) were significantly superior in reducing the larval population over untreated check (2.62 and 2.18 larvae/earhead, respectively). These treatments were on par with profenophos 50 EC @ 2.0 mL L^{-1} (0.46 and 0.41 larvae/earhead, respectively), quinalphos 25 EC @ 2.0 mL L^{-1} (0.53 and 0.43 larvae/earhead, respectively), novaluron 10 EC @ 1.5 mL L^{-1} (0.48 and 0.36 larvae/earhead, respectively), fenvalerate 0.4 DP @ 25 kg ha^{-1} (0.50 and 0.37 larvae/earhead, respectively), chlorpyriphos1.5 D @ 25kg ha^{-1} (0.47 and 0.40 larvae/earhead, respectively) and chlorpyriphos 20 EC @ 2.0 mL L^{-1} (0.51 and 0.42 larvae/earhead, respectively) (Table 1).

Table 1: Field efficacy of selected insecticides molecules against finger millet earhead caterpillars during *kharif* 2018

Sl. No	Chemical Name	Dose (mL L^{-1} or g L^{-1})	I Spray					II Spray				
			DBS	1 DAS	5 DAS	7 DAS	14 DAS	DBS	1 DAS	5 DAS	7 DAS	14 DAS
1	Thiodicarb 75 WP	1.0 g L^{-1}	3.23 (1.79)^{a}	1.86 (1.36)^{c}	1.98 (1.57)^{c}	0.98 (1.21)^{b}	1.11 (1.26)^{c}	1.11 (1.26)^{c}	0.71 (1.09)^{d}	0.46 (0.68)^{f}	0.26 (0.87)^{c}	0.21 (0.84)^{c}
2	Acephate 75 SP	1.5 g L^{-1}	4.02 (1.99)^{a}	2.67 (1.63)^{ab}	2.60 (1.76)^{b}	1.35 (1.35)^{b}	1.62 (1.45)^{b}	1.62 (1.45)^{b}	1.27 (1.33)^{b}	1.03 (1.02)^{b}	0.73 (1.11)^{b}	0.63 (1.06)^{b}
3	Profenophos 50 EC	2.0 mL L^{-1}	2.98 (1.72)^{a}	1.71 (1.29)^{c}	2.16 (1.63)^{bc}	1.17 (1.29)^{b}	1.37 (1.37)^{bc}	1.37 (1.37)^{bc}	1.03 (1.24)^{bc}	0.73 (0.85)^{cd}	0.46 (0.98)^{bc}	0.41 (0.95)^{bc}
4	Quinalphos 25 EC	2.0 mL L^{-1}	3.23 (1.79)^{a}	2.10 (1.45)^{bc}	2.37 (1.69)^{bc}	1.53 (1.42)^{b}	1.63 (1.46)^{b}	1.63 (1.46)^{b}	1.20 (1.30)^{b}	0.90 (0.95)^{bc}	0.53 (1.01)^{bc}	0.43 (0.96)^{bc}
5	Lambda cyhalothrin 5 EC	0.6 mL L^{-1}	3.17 (1.76)^{a}	1.80 (1.34)^{c}	2.00 (1.58)^{c}	1.00 (1.22)^{b}	1.13 (1.28)^{c}	1.13 (1.28)^{c}	0.78 (1.13)^{cd}	0.49 0.71)^{ef}	0.29 (0.89)^{c}	0.24 (0.85)^{c}
6	Novaluron 10 EC	1.5 mL L^{-1}	3.23 (1.79)^{a}	2.07 (1.43)^{bc}	2.23 (1.65)^{bc}	1.22 (1.31)^{b}	1.34 (1.35)^{bc}	1.34 (1.35)^{bc}	0.96 (1.21)^{bcd}	0.71 (0.83)^{d}	0.48 (0.96)^{bc}	0.36 (0.93)^{bc}
7	Fenvalerate 0.4 DP	25 kg ha^{-1}	3.12 (1.76)^{a}	1.96 (1.40)^{bc}	2.31 (1.67)^{bc}	1.33 (1.34)^{b}	1.43 (1.39)^{bc}	1.43 (1.39)^{bc}	1.03 (1.24)^{bc}	0.67 (0.82)^{de}	0.50 (0.95)^{bc}	0.37 (0.93)^{bc}
8	Chlorpyriphos 1.5 D	25 kg ha^{-1}	3.22 (1.79)^{a}	2.03 (1.42)^{bc}	2.53 (1.77)^{bc}	1.50 (1.41)^{b}	1.50 (1.41)^{bc}	1.50 (1.41)^{bc}	1.07 (1.25)^{bc}	0.80 (0.89)^{cd}	0.47 (0.98)^{bc}	0.40 (0.95)^{bc}
9	Chlorpyriphos 20 EC	2.0 mL L^{-1}	3.40 (1.84)^{a}	2.16 (1.47)^{bc}	2.49 (1.73)^{bc}	1.40 (1.37)^{b}	1.44 (1.39)^{bc}	1.44 (1.39)^{bc}	1.10 (1.26)^{b}	0.77 (0.88)^{cd}	0.51 (1.00)^{bc}	0.42 (0.97)^{bc}
10	Untreated control	-	3.21 (1.74)^{a}	3.30 (1.815)^{a}	3.23 (2.05)^{a}	3.67 (2.01)^{a}	3.86 (2.09)^{a}	3.86 (2.09)^{a}	3.06 (1.89)^{a}	2.61 (1.61)^{a}	2.62 (1.77)^{a}	2.18 (1.63)^{a}
	SE m ±	-	0.11	0.08	0.06	0.11	0.05	0.05	0.04	0.04	0.05	0.04
	CD @ p=0.05	-	NS	0.23	0.18	0.33	0.16	0.16	0.13	0.12	0.14	0.13

DBS-Day before spray; DAS- Day after spray; Values in the column followed by common letters are non-significant at P=0.05 as per Tukey's HSD [20]

Regarding species complex of earhead caterpillars of finger millet, the larval population was ranged from 4.39 to 4.63 larvae/earhead during *kharif* 2019. The treatments *viz.*, thiodicarb 75 WP @ 1.0 g L^{-1} (3.00 larvae/earhead) and lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (2.97 larvae/earhead) were found to be superior in reducing the larval population irrespective of the species complex over untreated control (4.65 larvae/earhead). These treatments were on par with profenophos 50 EC @ 2.0 mL L^{-1} (3.07 larvae/earhead), quinalphos 25 EC @ 2.0 mL L^{-1} (3.42 larvae/earhead), novaluron 10 EC @ 1.5 mL L^{-1} (3.50 larvae/earhead), fenvalerate 0.4 DP @ 25 kg ha^{-1} (3.32 larvae/earhead), chlorpyriphos 1.5 D @ 25 kg ha^{-1} (3.80 larvae/earhead) and chlorpyriphos 20 EC @ 2.0 mL L^{-1} (3.23 larvae/earhead). Similarly at 5, 7 and 14 days after first spray, the treatments *viz.*, thiodicarb 75 WP @ 1.0 g L^{-1} (2.20, 1.34 and 1.36 larvae/earhead, respectively) and lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (2.22, 1.33 and 1.36 larvae/earhead, respectively) were significantly superior in reducing the larval population of over the untreated check (4.19, 4.40 and 4.07 larvae/earhead, respectively). These treatments were on par with profenophos 50 EC @ 2.0 mL L^{-1} (2.47, 1.65 and 1.75 larvae/earhead, respectively), quinalphos 25 EC @ 2.0 mL L^{-1} (2.64, 2.03 and 1.93 larvae/earhead, respectively), novaluron 10 EC @ 1.5 mL L^{-1} (2.53, 1.74 and 1.69 larvae/earhead, respectively), fenvalerate 0.4 DP @ 25 kg ha^{-1} (2.59, 1.80 and 1.77 larvae/earhead, respectively), chlorpyriphos 1.5 D @ 25 kg ha^{-1} (2.77, 2.08 and 1.90 larvae/earhead, respectively) and chlorpyriphos 20 EC @ 2.0 mL L^{-1} (2.80, 1.92 and 1.83 larvae/earhead, respectively) (Table 2).

Further, at 1 day after second spray, the treatments thiodicarb 75 WP @ 1.0 g L^{-1} (0.72 larvae/earhead) and lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (0.75 larvae/earhead) were continue to be significantly superior by recording lower larval population of earhead caterpillars over the untreated control (3.50 larvae/earhead) and rest of the treatments. However, during 5, 7 and 14 days after spray, thiodicarb 75 WP @ 1.0 g L^{-1} registered lower population of 0.44, 0.37 and 0.12 larvae/earhead, respectively. This treatment was on par with lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (0.49 larvae/earhead) at 5 days after spray. Likewise, the treatments lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (0.40 larvae/earhead), profenophos 50 EC @ 2.0 mL L^{-1} (0.52 larvae/earhead), novaluron 10 EC @ 1.5 mL L^{-1} (0.53 larvae/earhead) and fenvalerate 0.4 DP @ 25 kg ha^{-1} (0.60 larvae/earhead) at 7 days

Table 2: Field efficacy of selected insecticides molecules against finger millet earhead caterpillars *kharif* 2019

Sl. No	Chemical Name	Dose (mL L^{-1} or g L^{-1})	I Spray					II Spray				
			DBS	1 DAS	5 DAS	7 DAS	14 DAS	DBS	1 DAS	5 DAS	7 DAS	14 DAS
1	Thiodicarb 75 WP	1.0 g L^{-1}	4.60 (2.14)^{a}	3.00 (1.87)^{d}	2.20 (1.64)^{c}	1.34 (1.35)^{c}	1.36 (1.37)^{c}	1.36 (1.37)^{c}	0.72 (0.11)^{d}	0.44 (0.97)^{e}	0.37 (0.93)^{d}	0.12 (0.80)^{f}
2	Acephate 75 SP	1.5 g L^{-1}	4.63 (2.15)^{a}	4.03 (2.13)^{ab}	3.23 (1.92)^{b}	2.17 (1.60)^{b}	2.03 (1.59)^{b}	2.03 (1.59)^{b}	1.60 (1.45)^{b}	1.03 (1.24)^{b}	0.83 (1.15)^{b}	0.63 (1.06)^{b}
3	Profenophos 50 EC	2.0 mL L^{-1}	4.47 (2.11)^{a}	3.07 (1.89)^{cd}	2.47 (1.72)^{bc}	1.65 (1.47)^{bc}	1.75 (1.49)^{bc}	1.75 (1.49)^{bc}	1.33 (1.35)^{bc}	0.70 (1.10)^{cd}	0.52 (1.02)^{bcd}	0.33 (0.91)^{de}
4	Quinalphos 25 EC	2.0 mL L^{-1}	4.61 (2.14)^{a}	3.42 (1.98)^{bcd}	2.64 (1.77)^{bc}	2.03 (1.59)^{bc}	1.93 (1.56)^{bc}	1.93 (1.56)^{bc}	1.50 (1.41)^{bc}	0.87 (1.17)^{bc}	0.67 (1.07)^{bc}	0.40 (0.95)^{bcd}
5	Lambda cyhalothrin 5 EC	0.6 mL L^{-1}	4.43 (2.11)^{a}	2.97 (1.86)^{d}	2.22 (1.65)^{c}	1.33 (1.35)^{c}	1.36 (1.35)^{c}	1.36 (1.38)^{c}	0.75 (1.12)^{d}	0.49 (0.99)^{de}	0.40 (0.95)^{cd}	0.17 (0.82)^{ef}
6	Novaluron 10 EC	1.5 mL L^{-1}	4.60 (2.15)^{a}	3.50 (2.00)^{bcd}	2.53 (1.72)^{bc}	1.74 (1.47)^{bc}	1.69 (1.48)^{bc}	1.69 (1.48)^{bc}	1.23 (1.32)^{c}	0.77 (1.13)^{bc}	0.53 (1.02)^{bcd}	0.37 (0.93)^{cde}
7	Fenvalerate 0.4 DP	25 kg ha^{-1}	4.40 (2.10)^{a}	3.32 (2.07)^{cd}	2.59 (1.74)^{bc}	1.80 (1.52)^{bc}	1.77 (1.50)^{bc}	1.77 (1.50)^{bc}	1.33 (1.35)^{bc}	0.83 (1.15)^{bc}	0.60 (1.05)^{bcd}	0.40 (0.95)^{bcd}
8	Chlorpyriphos 1.5 D	25 kg ha^{-1}	4.39 (2.09)^{a}	3.80 (1.93)^{bcd}	2.77 (1.81)^{bc}	2.08 (1.63)^{bc}	1.90 (1.55)^{bc}	1.90 (1.55)^{bc}	1.47 (1.40)^{bc}	1.00 (1.22)^{b}	0.73 (1.11)^{b}	0.57 (1.03)^{bc}
9	Chlorpyriphos 20 EC	2.0 mL L^{-1}	4.60 (2.14)^{a}	3.23 (1.96)^{cd}	2.80 (1.82)^{bc}	1.92 (1.56)^{bc}	1.83 (1.53)^{bc}	1.83 (1.53)^{bc}	1.40 (1.38)^{bc}	0.90 (1.18)^{bc}	0.70 (1.10)^{b}	0.57 (1.03)^{bc}
10	Untreated control	-	4.53 (2.13)^{a}	4.65 (2.26)^{a}	4.19 (2.16)^{a}	4.40 (2.20)^{a}	4.07 (2.12)^{a}	4.07 (2.12)^{a}	3.50 (2.00)^{a}	3.17 (1.91)^{a}	2.60 (1.76)^{a}	2.07 (1.60)^{a}
	SE m ±	-	0.06	0.19	0.09	0.09	0.07	0.07	0.04	0.04	0.05	0.04
	CD @ p=0.05	-	NS	0.06	0.27	0.27	0.22	0.22	0.13	0.13	0.14	0.11

DBS-Day before spray; DAS- Day after spray; Values in the column followed by common letters are non-significant at P=0.05 as per Tukey's HSD [20]

after spray and lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} (0.17 larvae/earhead) at 14 days after spray were recorded similar trend and were on par with each other. While, rest of the chemicals were moderately effective in reducing the larval population of different species of earhead caterpillars over the untreated control at different days of intervals (Table 2).

Irrespective of the nine insecticide molecules evaluated *viz.*, thiodicarb 75 WP, acephate 75 SP, profenophos 50 EC, quinalphos 25 EC, lambda cyhalothrin 5 EC, novaluron 10 EC, fenvalerate 0.4 DP, chlorpyriphos 1.5 D and chlorpyriphos 20 EC, all the insecticides were found to be effective in reducing different species of earhead caterpillars *viz., A. micaceana, S. scintillans, C. angustipennella, N. analis, Cydia* sp., *H. armigera, P. phoenicealis, C. cephalonica, Stathmopoda* sp., *S. frugiperda, Eublemma* sp., *C. punctiferalis, E. similis, M. separate and Ataboruza* sp., over untreated control.

It is evident from the field experiments that, two sprays at dough stage with thiodicarb 75 WP @ 1.0 g L^{-1} was found to be the most effective in reducing caterpillar complex compared to the rest of the insecticides, which exhibited highest percentage recovery (69.9%) over untreated control with minimum larval load and maximum reduction in larval population (0.94 larvae/earhead) during *kharif* 2018. Similar trend was also noticed during *kharif* 2019, where, thiodicarb 75 WP @ 1.0 g L^{-1} registered the highest recovery over untreated check (66.24%) as well as minimum larval population (1.21 larvae/earhead). Meanwhile, lambda cyhalothrin 5 EC at 0.6 mL L^{-1} was next best treatment, which recorded 69.1% of recovery over the untreated control and minimum mean larval population (0.97 larvae/earhead) during *kharif* 2018 and similar trend was noticed during *kharif* 2019, where, lambda cyhalothrin 5 EC at 0.6 mL L^{-1} recorded 66.1% of recovery over the check with low mean larval population (1.21 larvae/earhead) (Table 3).

The efficacy of thiodicarb 75 WP @ 1.0 g L^{-1} in the present study was supported by the findings of Muralikrishna *et al.* (2008) [13] where, he opined that, thiodicarb 75 WP @ 1g L^{-1} was the best insecticide in reducing the larval population of tobacco caterpillar *Spodoptera litura.* Similarly, the results of the present findings by Ahmed *et al.* (2000) [2], where he concluded that thiodicarb (0.075%) was the best molecule over other insecticides

Table 3: Bio-efficacy of insecticides on earhead caterpillar complex over untreated control, *kharif* 2018 and 2019

Sl. No	Chemical Name	Dose (mL L^{-1} or g L^{-1})	*Kharif* 2018		*Kharif* 2019	
			Mean (larvae/earhead)	% of larval reduction	Mean (larvae/earhead)	% of larval reduction
1	Thiodicarb 75 WP	1.0 g L^{-1}	0.94	69.9	1.21	66.24
2	Acephate 75 SP	1.5 g L^{-1}	1.49	52.5	1.93	45.98
3	Profenophos 50 EC	2.0 mL L^{-1}	1.13	63.9	1.47	58.91
4	Quinalphos 25 EC	2.0 mL L^{-1}	1.34	57.3	1.69	52.74
5	Lambda cyhalothrin 5 EC	0.6 mL L^{-1}	0.97	69.1	1.21	66.12
6	Novaluron 10 EC	1.5 mL L^{-1}	1.17	62.7	1.55	56.81
7	Fenvalerate 0.4 DP	25 kg ha^{-1}	1.19	62.1	1.63	54.37
8	Chlorpyriphos 1.5 D	25 kg ha^{-1}	1.30	58.5	1.73	51.69
9	Chlorpyriphos 20 EC	2.0 mL L^{-1}	1.29	58.9	1.68	52.97
10	Untreated control	-	3.13	-	3.58	-

tested, in recording highest larval mortality of beet armyworm *Spodoptera exigua* in chilli. The results of the present study was also in line with the findings of Zahid and Hamed. (2003) [21] and Mutkule *et al.* (2009) [14] who noticed significant suppression in the larval population of *H. armigera* and *S. litura* respectively in ground nut. Lakshminarayanamma *et al.* (2010) [12] also noticed that thiodicarb @ 0.075 was effective against semilooper, *Achaea janata*, tobacco caterpillar, *S. litura* and capsule borer, *C. punctiferalis*.

The results on lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} in the present study was in close agreement with the findings of Dudhbale *et al.* (2017) [7] where the larval population of leaf eating caterpillar was significantly lower with the application of lambda cyhalothrin 5 EC @ 300 mL ha^{-1}. Similarly, Nagare *et al.* (2018) [15] also noticed that spray with lambda cyhalothrin 5 EC @ 1.0 mL L^{-1} was effective in reducing population of earhead worm in sorghum. Whereas, Lakshminarayanamma *et al.* (2013) [11] opined that, lambda cyhalothrin 2.5 EC @ 1 mL L^{-1} was more effective in reducing the larval population of *S. litura* in castor. Likewise, Thorat *et al.* (2018) [19] lambda cyhalothrin 0.003 per cent was found to be most effective in recording significantly lowest fruit damage caused by fruit borer (*H. armigera*) in tomato, but in present findings, lambda cyhalothrin 5 EC @ 0.6 mL L^{-1} was the second best treatment for the management of all species of earhead caterpillar in finger millet.

Conclusion

The studies carried out in efficacy of new and conventional insecticides against earhead caterpillars in finger millet revealed that, two sprays at dough stage of the crop, thiodicarb 75 WP @ 1.0 g L^{-1} and lambda cyhalothrin 5 EC at 0.6 mL L^{-1} were found to be more effective in reducing the mean larval population and registered higher percentage recovery with least larval population compared to rest of the insecticides.

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