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Comparative efficacy of insecticides and biopesticides against *Bactrocera* spp. infesting cucumber

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Abstract
Evaluation of insecticides and biopesticides against *Bactrocera* spp. Infesting cucumber revealed lambda cyhalothrin (0.008%) as the most effective insecticide, with infestation values of 13.59 and 11.69 per cent, during 2014 and 2015, respectively. It was followed by the same insecticide at lower concentration (0.004%) where, fruit infestation of 19.52 and 16.13 per cent, were recorded during 2014 and 2015, respectively. Spinosad (0.004 and 0.002%) was next in the order of effectiveness with fruit infestation values of 25.41, 23.69 and 28.45, 25.85 per cent, during 2014 and 2015, respectively and was at par with fruit infestation of 15.48 and 24.15 per cent in deltamethrin (0.0056%). The per cent infestation recorded with azadirachtin (0.001 and 0.002%) was at par with malathion (0.1 and 0.2%).

Keywords: *Bactrocera*, lambda cyhalothrin, spinosad, azadirachtin, malathion, deltamethrin

Introduction
Bactrocera tau (Walker) and *B. cucurbitae* (Coquillett) are the two important species of fruit flies which infest the crops of family cucurbitacae and affect the quality of the produce (Nath *et al*., 2007; Prabhakar *et al*., 2007) [1, 2]. Among cucurbits; bitter gourd, cucumber and sponge gourd constitute the major group of vegetables being infested by fruit flies (Gupta and Verma 1992) [3]. In India, cucumber is cultivated in an area of 74 thousand hectare with an annual production of 1142 thousand MT (Anonymous, 2015) [4] and Bactocera spp remains a major threat to cucumber production.
The pest accounts for about 30-100 per cent yield losses if susceptible varieties and conducive environmental conditions are available to the pest (Raksit *et al.*, 2011, Dhillon *et al.*, 2005) [5, 6]. The management of the pest is mainly based on use of chemical insecticides. However, the indiscriminate use of these pesticides has resulted in various environmental and health problems viz. development of resistance in insect pests, greater insecticide residues in food items and destruction of natural predators. On realizing such problems in the recent years focus has again been shifted towards use of biocontrol agents and biopesticides. Keeping in view these facts the present study was undertaken to compare the efficacy of some insecticides and biopesticides against *Bactrocera* spp in cucumber.

Materials and Methods
The study was conducted on cucumber crop (var. K-75) raised in polybags filled with virgin forest soil, sieved and well decomposed farm yard manure in the ratio of 1:1.The planting was done at spacing of 180X65 cm distance at the experimental farm of the Department of Entomology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) during 2014 and 2015. The experiment was laid out in a Randomized Block Design (RBD), where each treatment was replicated thrice. The first spray was given after initiation of fruit setting, which was followed by two more foliar applications at an interval of 10 days. The spray was provided with the help of a knap sack sprayer till run off stage. Treatments namely, lambda-cyhalothrin (0.004 and 0.008%), deltamethrin (0.0028 and 0.0056%), spinosad (0.002 and 0.004%), malathion (0.1 and 0.2%), azadirachtin (0.01 and 0.02%) and *Beauveria bassiana* (1.0 and 2.0%), were used in the present study. In control, however only water was sprayed on the plants. The data generated in the study was analysed for analysis of variance (ANOVA) by using OPSTAT statistical software programme.

Results and Discussion

The perusal of the data presented in Table 1 and 2 reveled that after 10 days of first foliar application, numerically minimum infestation was recorded in lambda-cyhalothrin (0.008%) with 30.45 and 27.19 percent infestation and was statistically at par with lower concentration (0.004%) of lambda-cyhalothrin (32.18 and 29.75% infestation), higher concentration (0.004%) of spinosad (39.68 and 33.50%) and higher concentration (0.0056%) of deltamethrin with 35.79 and 34.77 per cent infestation, during 2014 and 2015 respectively, whereas, during 2014 lower concentration (0.002%) of spinosad was at par with both the concentrations of lambda-cyhalothrin. Fruit infestation in lower concentration (0.0028%) of deltamethrin was statistically at par with lower concentration (0.002%) of spinosad during 2015 and also with both the concentrations (0.1 and 0.2%) of malathion and (0.01 and 0.02%) azadirachtin during 2014 and 2015 (Table 1 and Table 2).

After 10 days of the second spray application, lambda-cyhalothrin at both the concentrations (0.004 and 0.008%) proved effective in fruit fly infestation. The fruit infestation recorded was 21.48 and 20.50 per cent at higher concentration (0.008%) and 24.87 and 21.49 per cent at lower concentration (0.004%) of lambda-cyhalothrin during both the years (Table 1 and 2). Whereas, the percent fruit infestation with lower and higher dose of lambda-cyhalothrin during both the years were at par with both the concentration of spinosad (0.002 and 0.004%), during 2014 and 2015, respectively and with both concentrations of deltamethrin during 2014. In 2015 both the concentrations of lambda-cyhalothrin (0.008 and 0.004%) and spinosad were at par with the higher concentration (0.0056%) of deltamethrin (26.66% infestation) and superior to the fruit infestation of 28.54 per cent recorded at lower concentration (0.0028%) of deltamethrin. During 2015, the fruit infestation of 28.54 percent was recorded in lower concentration (0.0028%) of deltamethrin which was at par with azadirachtin (0.02%) with 36.72 percent infestation.

Similar trend was observed when the data was recorded after 10 days of 3rd spray application. Lambda- cyhalothrin (0.008%) with 11.73 and 10.01 per cent infestation during both the years, was most effective and at par with lower concentration (0.004%) of lambda-cyhalothrin with 12.59 and 11.73 per cent fruit infestation during 2014 and 2015, respectively. Both the concentrations of lambda-cyhalothrin were at par with spinosad (0.002 and 0.004%) and deltamethrin (0.0028 and 0.0056%) concentrations during both the years (Table 1 and 2). Fruit infestation recorded in 0.01 per cent azadirachtin (27.65 and 20.99%) and 0.02 percent of azadirachtin (24.71 and 18.69%) were at par with 0.1 and 0.2 percent malathion (29.30, 21.72 and 26.91, 19.55% infestation) in both the years. *B. bassiana* (1.0%) with fruit infestation 41.55 and 35.50 per cent during 2014 and 2015, respectively was the least effective treatment, through being superior to control (78.56 and 79.84%) during both the years, respectively.

When overall means were taken into consideration, lambda-cyhalothrin (0.008%) with 20.67 and 18.67 per cent infestation during both the years, respectively was numerically the most effective treatment and was statistically at par with lower concentration (0.004%) of lambda-cyhalothrin with 22.65 and 20.47 per cent infestation, both the concentrations of spinosad (0.002% and 0.004%) and higher concentration (0.0056%) of deltamethrin with 25.48 and 24.15 per cent infestation, during 2014 and 2015, respectively. Fruit fly infestation in lower concentration (0.0028%) of deltamethrin treatment with 30.96 and 26.35 per cent infestation was statistically at par with both the concentrations of azadirachtin (0.01% and 0.02%) and malathion (0.1% and 0.2%) during 2014 and at par with both the concentrations of azadirachtin and higher concentration of malathion during 2015 (Table 1 and 2). *B. bassiana* (1.0%) with 50.29 and 47.59 per cent fruit infestation during 2014 and 2015, respectively was the least effective treatment. All the test treatments were superior to control (71.20 and 71.40%) during both the years.

The present results are in agreement with the study conducted by Thakur (2011) [7], who reported that lambda-cyhalothrin (0.004%) was the most effective insecticide in checking fruit fly infestation in cucumber, tomato and peach crops and the Spinosad (0.002%) was the next best treatment in managing fruit fly infestation in vegetables and fruit crops. Abrol (2017) [8] also reported the efficacy of lambda-cyhalothrin (0.004%) in managing fruit fly, *Bactrocera* spp. in bottlegourd and bittergourd, which was followed by spinosad (0.002%) and deltamethrin (0.0028%) and supports the results obtained in the present study where lambda-cyhalothrin (0.004 and 0.008%) was the most effective treatment. Sood and Sharma (2004) [9], reported deltamethrin to be more effective in comparison to malathion in checking cucurbit fruit fly, *B. cucurbitae* infestation in summer squash. Oke (2008) [10], reported lambda-cyhalothrin to be effective in managing melon fruit fly in cucumber. Khatun *et al.* (2016) [11] reported lambda cyhalothrin (0.005%) to be effective in managing *B. cucurbitae* infestation (17.23%) in bitter gourd.

Among biopesticides, Azadirachtin proved moderately effective and was at par with malathion however *B. bassiana* was least effective in checking fruit fly infestation in cucumber. Similar results obtained by Abrol (2017) [8] where, *B.bassiana* was least effective and in managing fruit flies in bittergourd and bottle gourd than azadirachtin. The results also find support from the study conducted by Nath *et al.* (2007) [1] who reported NSKE (5%) and bait spray of malathion effective in checking fruit fly infestation in bottle gourd.

Table 1: Bioefficacy of insecticides and biopesticides against fruit fly, *Bactocera* spp. infesting cucumber at Nauni during 2014

Treatment	Fruit Infestation (%) 10 days after			Mean fruit infestation (%)
	Spray 1	Spray 2	Spray 3	
Lambda–cyhalothrin (0.004%)	32.18 (34.56)	24.87 (29.91)	12.59 (20.78)	22.65 (28.42)
Lambda–cyhalothrin (0.008%)	30.45 (33.50)	21.48 (27.61)	11.73 (20.03)	20.67 (27.05)
Deltamethrin(0.0028%)	44.23 (41.69)	30.45(33.50)	19.56 (26.25)	30.96(33.81)
Deltamethrin (0.0056%)	35.79(36.75)	26.15(30.76)	15.83(23.45)	25.48(30.32)
Spinosad (0.002%)	40.08(39.28)	27.01(31.32)	19.36(26.11)	28.45(32.23)
Spinosad (0.004%)	39.68 (39.05)	24.22(29.48)	14.39(22.29)	25.41(30.28)
Malathion (0.1%)	48.78(44.31)	34.78(36.14)	29.30(32.77)	37.46(37.74)
Malathion (0.2%)	46.45(42.97)	33.50(35.37)	26.91(31.25)	35.43(36.53)

Azadirachtin (0.01%)	50.85(45.49)	34.78(36.14)	27.65(31.73)	37.53(37.79)
Azadirachtin (0.02%)	48.42(44.10)	33.06(35.10)	24.71(29.81)	35.10(36.34)
Beauveria bassiana (1.0%)	57.68(49.42)	51.66(45.95)	41.55(40.14)	50.29(45.17)
Beauveria bassiana (2.0%)	56.74(48.88)	50.09(45.05)	40.60(39.59)	49.13(44.51)
Control	64.23(53.27)	70.26(56.95)	78.56(62.42)	71.20(57.55)
Mean	45.74(42.56)	35.22(36.41)	26.95(31.28)	

Figures in parentheses are arc sine transformed values

CD $_{(0.05)}$

Treatment (T) 3.65

Spray Interval (I) 1.76

TXI 6.33

Table 2: Bioefficacy of insecticides and biopesticides against fruit fly, *Bactocera* spp. infesting cucumber at Nauni during 2015

Treatment	Fruit Infestation (%) 10 days after			Mean fruit infestation (%)
	Spray 1	Spray 1	Spray 3	
Lambda–cyhalothrin (0.004%)	29.75(33.06)	21.49(27.62)	11.73(20.03)	20.47(26.90)
Lambda–cyhalothrin (0.008%)	27.19(31.43)	20.50(26.93)	10.01(18.45)	18.67(25.60)
Deltamethrin (0.0028%)	37.28(37.63)	28.54(32.29)	14.93(22.73)	26.35(30.89)
Deltamethrin (0.0056%)	34.77(36.13)	26.66(31.09)	12.94(21.08)	24.15(29.43)
Spinosad (0.002%)	35.98(36.86)	27.93(31.90)	15.16(22.91)	25.85(30.56)
Spinosad (0.004%)	33.50(35.37)	25.92(30.61)	13.33(21.41)	23.69(29.13)
Malathion (0.1%)	44.31(41.74)	41.64(40.19)	21.72(27.78)	35.49(36.57)
Malathion (0.2%)	42.13(40.48)	37.28(37.63)	19.55(26.24)	32.54(34.78)
Azadirachtin (0.01%)	43.77(41.43)	39.91(39.18)	20.99(27.27)	34.48(35.96)
Azadirachtin (0.02%)	41.21(39.94)	36.72(37.30)	18.69(25.62)	31.73(34.29)
Beauveria bassiana (1.0%)	54.70(47.70)	52.76(46.58)	35.50(36.57)	47.59(43.62)
Beauveria bassiana (2.0%)	54.61(47.65)	51.47(45.85)	34.65(36.06)	46.83(43.19)
Control	62.47(52.23)	71.10(57.48)	79.84(63.33)	71.41(57.68)
Mean	41.53(40.13)	36.69(37.28)	22.65(28.42)	

Figures in parentheses are arc sine transformed values

CD $_{(0.05)}$

Treatment (T) 3.05

Spray Interval (I) 1.47

TxI 5.28

Conclusions

Findings of the present study revealed that the foliar spray of lambda cyhalothrin @ 0.008 per cent resulted in minimum fruit fly infestation in cucumber, which was closely followed by lower concentration of lambda cyhalothrin (0.004%) and spinosad (0.004 and 0.002%). From the stusy it can be concluded that the newer insecticides i.e. lambda cyhalothrin and spinosad are far superior in controlling fruit fly infestation in cucumber than the biopesticides *viz.* azadirachtin and *B. bassiana* and recommended insecticide *i.e.* malathion. Therefore, various modules can be evaluated where synthetic pyrethroids and botanicals can be used in rotation to achieve effective fruit fly control.

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