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Bio-efficacy of different insecticides/botanicals against fruit fly, *B. cucurbitae* on bottle gourd

DS Meena, VS Acharya, Veer Singh, K Mehra and VS Rajput

Abstract
Five insecticides and four botanicals evaluated for their bio efficacy against fruit fly, *B cucurbitae*, revealed that spinosad 45 SC (0.013%) was most effective followed by indoxacarb 14.5 SC (0.010%) and acephate 75 SP (0.075%). The next effective treatments were dimethoate 30 EC (0.030%) and quinalphos 25 EC (0.025%). The treatments khimp and tumba extract were found least effective against fruit fly infestation.

Keywords: Insecticides, botanicals, treatments, extract, infestation

Introduction
Bottle gourd, *Lagenaria siceraria* (Mol.) belongs to the family cucurbitaceae (Cucumber, squash etc.) known as Calabash, Doodhi and Lauki in different parts of India. Bottle gourd is one of the excellent fruits gifted by the nature to human beings having composition of all the essential constituents that are required for normal and good human health. Its consumption is advocated by traditional healers for controlling diabetes mellitus, hypertension, liver diseases, weight loss and other associated benefits. It is well known that bottle gourd is helpful in constipation, premature graying of hair, urinary disorders and insomnia. The crop was constantly observed for fruit fly damage from the initiation of fruit formation till last picking of the fruits. It has made it susceptible to the attack of number of insect pests during different stages of crop growth like melon fruit fly, *Bactrocera cucurbitae (*Coquillett), red pumpkin beetle, *Raphidopalpa foveicollis* (Lues), hadda beetle, *Epilachnadermurili* Mulsent), jassid, *Amrasca biguttula* Ishida) and whitefly, *Bemisia tabaci* Gennadius)etc. Amongst which, melon fruit fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) has been observed to cause serious damage to bottle gourd fruits (Maggots feed inside the fruits, but at times, also feed on flowers and stems). Losses to cultivated crops may reach 100 per cent if control measures are not applied (Vayssieres and Carel, 1999) [27]. There is need to identify the effective insecticides/botanicals against cucurbit fruit fly, *Bactrocera cucurbitae*.

Material and Method
The experiment was conducted in simple randomized block design. There were ten treatments including control and each replicated three times. The seeds of bottle gourd variety Thar Samridhi were sown on 8th March in 2017 and 13th March in 2018 in plots size 5.0 x 4.5 m, keeping row to row and plant to plant distance of 2.5 m and 0.75 m, respectively. The recommended package of practices was followed to raise the crop.
The spraying was done by using pre-calibrated knapsack sprayer. The first foliar spray of each treatment was commenced at the fruit setting stage on 15th May during 2017 and 17th May during 2018 when oviposition marks were noticed on bottle gourd fruits and the second spray was given just after observing ETL. The quantity of water at the rate of 400 L. per hectare was used in each spray.

Table 1: Details of insecticides/botanicals used

S. No	Insecticides/ Botanicals	Formulations	Conc. (%)/Dose
1 1	Spinosad	45 SC	0.013
2	Indoxacarb	14.5 SC	0.010
3	Acephate	75 SP	0.075
4	Quinalphos	25 EC	0.025
5	Dimethoate	30 EC	0.030
6	Azadirachtin	0.03 EC	5.0 ml/l
7	NSKE	-	5.0 ml/l
8	Khimp extract (*Leptadenia pyrotechnica*)	-	5.0 ml/l
9	Tumba extract (*Citrullus colocynthis*)	-	5.0 ml/l
10	Control	-	-

Observations

The observations on total number of fruits and infested fruits in each plot were recorded regularly before and 3, 6, 9, 12 and 15 days after each spray application in both the years 2017 and 2018.

Infested and healthy fruits were weighted and counted separately. Percentage of fruits damage on number and weight basis were worked out by the following formula (Preetha and Nadarajan, 2006).

$$\text{Per cent infestation (Number basis)} = \frac{\text{Total number of infested fruits}}{\text{Total number of picked fruits}} 100$$

$$\text{Per cent infestation (Weight basis)} = \frac{\text{Total weight of infested fruits}}{\text{Total weight of picked fruits}} 100$$

Statistical analysis of data

The percentage of infested fruits of bottle gourd was worked out at three days interval by counting as well as weighing the damaged and undamaged fruits. For analysis of variance the data of per cent infestation were transformed to angular values for 2017 and 2018 separately and in pooled randomized block design. The critical difference calculated was compared between mean per cent infestation.

Preparation of plant extract of different botanicals

The botanicals locally available in the vicinity were collected in appropriate quantities and brought into the laboratory. Plant sap of collected material was extracted with juice extracting machine (mixer grinder) by adding water as needed and was soaked overnight in sufficient quantity of water. Then filtered through muslin cloth and stored in capped bottles under room temperature. The volume was made up by adding the required quantity of water to get 5 per cent solution (Kumar *et al.* 2000). Sandoval at one ml per liter of spray solution was also used as surfactant.

Results and Discussion

Field experiments were conducted to study the bio-efficacy of different insecticides and botanicals against fruit fly, *B. cucurbitae* on bottle gourd, during summer, 2017 and 2018. The efficacy of different treatments was observed on the basis of per cent fruit infestation in number and weight basis and detailed concrete discussion is made here under.

The results revealed that all the treatments were significantly superior over control in reducing fruit damage judged on number as well as on weight basis during both the years. The results exhibited significant difference in respect to per cent infestation among different treatments in both the year. The results of pooled mean revealed that the treatment of spinosad, with mean fruit damage of 12.43 per cent on number and 10.58 per cent on weight basis proved most effective followed by indoxacarb and acephate with mean damage of 13.01 & 13.74 per cent on number and 11.13 & 11.55 per cent on weight basis, respectively, however, these three treatments were found statistically at par and significantly superior to rest of the treatments. The present results are in agreement to those of Waseem *et al.* (2009) [28] Hanumantappa e*t al.* (2013) [7] and Bhowmik *et al.* (2014) [4] who observed that most effective treatment in reducing the fruit infestation by melon fruit fly was spinosad followed by acephate. The treatment of dimethoate with mean per cent damage of 16.08 per cent on number and 14.14 per cent on weight basis and quinalphos with mean per cent damage of 17.92 per cent on number and 14.52 per cent on weight basis were next best treatments. These two treatments were significantly inferior to that of spinosad, indoxacarb and acephate and significantly superior to rest of the treatments. Bhatnagar and Yadava (1992) [3] reported that quinalphos proved most effective chemical for controlling fruit fly after malathian and carbaryl support the present findings. The treatment of tumba extract proved least effective with 22.25 per cent fruit damage on number and 18.18 per cent on weight basis followed by khimp extract, NSKE and azadiractin showing fruit damage of 21.64, 21.16 & 20.37 per cent on number and 17.76, 17.15 & 16.91 per cent on weight basis, respectively and all these treatments were statistically at par, significantly superior to that of untreated check and significantly inferior to other treatments. These results are in close conformity with the findings of various previous workers who also reported that NSKE and azadirachtin were significantly superior to that of untreated check and significantly inferior to other treatments against fruit fly. Tomer and Singh (2001) reported NSKE was found significantly superior over control against melon fruit fly while Ali *et al.,* (2011) [1] evaluated different treatments against fruit fly and recorded maximum per cent damage in the plots treated with NSKE. Contrary to the present results Khursheed and Raj (2012) [11] observed that azadiractin was best treatment followed by lamdacyhalothrin and carbaryl and Sawai *et al.* (2013) [22] who reported that treatment of azadiractin was at par with DDVP and emamectin benzoate. The overall effectiveness of botanical/ insecticides against fruit fly for both years and pooled mean data the descending order was: Spinosad>Indoxacarb>Acephate>Dimethoate>Quanalphos>Azadirachtin> NSKE >Khimp extract >Tumba extract.

Table 2: Bio-efficacy of insecticides/botanicals against fruit fly, *B. cucurbitae* on bottle gourd (Pooled) (First spray)

S. No.	Treatments	Conc. (%)/ Dose	Per cent fruit infestation											
				(Number basis)						(Weight basis)				
			Before spray	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	Before spray	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS
1.	Spinosad 45 SC	0.013	18.65 (25.57)	10.86 (19.24)	10.31 (18.73)	11.27 (19.62)	11.56 (19.87)	12.32 (20.54)	18.23 (25.27)	9.16 (17.62)	8.23 (16.67)	9.38 (17.83)	10.18 (18.60)	11.18 (19.51)
2.	Indoxacarb 14.5 SC	0.010	18.93 (25.76)	11.55 (19.86)	10.90 (19.28)	11.71 (20.04)	12.15 (20.40)	13.07 (21.19)	17.68 (24.85)	9.58 (18.02)	8.70 (17.14)	9.86 (18.31)	10.88 (19.28)	11.93 (20.19)
3.	Acephate 75 SP	0.075	18.65 (25.56)	12.10 (20.35)	11.50 (19.82)	12.53 (20.73)	13.43 (21.50)	13.85 (21.85)	17.79 (24.94)	9.83 (18.26)	8.91 (17.36)	10.25 (18.67)	11.17 (19.51)	12.48 (20.68)
4.	Quinalphos 25 EC	0.025	18.62 (25.53)	15.28 (23.00)	14.38 (22.28)	15.63 (23.28)	16.25 (23.76)	17.18 (24.48)	19.07 (25.87)	12.46 (20.66)	11.60 (19.90)	12.76 (20.93)	13.98 (21.95)	15.31 (23.03)
5.	Dimethoate 30 EC	0.030	19.24 (25.99)	14.58 (22.45)	13.46 (21.52)	15.00 (22.78)	15.58 (23.24)	17.08 (24.41)	18.32 (25.33)	12.22 (20.45)	11.20 (19.53)	12.53 (20.73)	13.77 (21.77)	14.92 (27.71)
6.	Azadirachtin	5ml/l	18.28 (25.27)	18.81 (25.70)	18.02 (25.12)	19.56 (26.25)	20.01 (26.58)	21.30 (27.49)	18.10 (25.16)	14.58 (22.44)	13.67 (21.67)	15.11 (22.88)	16.81 (24.20)	18.16 (25.22)
7.	NSKE	5ml/l	18.90 (25.75)	19.38 (26.12)	18.71 (25.63)	20.45 (26.88)	21.07 (27.32)	22.18 (28.10)	18.26 (25.28)	14.76 (22.59)	14.03 (21.99)	15.43 (23.13)	16.92 (24.28)	18.30 (25.32)
8.	Khimp extract (*Leptadenia pyrotechnica*)	5ml/l	19.58 (26.26)	19.85 (26.46)	19.11 (25.92)	20.80 (27.13)	21.36 (27.53)	22.61 (28.39)	18.46 (25.43)	15.13 (27.88)	14.56 (22.42)	16.13 (23.68)	17.58 (24.78)	19.01 (25.84)
9.	Tumba extract (*Citrullus colocynthis*)	5ml/l	19.35 (26.04)	20.45 (26.88)	19.80 (26.42)	21.51 (27.63)	21.82 (27.84)	23.86 (29.24)	18.23 (25.27)	15.53 (23.19)	19.46 (22.74)	16.47 (23.94)	18.15 (25.21)	19.57 (26.25)
10.	Control		18.62 (25.53)	21.47 (26.61)	27.21 (31.43)	32.41 (34.70)	39.89 (39.16)	44.41 (41.79)	17.85 (24.98)	17.87 (25.00)	23.65 (29.09)	28.03 (31.97)	30.08 (33.26)	31.56 (34.17)
	S.Em.±		0.46	0.61	0.63	0.61	0.56	0.76	0.52	0.63	0.64	0.66	0.62	0.64
	C.D at (P= 0.05)		1.37	1.82	1.87	1.81	1.69	2.26	1.54	1.86	1.90	1.97	1.84	1.90

Figures in parenthesis are arcsine values
DAS: Days After Spraying

Table 3: Bio-efficacy of insecticides/botanicals against fruit fly, *B. cucurbitae* on bottle gourd (Pooled) (Second spray)

S. No.	Treatments	Conc. (%)/Dose	Per cent fruit infestation											
				(Number basis)						(Weight basis)				
			Before spray	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS	Before spray	3 DAS	6 DAS	9 DAS	12 DAS	15 DAS
1.	Spinosad 45 SC	0.013	12.32 (20.54)	11.82 (20.10)	11.10 (19.45)	12.22 (20.45)	13.03 (21.16)	13.68 (21.70)	11.18 (19.51)	9.52 (17.96)	8.90 (17.35)	9.68 (18.13)	10.55 (18.94)	11.45 (19.76)
2.	Indoxacarb 14.5 SC	0.010	13.07 (21.19)	12.37 (20.59)	11.80 (20.09)	12.67 (20.85)	13.58 (21.62)	14.45 (22.34)	11.93 (20.19)	10.42 (18.83)	9.80 (18.24)	10.55 (18.94)	11.23 (19.57)	11.90 (20.16)
3.	Acephate 75 SP	0.075	13.85 (21.85)	13.48 (21.54)	12.22 (20.45)	13.52 (21.57)	14.72 (22.56)	15.28 (23.01)	12.48 (20.68)	10.93 (19.30)	10.25 (18.67)	11.03 (19.39)	11.88 (20.15)	12.53 (20.71)
4.	Quinalphos 25 EC	0.025	17.18 (24.48)	16.22 (23.74)	15.16 (22.92)	16.01 (23.59)	17.65 (24.84)	18.33 (25.35)	15.31 (23.03)	13.67 (21.70)	12.90 (21.04)	14.95 (22.74)	16.02 (23.58)	17.03 (24.35)
5.	Dimethoate 30 EC	0.030	17.08 (24.41)	16.06 (23.62)	14.90 (22.70)	15.56 (23.23)	17.47 (24.70)	18.03 (25.13)	14.92 (27.71)	13.41 (21.49)	12.71 (20.89)	14.35 (22.25)	15.58 (23.23)	16.58 (23.99)
6.	Azadirachtin	5ml/l	21.30 (27.49)	20.92 (27.21)	20.25 (26.74)	21.50 (27.62)	22.40 (28.24)	23.10 (28.72)	18.16 (25.22)	16.58 (24.03)	15.65 (23.29)	18.01 (25.11)	19.15 (25.95)	20.25 (26.73)
7.	NSKE	5ml/l	22.18 (28.10)	21.47 (27.60)	21.03 (27.30)	21.95 (27.93)	23.60 (29.05)	24.06 (29.37)	18.30 (25.32)	17.05 (24.39)	15.75 (23.37)	18.40 (25.40)	19.35 (26.09)	20.48 (26.89)
8.	Khimp extract (*Leptadenia pyrotechnica*)	5ml/l	22.61 (28.39)	21.88 (27.89)	21.33 (27.51)	22.93 (28.60)	24.13 (29.42)	24.52 (29.68)	19.01 (25.84)	17.78 (24.94)	16.68 (24.10)	18.88 (25.75)	20.18 (24.69)	21.08 (27.33)
9.	Tumba extract (*Citrullus colocynthis*)	5ml/l	23.86 (29.24)	22.50 (28.31)	22.26 (28.15)	23.60 (29.05)	24.80 (29.86)	24.83 (29.89)	19.57 (26.25)	18.15 (25.21)	17.00 (24.34)	19.51 (26.21)	20.68 (27.05)	21.82 (27.84)
10.	Control		44.41 (41.79)	48.27 (44.00)	43.58 (41.31)	39.72 (39.07)	37.85 (37.96)	34.33 (35.87)	31.56 (34.17)	36.23 (37.00)	42.58 (40.70)	37.95 (38.02)	34.18 (35.78)	30.32 (33.53)
	S.Em.±		0.76	0.64	0.68	0.59	0.67	0.65	0.64	0.71	0.74	0.66	0.68	0.65
	C.D at (P= 0.05)		2.26	1.89	2.01	1.77	2.00	1.93	1.90	2.12	2.20	1.98	2.03	1.93

Figures in parenthesis are arcsine values
DAS: Days After Spraying

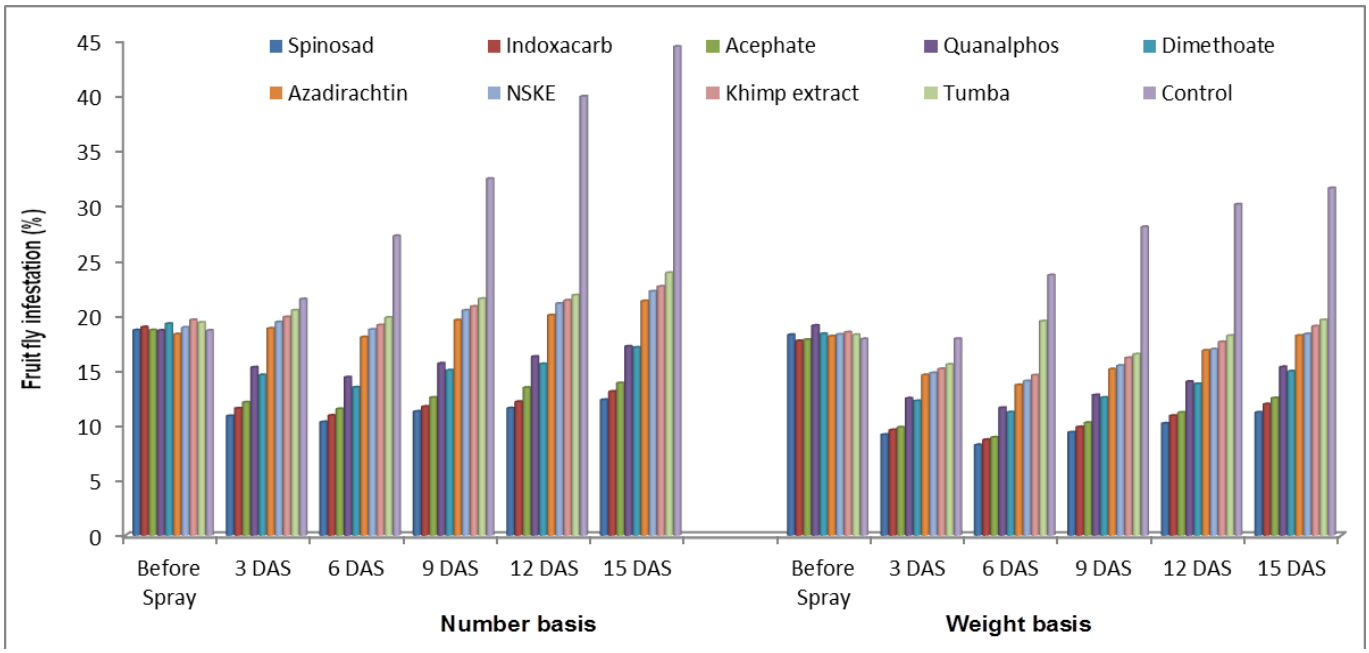

Fig 1: Bio-efficacy of insecticides/botanicals against fruit fly, *B. cucurbitae* on bottle gourd (Pooled) (first spray)

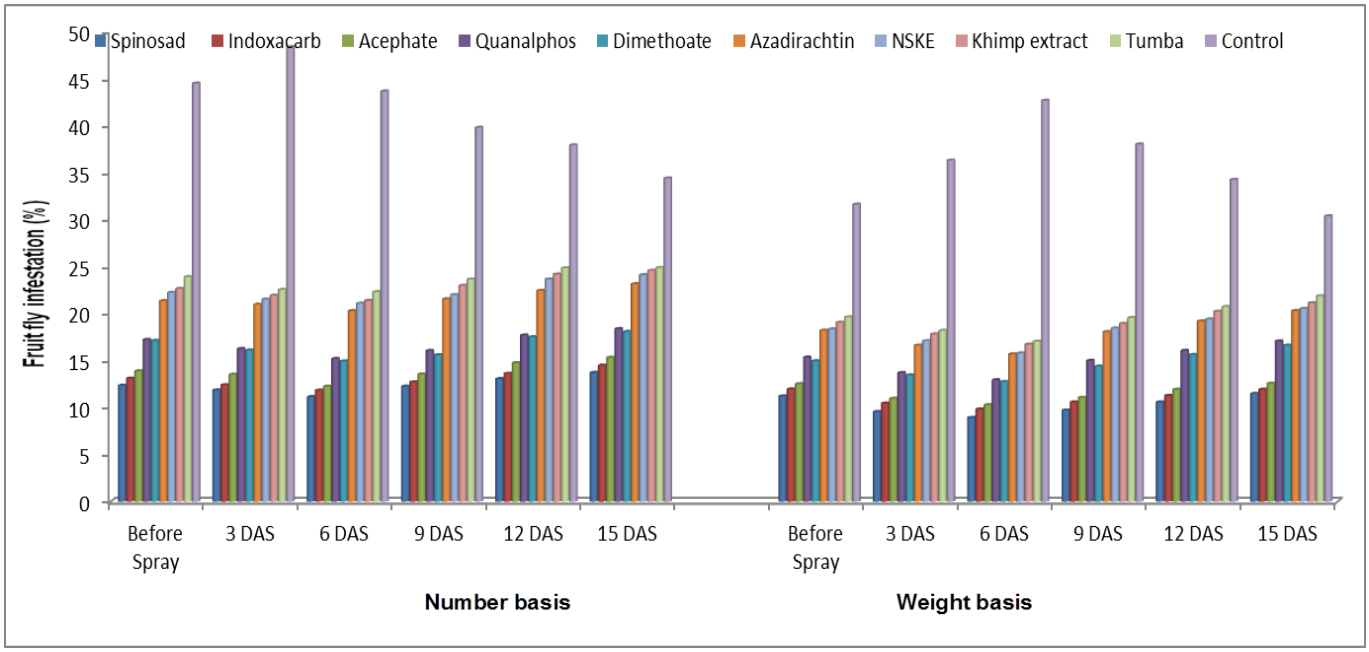

Fig 2: Bio-efficacy of insecticides/botanicals against fruit fly, *B. cucurbitae* on bottle gourd (Pooled) (second spray)

Conclusion

The effectiveness of different treatments was observed on the basis of per cent fruit infestation in number and fruit weight basis. The overall efficacy of treatments at 3, 6, 9, 12 and 15 days against fruit fly revealed that all the treatments were remained significantiy superior over control. The minimum infestation on number and weight basis was observed in spinosad followed by indoxacarb and acephate and these three treatments were comparable to each other in their efficacy. The next effective treatments were dimethoate followed by quinalphos.

Tumba extract @ 5 ml l^{-1} was proved least effective in respect to fruit damage on number and fruit weight basis followed by treatment of *Khimp* extract (5 ml l^{-1}).

The order was effectiveness after three days of application Spinosad>Indoxacarb>Acephate>Dimethoate>Quinalphos>Azadirachtin> NSKE >Khimp extract >Tumba extract.

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