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Article · March 2016

DOI: 10.31018/jans.v8i1.796

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Journal of Applied and Natural Science 8 (1): 333 - 339 (2016)

JANS

Efficacy of different bio-pesticides against sucking pests of okra (*Abelmoschus esculentus* L. Moench)

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Received: July 2, 2015; Revised received: December 10, 2015; Accepted: March 3, 2016

Abstract: The field experiment was carried out in the pre-kharif season of 2013 at Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India to evaluate the efficacy of different bio-pesticides against sucking pests of okra. The experiment was laid out in randomized complete block design with three replications for each treatment. The treatments *viz.* annonin 1% EC, karanjin 2% EC, Azadirachtin 1% EC, *Metarrhizium anisopliae, Verticillium lecanii* , *Beauveria bassiana* , *Bacillus thuringiensis var Kurstaki*, spinosad 45 % SC and imidacloprid 17.8% SL were applied at 15 days interval starting from seedling stage when whitefly and jassid infestation started. Results revealed that the overall best performance of insecticides against whitefly was recorded in imidacloprid treated plots with lowest mean population of whitefly (3.91 whitefly/15 leaves) followed by karanjin (4.16 whitefly/15 leaves) and azadirachtin (5.16 whitefly/15 leaves while the order of efficacy aginst jassid were imidacloprid (15.27 jassids/15 leaves) > karanjin (33.91jassids/15leaves)>azadirachtin(40.38jassids/15leaves). Effectiveness of test insecticides on the yield of okra wasspinosad>*Bt*>*B. bassiana*>azadirachtin>imidacloprid>annonin>karanjin>*M. anisopliae*.

Keywords: Annonin, Azadirachtin, Jassid, Karanjin, Whitefly.

INTRODUCTION

Okra or Ladies finger or Bhendi, *Abelmoschus esculentus* L. Moench (Malvaceae) is a good representative of the vegetables grown throughout the country along with other crops. It is important vegetable of the tropical countries and most popular in India. In India, the area under okra cultivation is 5.30 lakh hectare and its production is 63.5 lakh tonnes with an average yield of 12.0 MT/ha during 2012-13 (Anonymous, 2013). One of the major constraints in okra cultivation is its susceptibility to a number of insect pests during the various phases of its growth. Though, okra shoot and fruit borer appeared to be the most serious inflicting 45 -57.1% damage to fruits (Srinivasan and Krishnakumar, 1983) but recently the sucking pests are becoming major pests under changing climatic condition coupled with application of injudicious and spurious pesticides which causes considerable yield loss to the various commercial crops. Jassid and whitefly are the most limiting factor for production of marketable fruit yield of okra. The crop must be protected from the attack of insect pests particularly sucking pests. Seasonal incidence of different pests has been studied by many workers (Kashyap and Verma 1982; Mahmood *et al*., 1988) who reported that okra is infested severely by many pests during warm and rainy season such as leaf hopper and shoot and fruit borer (Gandhale *et al*., 1987; Clement and David 1989; Madan *et al*., 1996). It is reported that the pests like jassid, shoot and fruit borer and leaf roller can cause up to 69% yield loss in okra (Rawat and Sahu,1983). To mitigate the losses due to these pests, a huge quantity of pesticides is used in okra that led to the problem of development of resistance, resurgence, environmental pollution. Therefore, the present study was undertaken to evaluate the efficacy of different bio-pesticides for eco-friendly management of sucking pests of okra.

MATERIALS AND METHODS

The field experiment was carried out in the pre-kharif season of 2013 at C Block Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India to evaluate the efficacy of different bio-pesticides against sucking pests of okra. The experiment was laid out in randomized complete block design with three replications for each treatment. Crop was sown in the plot size of 3m x 4m area with 45 cm x 60 cm spacing. The crop was raised with recommended management practices except plant protection measures. The treatments *viz.* annonin 1% EC (2 ml/l), karanjin

ISSN : 0974-9411 (Print), 2231-5209 (Online)

2% EC (2ml/l), Azadirachtin 1% EC (2ml/l), *Metarrhizium anisopliae* - CFU Count 1 x 10 ^ 8 / g (5 g/l), *Verticillium lecanii*- CFU Count 1 x 10 ^ 8 / g (5g/l), *Beauveria bassiana* - CFU Count 1 x 10 ^ 8 / g (5g/l), *Bacillus thuringiensis var* Kurstaki-18,000 IU/ mg (2g/l), spinosad 45 % SC (1ml/l) and imidacloprid 17.8% SL (0.3ml/l) were applied at 15 days interval starting from seedling stage when whitefly and jassid infestation started. Spraying were done with pneumatic knapsack sprayer using spray fluid @ 500l/ ha.Observations were taken on 1 day before the spray as pretreatment and successive observations were recorded on 1, 3, 7 and 14 days after each spray. Whitefly and jassid were counted from randomly selected 5 tagged plants/plot covering top, middle and lower leaves/plant. The critical difference (CD) at 5% level of significance was worked out from the data of mean population before the spraying and subsequent various days' intervals after spraying.

RESULTS AND DISCUSSION

Efficacy of insecticides against whitefly: Results (Table 1) revealed that there was no significant difference of whitefly population among the treatments before spraying. After first spray lowest mean population of whitefly (2.41 whitefly/15 leaves) was observed in imidacloprid treated plots followed by karanjin (3.58 whitefly/15 leaves) and azadirachtin (4.33 whitefly/15 leaves). Among the microbial pesticides, *M. anisopliae* and *V. lecanii* were moderately effective with mean population of 5.42 and 5.74 whitefly/15 leaves, respectively. Whereas, in untreated (control) plots it was 10.83 whitefly/15 leaves. Highest percentage reduction of whitefly population over control was also recorded in imidacloprid treated plots (77.74%) followed by karanjin (66.94%) and azadirachtin (60.01%). Among the microbials, *B. bassiana* (25.39%) and *B. thuringiensis* var *Kurstaki* (26.13%) were not effective in reducing the whitefly population but these were found to be superior over control.

During second spray, results (Table 2) revealed that imidacloprid recorded minimum population of whitefly (4.83whitefly/15 leaves) followed by azadirachtin (7.24 whitefly/15 leaves). *V. lecanii* and karanjin were at par with spinosad treated plots with 8.25, 8.00 and 8.49 whitefly/15 leaves, respectively. *M. anisopliae*, *B. bassiana* and *B.t.* were found to be less effective in reducing whitefly population but were superior over control. Similar trend was observed in percent reduction of whitefly population over control as in first spray.

After final spray (Table 3) lowest mean population of whitefly (2.33 whitefly/15 leaves) was observed in imidacloprid treated plots followed by karanjin (4.75 whitefly/15 leaves) and azadirachtin (5.16 whitefly/15 leaves). Spinosad and annonin provided moderate control with 6.33 and 6.91 whitefly/15 leaves, respectively. Highest percentage reduction of whitefly population over control was also recorded in imidacloprid treated plots (89.60%) followed by karanjin (78.80%) and azadirachtin (76.97%).

Pooled data (Table 7) of three consecutive sprays revealed that imidacloprid provided best control with lowest mean population of whitefly (3.91 whitefly/15 leaves) followed by karanjin (4.16 whitefly/15 leaves) and azadirachtin (5.16 whitefly/15 leaves). *M. anisopliae*, *V. lecanii* and *B.t.* were less effective in reducing population of whitefly with mean population of 10.41, 8.41 and 11.24 whitefly/15 leaves, respectively. Highest percentage reduction of whitefly population over control was also recorded in imidacloprid treated plots (79.60%) followed by karanjin (70.93%) and azadirachtin (68.26%).

Present findings are in close conformity with the results of Raghuraman and Ajanta (2011) who reported that imidacloprid 17.8% SL @ 80 gm a.i./ha significantly suppressed whitefly and leafhopper populations, and consequently increased the yield in okra. Borkar *et al*. (2012) who reported that application of neem oil 1 % amalgamated as the most effective treatment in recording the minimum population of whitefly. Hajeri *et al*. (2007) reported that the neem based formulation achook was found to be effective insect repellent causing reduction of whitefly population to 0.89/plant and disease incidence to 5.0%. Leeuwen *et al*. (2006) observed that systematically applied spinosad was effective against whitefly nymphs at doses as low as 2 mg active ingredient per plant, which is in agreement with our present findings. *V. lecanii* provided moderate control against whitefly which is similar with the findings of Negasi *et al*. (1998) who reported that Isolate FR20 (*V. lecanii*) was the most pathogenic to third-instar larvae. *M. anisopliae* was less effective in reducing population of whitefly which is analogous with the findings of Bairwa *et al*. (2006) but conflicting with the findings of Malsam and Kilian (1998). The efficacy of *B. bassiana* against whitefly is disagreed with the findings of Islam *et al*. (2011) and Maketon *et al*. (2009).

Efficacy of insecticides against jassid: There was no significant difference of jassid population among the treatments before spraying (Table 4). During first spray, imidacloprid recorded lowest mean population (4.91 jassids/15 leaves) followed by karanjin (10.66 jassids/15 leaves) and *V. lecanii* (10.91 jassids/15 leaves) treated plots. Next best insecticides were azadirachtin and spinosad with mean population of 12.49 and 13.57 jassids/15 leaves, respectively. *M. anisopliae*, *B. bassiana* and *B.t.* were not effective as other treatments in reducing jassids population but were found to be superior over untreated control plots. Highest percentage reduction over control was also found in imidacloprid (76.98%) treated plots followed by karanjin (50.02%) and *V. lecanii* (48.85%) treated plots.

After second spray (Table 5), imidacloprid again

Table 1. Efficacy of insecticides against whitefly during first spray on okra during 2013

Treatment	Dose (ml /L or gm./L)	No. of whitefly/15 leaves before spraying	No. of whitefly /15 leaves at days interval				Mean of 1st spray	% reduction over control
			1 DAS	3 DAS	7 DAS	14 DAS		
Karanjin 2%EC	2ml/L	6.67 (2.67)	2.67(1.77)	3.67(2.02)	3.67(2.02)	4.33(2.20)	3.58	66.94
Annonin 1%EC	2ml/L	7.00(2.70)	3.33(1.90)	5.33(2.36)	5.67(2.40)	10.333.27)	6.16	43.12
Azadirachtin 1%EC	2ml/L	9.33(3.13)	3.00(1.79)	4.33(2.12)	4.33(2.20)	5.67(2.47)	4.33	60.01
Metarhizium anisopliae	5gm/L	6.33(2.59)	4.67(2.22)	5.67(2.46)	4.67(2.17)	6.67(2.62)	5.42	49.95
Verticillium lecanii	5gm/L	9.00(3.06)	4.33(2.18)	6.00(2.50)	5.33(2.38)	7.33(2.76)	5.74	46.99
Beauveria bassiana	5gm/L	9.67(3.14)	9.33(3.13)	7.00(2.72)	8.33(2.93)	7.67(2.85)	8.08	25.39
Bacillus (B.t.)	2gm/L	9.33(3.05)	9.00(3.08)	7.67(2.83)	7.33(2.80)	8.00(2.91)	8.00	26.13
Spinosad 45% SC	1ml/L	8.67(3.02)	3.67(1.97)	6.00(2.52)	7.00(2.71)	7.33(2.79)	6.00	44.59
Imidacloprid 17.8% SL	0.3ml/L	10.33(3.28)	1.67(1.35)	1.67(1.39)	3.00(1.56)	3.33(1.93)	2.41	77.74
Untreated	-	8 (2.86)	9.33(3.06)	10.67(3.31)	11.33(3.44)	12.00(3.52)	10.83	-
SE.m		0.279	0.328	0.295	0.292	0.218		
CD at 5%		NS	0.976	0.876	0.869	0.648		

Figures in the parenthesis are square root transformed values. NS = Non Significant

Table 2. Efficacy of insecticides against whitefly during second spray on okra

Treatment	Dose (ml /L or gm./L)	No. of whitefly/15 leaves before spraying	No. of whitefly /15 leaves at days interval				Mean of 2 nd spray	% reduction over control
			1 DAS	3 DAS	7 DAS	14 DAS		
Karanjin 2%EC	2ml/L	5.67 (2.48)	7.67(2.85)	7.00(2.72)	8.33(2.94)	9.00(3.07)	8.00	64.44
Annonin 1%EC	2ml/L	11.00(3.36)	9.00(3.04)	7.67(2.83)	9.00(3.06)	13.67(3.74)	9.83	56.31
Azadirachtin 1%EC	2ml/L	8.33(2.92)	6.33(2.52)	6.00(2.50)	7.33(2.66)	9.33(3.13)	7.24	67.82
Metarhizium anisopliae	5gm/L	8.00(2.91)	9.33(3.08)	8.67(3.01)	9.33(3.09)	13.00(3.64)	10.08	55.20
Verticillium lecanii	5gm/L	7.67(2.82)	8.00(2.89)	7.67(2.84)	6.66(2.66)	10.67(3.27)	8.25	63.33
Beauveria bassiana	5gm/L	8.33(2.96)	9.67(3.18)	9.00(3.07)	9.66(3.13)	11.67(3.45)	10	55.55
Bacillus (B.t.)	2gm/L	9.67(3.11)	9.00(3.08)	9.67(3.12)	10.00(3.16)	12.33(3.55)	10.25	54.44
Spinosad 45% SC	1ml/L	8.67(3.02)	8.00(2.88)	7.33(2.79)	8.66(3.02)	10.00(3.20)	8.49	62.26
Imidacloprid 17.8% SL	0.3ml/L	4.33(2.18)	2.33(1.66)	1.67(1.35)	5.66(2.43)	9.67(3.15)	4.83	78.53
Untreated	-	12.33(3.51)	16.33(4.08)	18.67(4.37)	25.33(5.07)	29.67(5.48)	22.5	
SE.m		0.326	0.314	0.307	0.389	0.315		
CD at 5%		NS	0.935	0.914	1.158	0.937		

Figures in the parenthesis are square root transformed values. NS = Non Significant

Table 3. Efficacy of insecticides against whitefly during third spray on okra

Treatment	Dose (ml /L or gm./L)	No. of whitefly/15 leaves before spraying	No. of whitefly /15 leaves at days interval				Mean of 3 rd spray	% reduction over control
			1 DAS	3 DAS	7 DAS	14 DAS		
Karanjin 2%EC	2ml/L	8.67 (2.98)	5.33 (2.38)	4.33(2.15)	4.00(2.11)	3.00(1.86)	4.16	81.43
Annonin 1%EC	2ml/L	10.67 (3.29)	6.33 (2.60)	5.67(2.45)	7.67(2.85)	8.00(2.90)	6.91	69.16
Azadirachtin 1%EC	2ml/L	9.00 (3.08)	5.67 (2.44)	5.33(2.40)	5.00(2.32)	4.67(2.23)	5.16	76.97
Metarhizium anisopliae	5gm/L	13.33 (3.72)	14.33(3.84)	9.67(3.17)	10.00(3.23)	7.67(2.83)	10.41	53.54
Verticillium lecanii	5gm/L	10.67(3.34)	11.00(3.38)	8.00(2.89)	7.67(2.85)	7.00(2.72)	8.41	62.47
Beauveria bassiana	5gm/L	11.33(3.42)	12.67(3.61)	10.67(3.32)	8.00(2.88)	7.67(2.85)	9.75	56.49
Bacillus (B.t.)	2gm/L	13.33(3.71)	13.00(3.67)	12.33(3.56)	10.33(3.29)	9.33(3.13)	11.24	49.84
Spinosad 45% SC	1ml/L	9.67(3.18)	7.67(2.84)	6.00(2.53)	6.67(2.66)	5.00(2.28)	6.33	71.75
Imidacloprid 17.8% SL	0.3ml/L	8.67(3.02)	4.33(2.18)	4.00(2.09)	4.00(2.11)	3.33(1.93)	3.91	82.55
Untreated	-	26.67(5.21)	27.00(5.23)	25.33(5.08)	20.67(4.59)	16.67(4.14)	22.41	
SE.m		0.233	0.213	0.264	0.198	0.211		
CD at 5%		0.693	0.635	0.784	0.588	0.628		

Figures in the parenthesis are square root transformed values. NS = Non Significant

Table 4. Efficacy of insecticides against jassid during first spray on okra during 2013

Treatment	Dose (ml /L or gm./L)	No. of jassids /15 leaves before spraying	No. of jassid / 15 leaves at days interval				Mean of first spray	% reduction over control
			1 DAS	3 DAS	7 DAS	14 DAS		
Karanjin 2%EC	2ml/L	10.33(3.28)	8.33(2.96)	6.66(2.67)	13.33(3.70)	14.33(3.84)	10.66	50.02
Annonin 1%EC	2ml/L	12.66(3.62)	12.00(3.52)	11.33(3.43)	18.66(4.37)	22.33(4.78)	16.08	24.61
Azadirachtin 1%EC	2ml/L	13.00(3.65)	8.66(3.01)	7.66(2.83)	16.33(4.08)	17.33(4.21)	12.49	41.44
Metarhizium anisopliae	5gm/L	10.33(2.89)	11.33(3.43)	9.66(3.15)	17.33(4.20)	24.66(5.00)	15.74	26.20
Verticillium lecanii	5gm/L	10.66(3.33)	9.33(2.76)	7.66(2.82)	11.33(3.42)	15.33(3.96)	10.91	48.85
Beauveria bassiana	5gm/L	12.00(3.52)	10.66(3.33)	10.00(3.20)	19.00(4.33)	22.33(4.76)	15.49	27.37
Bacillus (B.t.)	2gm/L	13.00(3.66)	11.33(3.43)	11.66(3.48)	22.66(4.81)	23.00(4.82)	17.16	19.54
Spinosad 45% SC	1ml/L	12.33(3.56)	8.66(3.01)	9.33(3.08)	15.66(3.99)	20.66(4.60)	13.57	36.38
Imidacloprid 17.8% SL	0.3ml/L	11.00(3.37)	5.33(2.38)	2.33(1.64)	4.66(2.18)	7.33(2.79)	4.91	76.98
Untreated	-	11.33(3.43)	14.00(3.78)	17.33(4.21)	24.33(4.97)	29.66(5.47)	21.33	-
SE.m ±	-	0.433	0.416	0.298	0.364	0.237	-	-
CD at 5%	-	NS	NS	0.886	1.082	0.704	-	-

Figures in the parenthesis are square root transformed values. NS = Non Significant

Table 5. Efficacy of insecticides against jassid during second spray on okra during 2013

Treatment	Dose (ml /L or gm./L)	No. of jassids /15 leaves before spray-ing	No. of jassid / 15 leaves at days interval				Mean of second spray	% reduction over control
			1 DAS	3 DAS	7 DAS	14 DAS		
Karanjin 2%EC	2ml/L	14.66(3.88)	12.00(3.53)	15.33(3.96)	27.33(5.26)	76.66(8.78)	32.83	52.18
Annonin 1%EC	2ml/L	22.66(4.81)	27.33(5.25)	29.66(5.43)	41.33(6.46)	89.66(9.49)	46.99	31.56
Azadirachtin 1%EC	2ml/L	18.00(4.29)	13.66(3.72)	18.66(4.37)	34.33(5.88)	78.33(8.87)	36.24	47.21
Metarhizium anisopliae	5gm/L	28.33(5.36)	21.33(4.67)	23.66(4.91)	35.00(5.95)	101.66(10.10)	45.41	33.86
Verticillium lecanii	5gm/L	16.00(4.04)	18.33(4.31)	15.66(3.99)	31.33(5.62)	85.33(9.25)	37.66	45.15
Beauveria bassiana	5gm/L	23.66(4.88)	23.33(4.86)	29.66(5.48)	62.00(7.88)	85.00(9.24)	49.99	27.19
Bacillus (B.t.)	2gm/L	23.66(4.91)	24.33(4.89)	25.33(5.07)	53.33(7.29)	95.66(9.80)	49.66	27.67
Spinosad 45% SC	1ml/L	22.33(4.77)	17.00(4.10)	21.33(4.67)	50.66(7.15)	113.66(10.66)	50.66	26.21
Imidacloprid 17.8% SL	0.3ml/L	8.33(2.96)	3.33(1.95)	3.66(2.03)	7.66(2.84)	28.33(5.36)	10.74	84.35
Untreated	-	30.33(5.53)	34.66(5.92)	41.33(6.46)	67.00(8.20)	131.66(11.47)	68.66	-
SE.m ±	-	0.245	0.296	0.281	0.362	0.342	-	-
CD at 5%	-	0.728	0.880	0.835	1.075	1.018	-	-

Figure in the parenthesis are square root transformed values. NS = Non Significant

Table 6. Efficacy of insecticides against jassid during third spray on okra during 2013

Treatment	Dose (ml /L or gm./L)	No. of jassids /15 leaves before spray-ing	No. of jassid / 15 leaves at days interval				Mean of third spray	% reduction over control
			1 DAS	3 DAS	7 DAS	14 DAS		
Karanjin 2%EC	2ml/L	83.66(9.17)	56.33(7.53)	40.33(6.37)	53.33(7.32)	83.00(9.13)	58.25	50.43
Annonin 1%EC	2ml/L	92.33(9.61)	82.33(9.08)	73.66(8.58)	95.66(9.79)	99.33(9.98)	87.75	25.33
Azadirachtin 1%EC	2ml/L	81.66(9.06)	68.66(8.28)	63.33(7.98)	71.33(8.45)	86.33(9.30)	72.42	38.38
Metarhizium anisopliae	5gm/L	105.33(10.28)	98.33(9.92)	112.33(10.60)	116.66(10.79)	121.33(11.03)	112.17	4.56
Verticillium lecanii	5gm/L	124.33(11.17)	99.33(9.98)	82.33(9.06)	87.66(9.37)	113.00(10.61)	95.58	18.67
Beauveria bassiana	5gm/L	78.33(8.87)	62.33(7.85)	66.00(8.15)	97.33(9.87)	115.33(10.75)	85.25	27.46
Bacillus (B.t.)	2gm/L	101.33(10.09)	84.33(9.21)	69.66(8.37)	96.33(9.83)	120.66(11.00)	92.75	21.08
Spinosad 45% SC	1ml/L	138.33(11.77)	79.66(8.93)	82.66(9.11)	81.33(9.02)	98.33(9.94)	85.50	27.25
Imidacloprid 17.8% SL	0.3ml/L	33.33(5.80)	18.66(4.27)	15.66(3.96)	34.66(5.88)	51.66(7.20)	30.17	74.33
Untreated	-	140.33(11.87)	116.33(10.80)	105.33(10.24)	119.10(10.93)	129.33(11.37)	117.53	-
SE.m ±	-	0.275	0.481	0.450	0.468	0.401	-	-
CD at 5%	-	0.819	1.429	1.339	1.391	1.192	-	-

Figures in the parenthesis are square root transformed values. NS = Non Significant

Table 7. Overall performance of insecticides against whitefly and jassid (Pooled of three sprays)

Treatment	Dose (ml /L or gm./L)	Mean number of insects / 15 leaves at days interval		% reduction over control		Yield (q/ha)	% increase yield over control
		Whitefly	Jassid	Whitefly	Jassid		
Karanjin 2%EC	2ml/L	5.25 (2.40)	33.91(5.86)	71.76	50.97	32.19	29.75
Annonin 1%EC	2ml/L	7.47(2.82)	48.61(7.00)	59.81	29.73	33.41	34.66
Azadirachtin 1%EC	2ml/L	5.58(2.45)	40.38(6.39)	69.99	41.62	37.92	52.84
Metarhizium anisopliae	5gm/L	8.64(3.02)	58.22(7.66)	53.52	15.84	30.62	23.42
Verticillium lecanii	5gm/L	7.47(2.81)	48.05(6.95)	69.81	30.53	29.38	18.42
Beauveria bassiana	5gm/L	9.28(3.12)	50.24(7.12)	50.07	27.36	39.28	58.32
Bacillus (B.t.)	2gm/L	9.83(3.21)	53.19(7.31)	47.09	23.10	42.26	70.33
Spinosad 45% SC	1ml/L	6.94(2.72)	49.91(7.10)	62.65	27.84	53.67	116.32
Imidacloprid 17.8% SL	0.3ml/L	3.72(2.04)	15.27(3.97)	80.00	77.92	37.74	52.12
Untreated	-	18.58(4.37)	69.17(8.35)	-	-	24.81	-
SE.m	-	0.08	0.17		-	3.27	-
CD at 5%	-	0.24	0.51		-	9.71	-

Figures in the parenthesis are square root transformed values. NS = Non Significant

provided best control with lowest mean population of 10.74 jassids/15 leaves followed by karanjin (32.83 jassids/15 leaves), azadirachtin (36.24 jassids/15 leaves) and *V. lecanii* (37.66 jassid/15 leaves) treated plots. Similar trend was also observed in percent reduction of jassid population over control. During third spray same trend (Table 6) of efficacy of insecticides against jassids was observed.

After all three consecutive sprays (Table 7), it was found that imidacloprid was recorded lowest mean population of jassid (15.27 jassids/15 leaves) followed by karanjin (33.91 jassids/15 leaves) and azadirachtin (40.38 jassids/15 leaves). Highest percentage reduction of jassid occurred in imidacloprid treated plots (78.55 %) followed by karanjin (33.91 %) and azadirachtin (40.38 %). Annonin, *B.t.*, *M. anisopliae* and *B. bassiana* were not effective in reducing population but were superior over untreated control plots.

Results of imidacloprid against jassid (15.27 jassids/15 leaves) are the analogous with the findings of Mitalilal *et al*. (2005) who reported that imidacloprid at 40 g a.i. ha^{-}1 was the best treatment in reducing the jassid population in okra. Bhargava and Bhatnagar (2001) reported that imidacloprid 600 FS at 9 ml/kg seeds and 70 WP at 10 g/kg seeds were found to be promising against jassid (*A. biguttula biguttula*). Efficacy of karanjin and azadirachtin against jassid are in agreement with the findings of Gurusamy *et al*. (2000) who found that neem leaf extract was the most effective in reducing jassid and produced highest yield (426 kg/ha) on cotton. Baladaniya *et al*. (2010) revealed that *V. lecanii* at 7 g/l gave significantly higher mortality of okra jassid which is in conformity with the present findings. Effectiveness of *M. anisopliae* against jassid are in disagreement with the results of Maketon *et al*. (2008) who reported that *M. anisopliae* strain CKM-048 at the dosage of 1.25×10^{13} conidia ha^{-}1 showed good controlling efficacy with the 73.33±10.00 % mortality.

Yield: Yield of okra were varied significantly in different treatment (Table 7). Highest fruit yield of okra was recorded in spinosad (53.67 q/ha) treated plots followed by *B.t.* (42.26 q/ha), *B. bassiana* (39.28 q/ha) and azadirachtin (37.92 q/ha) whereas, the yield obtained from untreated control plots was 24.81 q/ha.

Conclusion

The present study on evaluation of the efficacy of different bio-pesticides for eco-friendly management of sucking pests of okra revealed that among the bio pesticides used azadirachtin and karanjin were found very effective against the target pests. Therefore, azadirachtin and karanjin can be an alternative eco–friendly management option for the sucking pests of okra.

ACKNOWLEDGEMENTS

The authors are highly thankful to Agri Life, Hydera-

bad, for supplying the most of the bio-pesticides with free of cost to conduct this experiment.

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