Research Paper :

Efficacy of *Acremonium zeylanicum* on sugarcane woolly aphid under laboratory conditions

NAVEENKUMAR B. PATIL, C. P. MALLAPUR AND Y.H. SUJAY

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See end of the article for authors' affiliations

Correspondence to :
Y.H. SUJAY
A.I.C.R.P. on Soybean, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA
Email : morphosis77@gmail.com

SUMMARY

The fungus caused differential mortality of sugarcane wooly aphid on different instars, at varied concentrations. The results on the efficacy of the entomopathogenic fungus at varying concentrations revealed that the mortality of aphids increased with the increase in concentration and time of application. Of the four different instars, first instar nymphs showed highest mortality (92.50%) at 1 x 10^{10} conidia/l concentration of the fungus. As the stage of the instar advanced, the mortality rate declined (88.50, 84.00 and 83.30% in II, III and IV instar, respectively). On the contrary, lower mortality of aphids was recorded at 1 x 10^4 conidia/l concentration after 10 days of application (69.00, 65.00, 56.00 and 48.00% in I, II, III and IV instar nymphs of SWA, respectively).

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Sugarcane is one of the important commercial crops in the tropical region. Sugarcane and sugar beet are the two main sources of white crystal sugar in the world. Sugarcane contributes about 70 per cent of worlds total white crystal sugar production. India ranks second among the sugarcane growing countries in the world both in area and production. In the country, sugar industry is the second largest agro-based industry next only to cotton textile industry with more than 450 sugar factories spread over the country (Anonymous, 2005).

Due to monoculture in sugarcane, availability of food throughout the year, staggered planting, soft cane and high sugar varieties and favourable climatic conditions, some of the minor pests like whitefly, scale insects and sugarcane woolly aphid have attained the status of major pests. Though, synthetic insecticides are effective against the woolly aphid, they do not find place in sugarcane ecosystem for reasons like difficulty in spraying, operational hazards, improper coverage of crop canopy, high investment for pesticide application and destruction of natural enemies treasure in the sugarcane ecosystem (Lingappa *et al*., 2004).

MATERIALS AND METHODS

A laboratory experiment was conducted in the Department of Agricultural Entomology, College of Agriculture, Dharwad to evaluate *A. zeylanicum* against SWA with varying concentrations of fungal suspension. Four concentrations (1x10^{10}, 1x10^8, 1x10^6 and 1x10^4 conidia/g) along with an untreated check were compared using CRD design with four replications. Sugarcane leaf bits (15 cm long) carrying 50 aphids were taken and one end of the leaf bit was immersed in glass vial containing water to maintain turgidity of leaves. Different concentrations of the conidial suspension required for spray were prepared by serial dilution and sprayed using hand atomizer such that all aphids were uniformly treated. High relative humidity was maintained inside laboratory using humidifier so as to encourage fungal growth. Treated leaves were kept in plastic jars and daily observation was made on the mortality of aphids upto 10 days. Mean of the four replications were calculated

and the percentage mortality assessment was done separately for each concentration. Then the data were transformed into arcsine values and subjected to analysis of variance.

RESULTS AND DISCUSSION

The results obtained from the present investigation are summarized below :

Efficacy of fungus on 1st instar nymphs of SWA:

The efficacy of the entomopathogenic fungus at varying concentrations was evaluated under laboratory conditions against first instar nymphs of SWA. The data on SWA mortality at 1 DAS revealed that there was no mortality of the pest in any of the treatments. However, at 2 DAS, the highest mortality (5.00%) of SWA was recorded in 1 x 10^{10} conidia/l and it stood at par with 1 x 10^8 conidia/l (3.00%). As the concentration of fungus decreased, the per cent mortality also decreased significantly and the lowest mortality was recorded (1.00%) at 1 x10^4 conidia/l concentration (Table 1).

Significantly higher mortality (30.50%) was recorded in 1 x 10^{10} conidia/l concentration followed by 1 x 10^8 conidia/l (24.00%) at 3 DAS while, the lowest mortality (12.50%) was recorded in 1 x 10^4 conidia/l. However, the control treatment evidenced no mortality of the aphid. Similarly, on fourth day of spray, highest mortality (53.50%) was revealed in 1 x 10^{10} conidia/l concentration which proved superior over rest of the treatments. There was significant reduction in the per cent mortality of aphid with decreased concentration of the fungus, being lowest in 1 x 10^4 conidia/l (25.00%).

At 5 DAS, significantly highest per cent mortality (71.00%) was recorded in 1 x 10^{10} conidia/l concentration whereas, 1 x 10^8 and 1x 10^6 conidia/l treatments registered 53.00 and 47.00 per cent mortality of 1st instar nymphs, respectively. The least mortality was recorded in 1x10^4 conidia/l concentration (38.63%) while, the control treatment recorded 1.00 per cent mortality. After 6 days of spray the highest concentration (1x10^{10} conidia/l) treatment recorded significantly higher mortality (79.00%) which stood superior over rest of the treatments. The remaining fungal treatments (1x10^4, 1x10^6 and 1x10^8 conidia/l) registered mortality range of 48.50 to 59.00 per cent without any statistical difference among themselves.

The entomopathogenic fungus at 1x10^8 conidia/l concentration caused 85.50 per cent mortality of first instar nymphs of SWA at 7 DAS proving its superiority over rest of the treatments. There was significant reduction in the per cent mortality of aphid with every reduced concentration of the fungus and lowest mortality (52.00%) was recorded in 1 x 10^4 conidia/l treatment. On eight day of spray, highest mortality (88.50%) was revealed in 1x10^8 conidia/l concentration which proved superior over rest of the treatments. There was significant difference in the per cent mortality of aphids among the treatments and the lowest mortality (60.00%) was recorded in 1 x 10^4 conidia/l concentration.

The treatment with maximum concentration (1x10^{10} conidia/l) recorded significantly highest mortality (91.00%) which stood superior over rest of the treatments

Table 1: Effect of *Acremonium zeylanicum* on first instar nymphs of sugarcane woolly aphid

Sr. No	Treatments (conidia/l)	Per cent mortality of SWA									
		1DAS	2DAS	3DAS	4DAS	5DAS	6DAS	7DAS	8DAS	9DAS	10DAS
1.	1x10 ^{10}	0.00a	5.00a	30.50a	53.50a	71.00a	79.00a	85.50a	88.50a	91.00a	92.50a
		(4.05)	(12.92)	(33.51)	(46.99)	(57.39)	(62.70)	(67.59)	(70.15)	(72.51)	(74.08)
2.	1x10 ^{8}	0.00a	3.00ab	24.00b	43.00b	53.00b	59.00b	70.00b	78.50b	82.50b	83.00b
		(4.05)	(9.97)	(29.32)	(40.96)	(46.70)	(50.16)	(56.77)	(62.00)	(65.24)	(65.62)
3.	1x10 ^{6}	0.00a	2.00dc	18.00c	33.50c	47.00b	52.00bc	57.00c	62.50c	69.00c	74.00c
		(4.05)	(8.13)	(25.09)	(35.00)	(43.26)	(46.13)	(49.00)	(52.22)	(56.14)	(59.32)
4.	1x10 ^{4}	0.00a	1.00cd	12.50d	25.00d	39.00c	48.50c	52.00c	60.00c	66.00c	69.00c
		(4.05)	(6.42)	(20.70)	(29.99)	(38.63)	(44.12)	(46.13)	(50.75)	(54.31)	(56.14)
5.	Untreated check	0.00a	0.00d	0.00e	0.50e	1.00d	1.50d	2.00d	3.50d	4.00d	4.00d
		(4.05)	(4.05)	(4.05)	(5.37)	(6.42)	(7.60)	(8.62)	(10.78)	(11.53)	(11.53)
S.E.±		NS	0.77	0.59	0.77	0.86	1.02	1.17	1.14	1.14	1.22
C.D. (P=0.01)		NS	4.98	3.84	5.01	5.62	6.63	7.63	7.40	7.42	7.94
CV (%)		-	18.69	5.24	4.86	4.49	4.84	5.15	4.62	4.39	4.57

Means followed by same letter in the column do not differ significantly by DMRT (P=0.01) NS=Non-significant
DAS –Days after spraying
The figures in the parentheses are arcsine transformed values

at 9 DAS. As the concentration reduced the per cent mortality of aphid also reduced significantly and the lowest mortality (66.00%) was recorded in 1 x 10^4 conidia/l concentration. At 10 DAS however, significantly higher mortality (92.50%) was observed in 1 x 10^{10} conidia/l concentration whereas, 1 x 10^8 and 1 x 10^6 conidia/l treatments registered 74.00 and 69.00 per cent mortality of 1st instar nymphs, respectively. The least mortality was registered in 1 x 10^4 conidia/l concentration (69.00%) while, the control treatment recorded 4.00 per cent mortality.

Efficacy of fungus on 2nd instar nymphs of SWA:

A day after imposing the sprays no mortality was observed in any of the treatments. However, at 2 DAS, a maximum of 5.5 per cent mortality was recorded in 1 x 10^6 conidia/l concentration (Table 2).

After 3 days of treatment imposition, the highest concentration of fungal suspension (1 x 10^{10} conidia/l) registered as high as 25.5 per cent mortality of the aphid. With 22.0 per cent mortality, the next lower concentration (1 x 10^8 conidia/l) stood at par with its higher concentration treatment but was superior over its lower concentrations. No mortality was recorded in control treatment. At 4 days also, a similar trend was observed with significantly higher mortality being recorded in 1 x 10^{10} conidia/l concentration and the lowest mortality was observed in 1 x 10^4 conidia/l treatment.

The highest concentration treatment (1 x 10^{10} conidia/l) recorded significantly higher mortality of the aphid at all the intervals as compared to other treatments (59.00, 77.00, 81.00, 84.00, 86.50 and 88.50% mortality at 5, 6, 7, 8, 9 and 10 DAS, respectively). The next to follow was 1 x 10^8 conidia/l concentration treatment, which recorded a mortality range of 47.5 per cent at 5 DAS to 80.5 per cent at 10 DAS. The treatment though was inferior to its higher concentration treatment stood superior over rest of the concentrations at all the intervals.

The treatments with 1 x 10^6 and 1 x 10^4 conidia/l concentration recorded mortality at par with each other after 6 days of spray imposition (50.53% on 7th day to 65.69% on 10th day). However, the treatments differed in their efficacy at 5 and 6 DAS. In the control treatment, the mortality rate gradually increased from 1.50 per cent at 6 DAS to 4.00 per cent at 10 DAS.

Efficacy of fungus on third instar nymphs of SWA:

A similar trend in the efficacy of various concentrations of the fungus was observed against third instar nymphs of SWA also (Table 3).

A day after treatment imposition, no mortality was observed in any of the treatments. Though slight mortality (maximum of 3.5% in T_1) was observed at 2 DAS in higher concentration of the fungus, substantial death was noticed from 3rd day onwards with highest mortality of 31.5 per cent at 4 DAS to 84.00 per cent at 10 DAS in 1 x 10^{10} conidia/l concentration. The next best treatment was 1 x 10^8 conidia/l concentration which stood statistically superior over other lower concentrations at all the intervals of observations (48.5% at 5 DAS to 77.5% at 10 DAS).

Similarly, the next lower concentration (1 x 10^6 conidia/l) proved statistically superior over its sub

Table 2: Effect of *Acremonium zeylanicum* on second instar nymphs of sugarcane woolly aphid

Sr. No.	Treatments (conidia /l)	Per cent mortality of SWA									
		1DAS	2DAS	3DAS	4DAS	5DAS	6DAS	7DAS	8DAS	9DAS	10DAS
1.	1x10 ^{10}	0.00a	5.50a	25.50a	48.50a	59.00a	77.00a	81.00a	84.00a	86.50a	88.50a
		(4.05)	(13.56)	(30.32)	(44.12)	(50.16)	(61.32)	(64.13)	(68.00)	(68.42)	(70.15)
2.	1x10 ^{8}	0.00a	3.50ab	22.00a	31.00b	47.50b	57.00b	66.00b	73.50b	77.50b	80.50b
		(4.05)	(10.78)	(27.96)	(33.82)	(43.55)	(49.00)	(54.31)	(58.99)	(61.66)	(63.77)
3.	1x10 ^{6}	0.00a	2.00bc	17.50b	22.50c	36.00c	48.00c	53.00c	59.50c	63.50c	69.00c
		(4.05)	(8.13)	(24.72)	(28.31)	(36.86)	(43.84)	(46.70)	(50.46)	(52.81)	(56.14)
4.	1x10 ^{4}	0.00a	1.00cd	12.00c	18.00d	26.00d	36.50d	50.00c	57.50c	61.00c	65.00c
		(4.05)	(6.42)	(20.26)	(25.09)	(30.64)	(37.15)	(44.98)	(49.29)	(51.33)	(53.71)
5.	Untreated check	0.00a	0.00d	0.00d	0.50e	1.00e	1.50e	2.00d	3.50d	4.00d	4.00d
		(4.05)	(4.05)	(4.05)	(5.37)	(6.42)	(7.60)	(8.62)	(10.78)	(11.53)	(11.53)
S.E.±		NS	0.71	0.59	0.75	0.74	1.01	1.23	1.02	1.08	1.07
C.D. (P=0.01)		NS	4.64	3.85	4.86	4.85	6.60	7.98	6.61	7.03	6.96
CV (%)		-	16.80	5.51	5.48	4.45	5.11	5.62	4.28	4.40	4.19

Means followed by same letter in the column do not differ significantly by DMRT (P=0.01)
DAS –Days after spraying
The figures in the parentheses are arcsine transformed values

concentration at all the intervals (9.00 to 71.0% mortality from 5 DAS to 10 DAS). With least per cent mortality ranging from 17.5 at 5 DAS to 56.0 at 10 DAS, the treatment 1 x 10^4 conidia/l concentration differed statistically from control treatment wherein a maximum of 3.0 per cent mortality was noticed at 10 DAS.

Efficacy of fungus on fourth instar nymphs of SWA:

The fourth instar nymphs of SWA also responded in a way similar to early instars against varying concentrations of *A. zeylanicum*, though the mortality of the aphid began at 2 DAS, notable death was noticed only after 4 days of spray (Table 4).

On 3rd day, with highest mortality of 13.0 per cent, T_1 stood statistically superior over rest of the treatments. Fourth day onwards, the highest concentration of the fungus ($1x10^{10}$ conidia/l), recorded significantly superior mortality of the aphid (28.5% at 4 DAS to 83.3% at 10 DAS). In the order of decreasing concentration, the other treatments recorded a maximum mortality of 69.5, 60.0 and 48.0 per cent, respectively, on 10th day of treatment imposition and the treatments differed statistically among themselves at all the intervals. The control treatment exhibited a maximum death of 3.0 per cent even at 10

Table 3: Effect of *Acremonium zeylanicum* on third instar nymphs of sugarcane woolly aphid

Sr. No.	Treatments (conidia /l)	Per cent mortality of SWA									
		1DAS	2DAS	3DAS	4DAS	5DAS	6DAS	7DAS	8DAS	9DAS	10DAS
1.	$1x10^{10}$	0.00a	3.50a	18.00a	31.50a	56.50a	70.00a	76.50a	80.50a	82.00a	84.00a
		(4.05)	(11.16)	(24.72)	(34.13)	(48.72)	(56.77)	(60.98)	(63.77)	(64.87)	(66.40)
2.	$1x10^8$	0.00a	3.00a	11.00b	29.00a	48.50b	59.50b	69.00b	73.50b	76.50b	77.50b
		(4.05)	(10.78)	(19.36)	(32.57)	(44.12)	(50.46)	(56.14)	(58.99)	(60.98)	(61.66)
3.	$1x10^6$	0.00a	0.50b	7.00c	18.00b	29.00c	43.00c	54.00c	59.00c	68.50c	71.00c
		(4.05)	(5.37)	(15.34)	(25.09)	(32.57)	(40.96)	(47.28)	(50.16)	(55.84)	(57.39)
4.	$1x10^4$	0.00a	0.00b	3.00d	10.00c	17.50d	29.50d	41.00d	48.50d	53.50d	56.00d
		(4.05)	(4.05)	(9.97)	(18.43)	(24.72)	(32.88)	(39.80)	(44.12)	(46.99)	(48.43)
5.	Untreated check	0.00a	0.00b	0.50e	0.50d	1.00e	1.50e	2.00e	2.50e	2.50e	3.00e
		(4.05)	(4.05)	(5.37)	(5.37)	(6.42)	(7.32)	(8.38)	(9.09)	(9.09)	(9.97)
S.E.±		NS	0.53	0.76	0.78	0.80	0.74	1.05	0.70	0.72	0.79
C.D. (P=0.01)		NS	3.44	4.92	5.07	5.18	4.83	6.86	4.56	4.67	5.17
CV (%)		-	15.05	10.17	6.76	5.10	3.94	4.97	3.10	3.00	3.23

Means followed by same letter in the column do not differ significantly by DMRT (P=0.01)
DAS –Days after spraying
The figures in the parentheses are arcsine transformed values

Table 4: Effect of *Acremonium zeylanicum* on fourth instar nymphs of sugarcane woolly aphid

Sr. No.	Treatments (conidia /l)	Per cent mortality of SWA									
		1DAS	2DAS	3DAS	4DAS	5DAS	6DAS	7DAS	8DAS	9DAS	10DAS
1.	$1x10^{10}$	0.00a	2.00a	13.00a	28.50a	43.50a	61.00a	69.00a	73.50a	79.00a	83.30a
		(4.05)	(8.13)	(21.13)	(32.25)	(41.25)	(51.33)	(56.14)	(58.99)	(62.70)	(66.01)
2.	$1x10^8$	0.00a	1.50a	8.00b	22.00b	34.50b	46.00b	53.50b	58.00b	65.50b	69.50b
		(4.05)	(7.32)	(16.42)	(27.96)	(35.96)	(42.98)	(46.99)	(49.58)	(54.01)	(56.45
3.	$1x10^6$	0.00a	1.00ab	4.50c	16.00c	24.00c	35.00c	40.00c	49.50c	56.00c	60.00c
		(4.05)	(6.42)	(12.24)	(23.57)	(29.32)	(36.26)	(39.22)	(44.70)	(48.43)	(50.75)
4.	$1x10^4$	0.00a	0.50ab	3.00c	12.00d	19.00d	24.50d	28.00d	33.00d	44.00d	48.00d
		(4.05)	(5.375)	(9.97)	(20.26)	(25.83)	(29.66)	(31.94)	(35.04)	(41.54)	(43.84)
5.	Untreated check	0.00a	0.00b	0.00d	0.50e	1.00e	1.00e	1.50e	2.50e	3.00e	3.00e
		(4.05)	(4.05)	(4.05)	(5.37)	(6.42)	(6.42)	(7.60)	(9.32)	(9.97)	(9.97)
S.E.±		NS	0.64	0.69	0.69	0.80	0.81	1.01	0.97	0.72	0.68
C.D. (P=0.01)		NS	4.19	4.51	4.50	5.22	5.27	6.61	6.31	4.67	4.44
CV (%)		-	21.15	10.90	6.33	5.80	4.87	5.60	4.92	3.31	3.01

Means followed by same letter in the column do not differ significantly by DMRT (P=0.01) NS=Non-significant
DAS -Days after spraying
The figures in the parentheses are arcsine transformed values

DAS.

The present findings are in close conformity with Puttannavar (2004) who observed that irrespective of the concentrations, higher mortality of SWA was recorded in 1 x 10^8 conidia/l in case of different entomopathogenic fungi *viz., M. anisopliae, V. lecanii*, *B. bassiana* and *N. rileyi*. Nirmala (2003) reported that field trials conducted with oil in water emulsion of *B. bassiana* and *M. anisopliae* caused 19.84 and 42.26 per cent mycosis, respectively. Kulkarni *et al.* (2003) sprayed different entomopathogens *viz., M. anisopliae, V. lecanii* and *B. bassiana* @ 2 g/l on SWA, *M. anisopliae* was found to be the most effective after 10 days.

According to Hincapie *et al.* (1990), the highest concentrations of *V. lecanii* caused 39.5 to cent per cent mortality of chrysanthemum aphid, *M. persicae*. The observations made by Kadam *et al.* (2002) indicated that the different concentrations of *V. lecanii* spray gave more than 90 per cent biosuppression of *C. lanigera* at 5 days after application under laboratory conditions. These findings are in support of the present investigations.

Though, synthetic insecticides are effective against the woolly aphid, they do not find place in sugarcane ecosystem for reasons like difficulty in spraying, operational hazards, improper coverage of crop canopy, high investment for pesticide application and destruction of natural enemies treasure in the sugarcane ecosystem. Hence, by the use of *A. zeylanicum* can able to minimize the above problems at some extent.

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Authors' affiliations:
NAVEENKUMAR B. PATIL AND C.P. MALLAPUR, Department of Agricultural Entomology, College of Agriculture, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA

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