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Original Research Article

Field Efficacy of *Pseudomonas fluorescens* against the Cotton Leafhopper, *Amrasca devastans* Distant (Hemiptera: Aphididae) in Bt and Non Bt Cotton

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A B S T R A C T

An experiment was conducted to evaluate the efficacy of *Pseudomonas fluorescens* against leafhopper of Bt cotton and non Bt cotton in two location of Vanavarayar Institute of Agriculture, Pollachi and South Indian Millers Association, Udumelpet. Seven treatments i.e. foliar application of *P. fluorescens* @1%, soil application of *P. fluorescens* 2.5 kg/ha, soil and foliar application of *P. fluorescens* @1%, foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1%, foliar application of *Beauveria basianna* @ 1%, imidacloprid 200 SL @ 200ml/ha and Untreated check were evaluated. Among the bio inoculants treatment the maximum per cent reduction in leafhopper population with a mean of 71.00; 83.45; 85.01 and 63.28; 82.32; 91.58 at 1st, 2nd and 3rd spray after application in both the locations respectively in Bt cotton during 2013-14. The similar trend was also observed in non Bt cotton. During 2014-15, the maximum per cent reduction in leafhopper population recorded among the bio inoculants treatment, the soil and foliar application of *P. fluorescens* @1% in two locations and both Bt and non Bt cotton. The highest mean seed cotton yield was obtained in soil and foliar application of *P. fluorescens* @1% in two locations, and both years of 2013-14 and 2014-15.

Keywords

Bioefficacy, Biopesticides, *Pseudomonas fluorescens*, Bt cotton, Non Bt cotton, Leafhopper

Introduction

Cotton (*Gossypium* spp.) popularly known as “white gold” or “king of fibers” is one of the most important commercial fibre crops of global significance and a major source of raw material for the domestic textile industry in India. Cotton and textile exports account for nearly one third of total foreign exchange earnings of India. It also provides a means of livelihood for millions of farmers and workers involved in the cotton industry, from growing and processing to trading (Mayee *et al.*, 2004). The American cotton, *G. hirsutum* represents 90% of the hybrid cotton genotypes grown in India (Kohel *et al.*, 2001; Hong-Bin *et al.*, 2008). The domestic consumption of cotton in India was about 40 million bales during 2014–2015 (Anonymous, 2015). The insect pest spectrum of cotton is quite complex and as many as 1326 species of insect pests have

been recorded on this crop throughout the world (Agarwal *et al.,* 1984). However, main losses in cotton production are due to its susceptibility to about 162 species of insect pests (Manjunath, 2004). Dhawan and Sidhu (1986) estimated yield loss in cotton due to sucking pests' upto 21.2 per cent. While, Chavan *et al.,* (2010) reported 28.13 per cent avoidable yield loss due to major sucking pests in cotton. Dhawan *et al.,* (1988) showed that the extent of losses caused by sucking pests, bollworms and both sucking pests and bollworms were 12, 44 and 52%, respectively. Among the sucking pest complex of *Bt* cotton, the cotton leafhopper, *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae) is an alarming pest causing both quantitative and qualitative losses.

Cotton is severely attacked by leaf hoppers causing 35% (Neelakantan, 1957) and 18.8% (Javed *et al.,* 1992) reduction in yields. Cotton seems to be specifically designed by nature to attract insects. Its plant has succulent leaves, attractive flowers and nectar in flowers as well as fruits of different sizes at reproductive phase. It suffers from insect ravages throughout its growth period (Gangadhar *et al.,* 2007). Earlier it was considered as a serious pest during vegetative phase of crop. At present it is serious pest during reproductive phase too, prevailing up to 120 days after sowing and has become one of the limiting factors in economic productivity of the crop (Balakrishnan *et al.,* 2007). Cotton leafhopper, *Amrasca devastans* (Dist.) is a principal insect pest of cotton causing more than 37% seed cotton losses. It also reduces photosynthesis activity in its hosts (Razaq *et al.,* 2014).

After the introduction of Bt cotton, there was a check to the bollworm complex. But, the sucking pest population especially leafhoppers increased gradually reaching economic injury level in many parts of India (Mohan and Nandini, 2011).

Among the various strategies adopted by farmers to combat pest menace, insecticides form the first line of defence. Several potent insecticides have been recommended for managing the sucking pests. In spite of repeated use of insecticides, it is becoming difficult to manage this pest and control failures have been experienced by the cotton growers at times. Though control failure may be due to many factors, one of the major factors is the development of resistance to insecticides (Jeya Pradeepa and Regupathy, 2002). The pesticide usage on cotton to control the insect pests is both extensive and intensive. The indiscriminate use of insecticides resulted in development of resistance in insects to insecticides and resurgence of sucking pests (Rohini *et al.,* 2012). Also, the fact that the Bt cotton seeds are available in the market as imidacloprid treated which is giving an impetus for cotton leafhopper to develop resistance against insecticides (Kshirsagar *et al.,* 2012).

Therefore there is an urgent need to replace pesticides with alternative means of control that are safe, low in cost, local in production and also environment friendly. Bio pesticides or biological pesticide on pathogenic microorganisms specific to a target pest offer an ecologically sound and effective solution to pest problems. They pose less threat to the environment and to human health.

Until very recently, insecticidal activities in the *P. fluorescens* group had only been sparsely documented. Notably, strains of *P. fluorescens* were reported to exhibit insecticidal activity toward agricultural pest insects such as aphids (Hashimoto, 2002), phytophagous ladybird beetles (Otsu *et al.,*

2004), and termites (Devi and Kothamasi, 2009).

The recent trends in pest management emphasis on nonchemical approaches and there is worldwide demand for organically grown fibre, which is increasing annually in export markets. Therefore, attempts have been made to find out efficacy of *P. fluorescens* for controlling devastating pests in crops.

Materials and Methods

The present field experiments were carried out at two locations, Vanavarayar Institute of Agriculture, Pollachi (VIA) and South Indians Millers Association, Udumelpet (SIMA) during kharif 2013-14 and 2014-15 to evaluate the efficacy of *P. fluorescens* against leafhopper of Bt and non Bt cotton.. The trial was laid out in a randomized block design (RBD) with seven treatments including control, each replicated four. The treatments namely, T1- Foliar application of *P. fluorescens* @1%, T2 – Soil application of *P. fluorescens* 2.5 kg/ha, T3 – Soil and Foliar application of *P. fluorescens* @1%, T4 – Foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1%, T5 - Foliar application of *Beauveria basianna* @ 1%, T6 – imidacloprid 200 SL @ 200ml/ha and T7 – Untreated check were evaluated.

All the treatments had two sprays except check. Bt Cotton hybrid *Bt* cotton (RCH 20) and Non *Bt* cotton (LRA 5166) were sown in a plot size 5 x 4 m with spacing of 90 x 60 cm.

All recommended package and practices was followed to raise the crop as per package and practice except plant protection measures. The treatments were imposed as and when leafhopper crossed ETL, one nymph or adult of leafhopper per leaf.

Observations on pest incidence were recorded from five fixed plants/plot which were tagged after selecting randomly for this purpose. The number of sucking pest's leaf hopper was recorded from three leaves (top, middle and bottom) per plant (Krishnaiah *et al.*, 1979; Charravarthy and Ananda Rao, 1985). Pre-treatment population was taken just before the application of treatments and post treatment count 7 days after spray.

The values were then transformed to square root transformation for number and data subjected to analysis of variance. First spray was done at economic threshold level (ETL) and subsequent spray was given at fortnight interval.

The per cent reduction in population of insect pests vis-à-vis control was computed using the method described by Henderson and Tilton, 1955.

$$\text{Per cent reduction in population} = 100 \times \left[1 - \frac{Tb \times C a}{Ta \times C b}\right]$$

Where,

Ta = Number of insects after treatment

Tb = Number of insects before treatment

Ca = Number of insects in untreated check after treatment

Cb = Number of insects in untreated check before treatment

The reduction percentage figures were transformed into arc sine values and subjected to analysis of variance. The seed cotton yield was recorded plot wise at harvest and it was converted into kg ha-1 for analysis and comparison. At harvest, seed

cotton yield was recorded in kg/ plot and it was converted into q/ ha for analysis and comparison.

Results and Discussion

Bio-efficacy of *P. flourescens* against leafhopper during 2013-14

Bt cotton

The pre-treatment population of leafhopper was in the range of 9.6 to 11.5 and 8.23 to 8.96 per plant before first spray at VIA and SIMA, respectively and all the treatments/ plots are statistically at par. The maximum reduction in the leafhopper population with a mean of 79.35; 84.12; 88.58 and 70.90; 85.03; 93.60 per cent was recorded in imidacloprid 200 SL @ 200ml/ ha at 1st, 2nd and 3rd spray after application in both the locations respectively and it was statistically at par with soil and foliar application of *P. fluorescens* @1%, 71.00; 83.45; 85.01 and 63.28; 82.32; 91.58 at 1st, 2nd and 3rd spray after application in both the locations respectively. Followed by the foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1% showed significant maximum mean per cent reduction (81.37 and 81.85) in the population of leafhopper at third spray after applications in both the locations, respectively (Table 1).

Non Bt cotton

In all the observations on leafhopper population in bio inoculants treatments the maximum reduction percentage of leafhopper with mean of 77.31; 90.44; 94.85 and 69.28; 87.93; 93.81 per cent was recorded in soil and foliar application of *P. fluorescens* @1% at 1st, 2nd and 3rd spray of applications in both locations, respectively and it was statistically at par with foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1% at 1st, 2nd and 3rd spray of applications in both locations (Table 2).

Bio-efficacy of *P. flourescens* against leafhopper during 2014-15

Bt cotton

During the year 2014 -15, the pre-treatment population of leafhopper did not vary significantly in all the plots before first spray (12.5 to 14.6 and 6.77 to 7.64/ per plant respectively). The highest reduction in population of leafhopper with mean of 47.49; 71.53; 86.55 and 67.33; 85.79; 91.82 per cent was recorded in imidacloprid 200 SL @ 200ml /ha at 1st, 2nd and 3rd spray after application in both the locations respectively and it was statistically at par with soil and foliar application of *P. fluorescens* @1%, 47.49; 71.53; 86.55 and 67.33; 85.79; 91.82 at 1st, 2nd and 3rd spray after application in both the locations respectively (Table. 3).

Non Bt Cotton

The data collected after three applications of various treatments on leafhoppers revealed that the soil and foliar application of *P. fluorescens* @1% was significantly adverse impact on the population of compare to other bio inoculants treatments. The soil and foliar application of *P. fluorescens* @1% recorded 84.35; 93.36; 94.26 and 72.84; 84.98; 93.44 at 1st, 2nd and 3rd spray after application in both the locations respectively. Followed by the foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1% showed significant maximum mean per cent reduction (86.28 and 86.95) in the population of leafhopper at third spray after applications in both the locations, respectively (Table 4).

Table.1 Evaluation of *P. fluorescens* against leafhopper, *Amrasca devastans* in *B t* cotton during 2013-14

Treatments	Per cent mean reduction in population of leaf hopper							
	VIA				SIMA			
	PTC	1st spray	2nd spray	3rd spray	PTC	1st spray	2nd spray	3rd spray
Foliar application of *P. fluorescens* @1%	11.3 (3.37)	66.56 (54.68)	77.37 (61.60)	79.51 (63.09)	8.44 (2.53)	52.93 (46.68)	69.69 (56.60)	79.21 (62.89)
Soil application of *P. fluorescens* 2.5 kg/ha	9.6 (3.10)	63.22 (52.67)	75.05 (60.04)	78.59 (62.45)	8.27 (2.35)	48.14 (43.94)	69.04 (56.19)	78.65 (62.50)
Soil and Foliar application of *P. fluorescens* @1%	11.5 (3.39)	71.00 (57.42)	83.45 (66.03)	85.01 (67.26)	8.96 (2.54)	63.28 (52.71)	82.32 (65.14)	91.58 (73.17)
Foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1%	10.8 (3.29)	69.26 (56.33)	80.34 (63.72)	81.37 (64.46)	8.23 (2.34)	62.11 (52.01)	77.40 (61.62)	81.85 (64.80)
Foliar application of *Beauveria basianna* @ 1%	9.70 (3.11)	68.62 (55.94)	77.63 (61.78)	79.51 (63.10)	8.42 (2.51)	58.69 (50.01)	73.73 (59.18)	79.83 (63.34)
Imidacloprid 200 SL @ 200ml/ha	11.0 (3.31)	79.35 (62.98)	84.12 (66.52)	88.58 (70.35)	8.91 (2.98)	70.90 (57.35)	85.03 (67.24)	93.60 (75.59)
Untreated check	10.6 (3.25)	-	-	-	8.55 (2.62)	-	-	-
SEd	NS	0.62	0.86	1.15	NS	0.51	0.41	1.32
CD(.05)		1.32	1.83	2.44		1.08	0.87	2.81

VIA: Vanavarayar Institute of Agriculture, Pollachi SIMA: South Indian Millers Association, Udumelpet.
PTC: Pre treatment count, ROC: Reduction over control. Figures in parentheses are square root transformed values

Table.2 Evaluation of *P. fluorescens* against leafhopper, *Amrasca devastans* in Non *Bt* cotton during 2013-14

Treatments	Per cent mean reduction in population of leaf hopper							
	VIA				SIMA			
	PTC	1st spray	2nd spray	3rd spray	PTC	1st spray	2nd spray	3rd spray
Foliar application of *P. fluorescens* @1%	8.46 (2.91)	49.79 (44.88)	76.38 (60.92)	91.06 (72.61)	6.45 (2.54)	56.20 (48.56)	72.76 (58.54)	82.60 (65.35)
Soil application of *P. fluorescens* 2.5 kg/ha	8.82 (2.97)	44.41 (41.79)	73.89 (59.28)	91.10 (72.65)	7.06 (2.66)	53.97 (47.28)	66.73 (54.78)	81.35 (64.43)
Soil and Foliar application of *P. fluorescens* @1%	8.11 (2.85)	77.31 (61.57)	90.44 (72.05)	94.85 (76.89)	7.42 (2.72)	69.28 (56.34)	87.93 (69.76)	93.81 (75.68)
Foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1%	8.06 (2.84)	75.46 (60.31)	83.11 (65.76)	90.95 (72.50)	6.37 (2.52)	68.41 (55.81)	80.71 (63.99)	92.48 (74.11)
Foliar application of *Beauveria basianna* @ 1%	8.62 (2.94)	71.92 (58.00)	77.66 (61.80)	86.52 (68.53)	6.66 (2.58)	56.49 (48.73)	74.59 (59.74)	87.85 (69.63)
imidacloprid 200 SL @ 200ml/ha	7.95 (2.82)	90.19 (71.90)	90.67 (72.28)	96.21 (79.00)	6.34 (2.52)	84.88 (67.12)	93.86 (76.04)	97.96 (82.13)
Untreated check	8.33 (2.89)	-	-	-	6.91 (2.63)	-	-	-
SEd	NS	1.03	1.01	0.95	NS	0.51	1.56	1.15
CD(.05)		2.19	2.15	2.02		1.06	3.32	2.46

VIA: Vanavarayar Institute of Agriculture, Pollachi SIMA: South Indian Millers Association, Udumelpet.
PTC: Pre treatment count, ROC: Reduction over control. Figures in parentheses are square root transformed value

Table.3 Evaluation of *P. fluorescens* against leafhopper, *Amrasca devastans* in *Bt* cotton during 2014-15

Treatments	Per cent mean reduction in population of leaf hopper							
	VIA				SIMA			
	PTC	1st spray	2nd spray	3rd spray	PTC	1st spray	2nd spray	3rd spray
Foliar application of *P. fluorescens* @1%	12.5 (3.53)	30.24 (33.36)	63.46 (52.81)	69.27 (56.34)	7.59 (2.75)	58.27 (49.76)	76.04 (60.72)	75.33 (60.23)
Soil application of *P. fluorescens* 2.5 kg/ha	13.7 (3.70)	29.57 (32.94)	60.69 (51.18)	70.53 (57.12)	6.82 (2.61)	56.09 (48.50)	74.95 (59.97)	73.26 (58.87)
Soil and Foliar application of *P. fluorescens* @1%	14.6 (3.82)	47.49 (43.56)	71.53 (57.76)	86.55 (68.56)	7.64 (2.76)	67.33 (55.15)	85.79 (67.86)	91.82 (73.40)
Foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1%	13.3 (3.65)	43.36 (41.18)	70.32 (57.00)	74.28 (59.53)	7.23 (2.69)	65.45 (54.01)	81.69 (64.69)	82.47 (65.26)
Foliar application of *Beauveria basianna* @ 1%	14.8 (3.85)	46.46 (42.97)	62.05 (51.98)	69.96 (56.78)	6.77 (2.60)	60.56 (51.10)	78.27 (62.24)	79.10 (62.83)
imidacloprid 200 SL @ 200ml/ha	14.3 (3.78)	66.30 (54.52)	72.27 (58.23)	86.79 (68.69)	7.51 (2.74)	83.45 (66.02)	91.99 (73.67)	92.85 (74.56)
Untreated check	12.9 (3.59)	-	-	-	7.45 (2.73)	-	-	-
SEd	NS	0.66	0.33	0.80	NS	0.62	1.09	0.95
CD(.05)		1.41	0.70	1.71		1.34	2.34	2.03

VIA: Vanavarayar Institute of Agriculture, Pollachi SIMA: South Indian Millers Association, Udumelpet.
PTC: Pre treatment count, ROC: Reduction over control. Figures in parentheses are square root transformed value

Table.4 Evaluation of *P. fluorescens* against leafhopper, *Amrasca devastans* in *Bt* cotton during 2014-15

Treatments	Per cent mean reduction in population of leaf hopper							
	VIA				SIMA			
	PTC	1st spray	2nd spray	3rd spray	PTC	1st spray	2nd spray	3rd spray
Foliar application of *P. fluorescens* @1%	6.84 (2.62)	58.81 (50.08)	71.57 (57.79)	81.96 (64.87)	6.11 (2.47)	52.16 (46.24)	60.76 (51.22)	76.89 (61.28)
Soil application of *P. fluorescens* 2.5 kg/ha	7.16 (2.68)	55.09 (47.92)	70.42 (57.06)	80.54 (63.83)	6.32 (2.51)	48.12 (43.93)	57.64 (49.40)	73.18 (58.83)
Soil and Foliar application of *P. fluorescens* @1%	7.43 (2.73)	84.35 (66.72)	93.36 (75.14)	94.26 (76.28)	6.55 (2.56)	72.84 (58.60)	84.98 (67.22)	93.44 (75.29)
Foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1%	7.09 (2.66)	71.94 (58.02)	83.77 (66.25)	86.28 (68.27)	6.04 (2.46)	69.83 (56.69)	74.13 (59.43)	86.95 (68.83)
Foliar application of *Beauveria basianna* @ 1%	6.88 (2.62)	57.08 (49.07)	77.34 (61.59)	81.89 (64.83)	5.99 (2.45)	48.59 (44.19)	66.41 (54.59)	81.41 (64.48)
imidacloprid 200 SL @ 200ml/ha	7.15 (2.67)	91.62 (73.20)	93.93 (75.78)	96.42 (80.41)	6.47 (2.54)	91.17 (72.73)	93.66 (75.50)	97.08 (80.18)
Untreated check	7.32 (2.70)	-	-	-	6.24 (2.50)	-	-	-
SEd	NS	1.03	0.83	1.81	NS	0.59	0.83	0.86
CD(.05)		2.19	1.76	3.87		1.25	1.77	1.89

VIA: Vanavarayar Institute of Agriculture, Pollachi SIMA: South Indian Millers Association, Udumelpet.
PTC: Pre treatment count, ROC: Reduction over control. Figures in parentheses are square root transformed value

Table.5 Seed cotton yield and economics of different treatment (Bt cotton)

	VIA				SIMA			
	Seed cotton yield (q/ha)		Mean yield	Profit* Rs/ha	Seed cotton yield (q/ha)		Mean yield	Profit* Rs/ha
	2013-14	2014-15			2013-14	2014-15		
Foliar application of *P. fluorescens* @1%	23.20	23.90	23.55	18,737	26.34	24.61	25.48	26,732
Soil application of *P. fluorescens* 2.5 kg/ha	22.80	23.40	23.10	16,892	25.90	23.82	24.86	24,190
Soil and Foliar application of *P. fluorescens* @1%	26.60	28.68	27.64	35,506	29.67	29.12	29.40	41,760
Foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1%	24.50	26.18	25.34	26,076	27.73	27.33	27.53	34,280
Foliar application of *Beauveria basianna* @ 1%	23.83	24.70	24.27	21,689	26.22	25.44	25.83	27,480
imidacloprid 200 SL @ 200ml/ha/ Triazophos 0.05%	25.60	27.03	26.32	29,360	28.54	27.64	28.09	37,433
Untreated check	19.18	18.78	18.98	-	18.98	18.94	18.96	-
CD (p=0.05)	1.86	1.49			0.28	1.03		
SEm±	0.88	0.71			0.59	0.49		

VIA: Vanavarayar Institute of Agriculture, Pollachi SIMA: South Indian Millers Association, Udumelpet
*Increased profit over control

Table.6 Seed cotton yield and economics of different treatment (Non Bt cotton)

	VIA				SIMA			
	Seed cotton yield (q/ha)		Mean yield	Profit* Rs/ha	Seed cotton yield (q/ha)		Mean yield	Profit* Rs/ha
	2013-14	2014-15			2013-14	2014-15		
Foliar application of *P. fluorescens* @1%	16.91	16.52	16.72	17,199	17.84	16.45	17.15	15,444
Soil application of *P. fluorescens* 2.5 kg/ha	16.64	15.76	16.20	15,171	16.92	16.08	16.50	12,909
Soil and Foliar application of *P. fluorescens* @1%	19.57	18.73	19.15	26,676	20.77	19.46	20.12	27,165
Foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1%	17.43	16.82	17.13	18,798	18.61	17.19	17.90	18,416
Foliar application of *Beauveria basianna* @ 1%	16.89	16.44	16.67	17,004	17.83	16.27	17.05	15,050
imidacloprid 200 SL @ 200ml/ha/ Triazophos 0.05%	19.12	18.46	18.79	25,272	20.56	19.31	19.94	26,250
Untreated check	12.67	11.95	12.31	-	13.49	12.88	13.19	-
CD (p=0.05)	0.25	0.18			0.20	0.27		
SEm±	0.52	0.37			0.42	0.56		

VIA: Vanavarayar Institute of Agriculture, Pollachi SIMA: South Indian Millers Association, Udumelpet
*Increased profit over control

Effect on seed cotton yield

Bt cotton

The soil and foliar application of *P. fluorescens* @1% recorded the maximum seed cotton yield of 27.64 and 29.40 q/ha in both locations, VIA and SIMA respectively followed by imidacloprid 200 SL @ 200ml /ha and statistically at par with each other. Whereas among the bio inoculants the foliar application of *P. fluorescens* @1% and *Beauveria basianna* @ 1% gave more yield and observe next better treatment (Table.5). The maximum profit of Rs 35,506 and Rs. 41,760 were obtained in soil and foliar application of *P. fluorescens* @1% in both locations, respectively.

Non Bt cotton

The highest yields were recorded in plots treated with soil and foliar application of *P. fluorescens* @1% (19.15 kg/ha in VIA and 20.12 kg/ha in SIMA) and was comparable to those of imidacloprid 200 SL @ 200ml /ha (18.79 kg/ha in (VIA) and 19.31 kg/ha (SIMA)). The maximum profit of Rs 26,676 and Rs. 27,165 was obtained in soil and foliar application of *P. fluorescens* @1% in both locations, respectively (Table. 6).

Bio pesticide application to manage crop pests is an alternative approach to minimize pesticide hazards. It has advantages such as, easy application, low cost, less pollution, selective and least interference in natural equilibrium over chemical insecticide application. In the present study brought out the effectiveness of *P. flourescens* against *A. devastans* on cotton. The results revealed that highest mean reduction percentage of *A. devastans* was observed in soil and foliar application of *P. fluorescens* @1%. The present findings are in close conformity with the findings of Murugesan and Kavitha (2009) who reported that cotton leaf hopper, *A. devastans* significantly reduced by *P. flourescens* as seed treatment against the sucking pest through induced resistance.

P. fluorescen, a plant growth promoting rhizobacteria (PGPR), treated plants harboured lesser population of leafhopper and obtained more bolls with the seed treatment and foliar spray (Sathyan *et al.*, 2015). *P. fluorescens* significant impact on whitefly, *Bemisia tabcii* (Soundarajan and Chitra, 2011) and foliar application of *P. fluorescens* induced resistance in onion thrips, *Thrips tabci* (Sanjay and Sivasubramanian, 2012).

The results of two year trials revealed the potential of *P. fluorescens* as a microbial agent by causing significant mortality of cotton leafhopper in cotton can be best utilized for ecofriendly IPM programme of either Bt cotton or conventional cotton cropping system.

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