Field evaluation of *Pseudomonas fluorescens* against the pink bollworm, *Pectinophora gossypiella* and the spiny bollworm, *Earias vitella.*

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ABSTRACT

Pseudomonas fluorescens and *Beauveria basianna* were evaluated in cotton growing season against the common bollworms that infested cotton, pink bollworm, *Pectinophora gossypiella* and the spiny bollworm, *Earias vitella.* Reduction in the infestation and larval content was determined after three successive sprays with 15 days interval. The indirect effect of *Pseudomonas fluorescens* on seed cotton yield was considered and compared with the untreated check. Results of the present study revealed that the foliar application of *P. fluorescens* and *Beauveria basianna treatment* exhibited the greatest reduction in bollworms infestation. Soil and Foliar application of *P. fluorescens,* was recorded with the highest amount of seed cotton yield.

Keywords: *Pseudomonas fluorescens, Beauveriabasianna and Eariasvitella.*

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INTRODUCTION

Cotton *Gossypium* spp. (Family: Malvaceae) is one of the most economic non-field crops of global importance and main cash crop in the world. In India it is cultivated in 105 lakh hectares with production of 351 lakh bales of seed cotton. Moreover, due to the top most position in Indian Agriculture it is also popularly known as white gold. Cotton fibre is an important raw material for textile industries and plays a key role in national economy in term of employment generation and foreign exchange. Production of cotton is limited by various factors among which insect pests are very important. During growth period 148 insect pests have been recorded on cotton crop out of which only 17 species have been recorded as major insect pests of cotton crop. Cotton pests can primarily be divided into sucking pests and bollworm. Among the bollworm the pink bollworm, *Pectinophora goeeypiella* (Saund) and spiny bollworm, *Earias vitella* (Boisd.) are the most serious cotton pests (Hussein *et al.,* 2001). Pests are such a serious threat to cotton production that the cost of cotton pest control is about $12.5 million (Younis *et al.,* 2007). Bollworms have caused the greatest yield losses in nearly one million hectares cultivated annually in the world. (Haque, 1991; EI-Nagger, 1998). The reduction in cotton yield was mostly related to the late season infestation with both species and the economic yields are almost impossible to achieve without their chemical control. For both species most of larvae live inside the green bolls and pesticides used must be carefully selected to affect egg and adult stages with minimum side effect on beneficial arthropods. While searching for the best alternative use of bioinaculants and botanicals will be a good choice for controlling insect pests and they pave the way for eco-friendlier pest management. Bioinaculants of microbial controls an essential component in bio-intensive pest management, help reduce the dependence on chemical pesticides and ecological deterioration and serve as insecticides. The utilization of plants owns defense mechanism is the subject of current interest in the management of pest. Induced protection of plants against various pests and diseases by biotic and abiotic inducers has been reported in many crops. Plant growth promoting rhizobacteria (PGPR) has been shown to be capable of inducing pest resistance in addition to promoting plant growth. The main objective of the present study was to evaluate *in – situ* efficacy of *Pseudomonas fluorescens* against bollworm infestation and the reduction in the infestation must be associated with the greatest cotton yield

MATERIALS AND METHODS

Field experiments were conducted during 2014 -2015 at Vanavarayar Institute of Agriculture, Pollachi, Coimbatore District. *P. fluorescens* was evaluated against the two common bollworm infested cotton, *Pectinophora gossypiella* and *Eariasvitella*. The experiment was laid out in randomized block design (RBD). There were six treatments *viz.*, 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 @ 1%, T5 - Foliar application of *B. basianna* @ 1%, T6 - Profenophos 50 EC @ 1 lit/ha. along with a T7 - control treatment. Each treatment was replicated four times. The plot size of each experimental unit was 6 x 5 m. Row to row and plant to plant distance was maintainex as 90 x 60 cm. The percent infestation was calculated by the following formula:

$$\% \text{ infestation: } \frac{\text{No. of green bolls damaged}}{\text{Total no. of bolls}}$$

Biweekly pests counting was carried out before and after the treatment spray upon attainment of economic threshold level (ETL) of both pink boll worm and spotted bollworm infestation (5 larvae/ 25 plants or 10% infestation of fruiting bodies). Treatments were sprayed according to their label recommended dose with the help of knapsack hand sprayer early in the morning using hollow- cone nozzle. Samples of 100 green bolls per treatment (25 bolls for each treatment) were taken at random and dissected. For each treatment, reduction percentages in bollworm infestation, bollworm larval content were calculated using Henderson and Titlon (1955) equation :

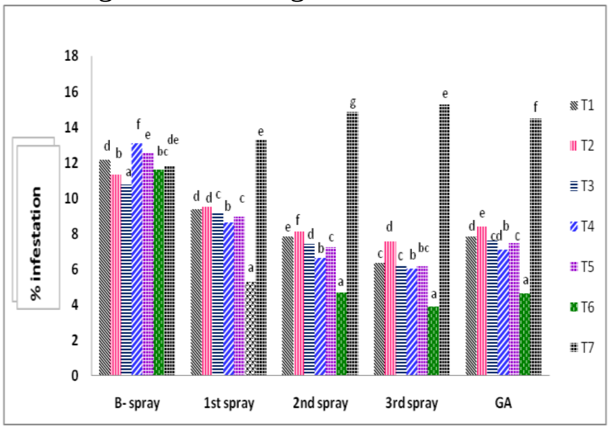
Per cent Reduction = [1- { (Control before* treatment after) / (Control after* treatment before) }]* 100.

The seed cotton yield for each plot was harvested and weighed then mean weight of seed cotton yield was compared among the treatment and the untreated check. Data were analyzed using analysis of variance followed by Tukey's multiple comparison tests (Gonez and Gonez, 1984).

RESULTS

The pre spray infestation of both species ranged between 10–13%. Six weeks after application, the infestation averaged 3.86 to 7.54 % in *P. fluorescen s*and *B. basianna* treatments compared to 15.25 % in control treatment (fig.1).

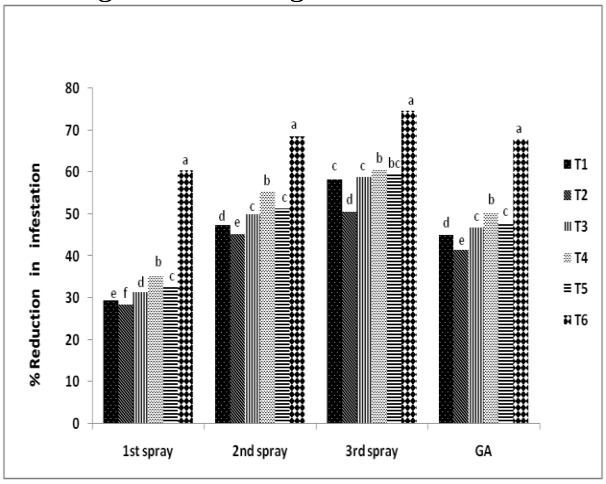
Fig. 1. Percentages of bollworms infestation before and after applying *P. fluorescens* treatments in three successive sprays with 15 days interval. ANOVA, Tukey's at 0.05 level of probability; same alphabets during a counting indicates insignificant



GA: The general average of the three successive sprays.

Bollworm infestation in Foliar application of *P. fluorescens* and *Beauveria basianna* treatment was significantly higher than that in the Profenophos 50 EC treatment, however, was significantly lower compared to the other treatments and the control. Reduction percentage in bollworms infestation was calculated and used to compare the bioinoculants and pesticide treatments (Fig. 2).

Fig. 2. Percentages of the reduction bollworms infestation after applying *P. fluorescens* treatments in three successive sprays with 15 days interval. ANOVA, Tukey's at 0.05 level of probability; same alphabets during a counting indicates insignificant.

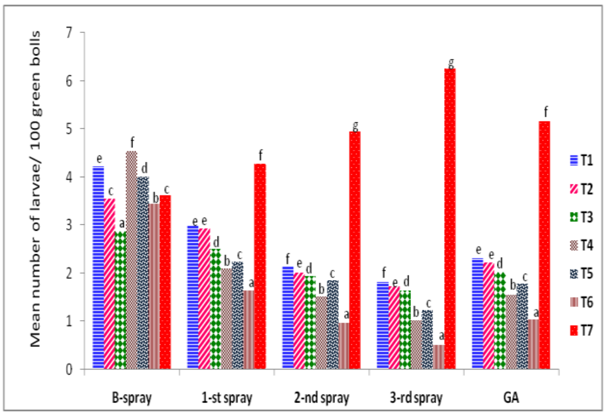


GA: The general average of the three successive sprays.

Reduction in the general average of infestation after the three sprays revealed that, there is no significant difference among the soil and foliar application of *P. fluorescens* and foliar application of *B. basianna* treatments. The percentage of reduction ranged between 41.4 % in Soil application of *P. fluorescens 2.5* kg/ha treatment and up to 67.89 % in Profenophos 50 EC @ 1 lit/ha.

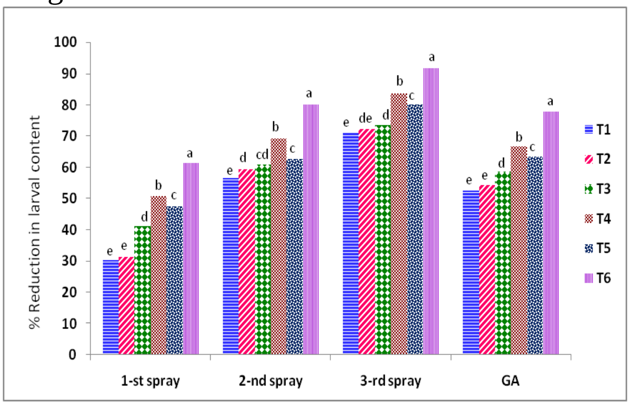
The foliar application of *P. fluorescens* and *B. basianna* treatment, exhibited the highest reduction in the infestation that was significantly different compared to the profenophos pesticide treatment. In general, mean number of larvae before and after spray was much lower compared to the level of infestation. Before spray, mean number of larvae ranged between 2.8 to 4.5 (Fig 3.). After three successive sprays with 15 days interval, mean number of larvae averaged 1% in pesticide treatment compared to 1.5% in foliar application of *P. fluorescens* @1% & *B. basianna* @ 1%, treatment and 5.16 % in the control (Fig 3.). As shown in Fig. 4, the percentage of reduction in the general average of larvae counted in profenophos pesticide treatment was significantly higher compared to other treatments.

Fig. 3. Mean number of bollworms larvae before and after applying *P. fluorescens* treatments in three successive sprays with 15 days interval. ANOVA, Tukey's at 0.05 level of probability; same alphabets during a counting indicates insignificant



GA: The general average of the three successive sprays.

Fig. 4. Percentage of the reduction in bollworms larval content after applying *P. fluorescens* treatments in three successive sprays with 15 days interval. ANOVA, Tukey's at 0.05 level of probability; same alphabets during a counting indicates insignificant

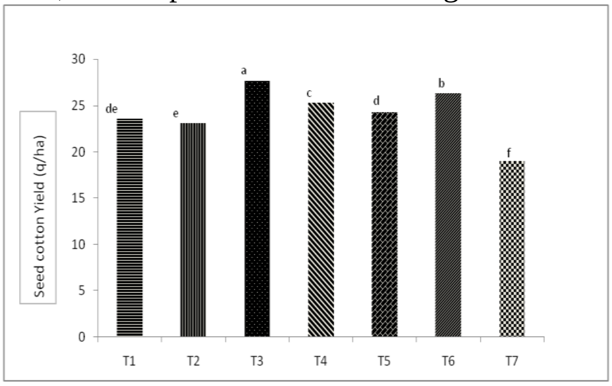


GA: The general average of the three successive sprays.

The above treatments exhibited 53 to 78 % reduction in larval content. The treatment of profenophos resulted in 77.78% reduction in the larval content. The other treatments could be arranged descendingly as follows: foliar application of *P. fluorescens* and *B. basianna*, foliar application of *B. basianna*, soil and foliar application of *P. fluorescens*, soil application of *P. fluorescens* 2.5 kg/ha, foliar application of *P. fluorescens*.

The highest seed cotton yield was obtained from soil and foliar application of *P. fluorescens* followed by the profenophos pesticide treatment. The difference in seed cotton yield was significant in the treatments of bioinaculants. Control treatment had the lowest seed cotton yield that was significantly less compared to all other treatments.

Fig. 5. Cotton seed yield in control and *P. fluorescens* treatments. ANOVA, Tukey's Test, same alphabets indicates insignificant



DISCUSSION

Plant growth-promoting rhizobacteria (PGPR) which inhibiting in the rhizosphere, around/on the root surface, which improve the plant growth directly or indirectly. Qureshi and Ahmed (1991) proposed that spiny bollworm caused an economic injury when the infestation level reached 10%. However, Sing and Sandy (1993) and Purohit and Deshoande (1994) suggested that the chemical application should be done at 5% level of infestation. Saravanakumar *et al.* (2008), reported that application of fluorescent *Pseudomonasds* either individually or in combinations significantly reduced the leaf folder attack in rice. Commare *et al.* (2002) and Karthiba *et al.* (2010), revealed that the *P. fluorescens* strains was demonstrated to simultaneously reduce the incidence of a herbivorous insect , the rice leaf folder and a phytopathogenic fungus in rice under greenhouse and field conditions. Rajendran *et al.* (2007) demonstrated the PGPR and endophytic bacteria mediated induction of defense responses in cotton plants against bollworm (*Helicopverpa armigera)* insect pest. In addition *Pseudomonas* rhizobacteria have been reported to stimulate plant growth under different condition in vitro (Saravanakumar and Samiyappan, 2007). Similar to this Williams and Asher (1996), demonstrated that *Pseudomonas* spp. significantly improved the emergence and proportion of healthy seedlings in sugar beet when compared with untreated seeds. Further, Vivekananthan *et al.* (2004) reported that application of *P. fluorescens* increased the fruit yield in mango. Similar to previous findings, the current study also documented the reduced bollworm infestation and increased the seed cotton yield in plots treated with *P. fluorescens.* Our study revealed that the bio inoculants had a significant influence on bollworms reduction and high yield in cotton and can be best utilized for cotton IPM programmes. Further, PGPR showed more consistent improvements of cotton, highlighting the importance of inoculant selection as reported by Araújo *et al.* (2018).

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