JBiopest 12(2): 224-231 (2019)

Impact of biofertilizers and biopesticides on the growth and yield of Jasmine (*Jasminum sambac* L.)

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ABSTRACT

Jasmine (*Jasminum sambac* L.), one of the most important fragrant flowers widely cultivated in India, is seriously damaged by numerous insect pests. To devise a suitable Integrated Pest Management (IPM) module, a study using biofertilizers and biopesticides separately and in combination was conducted in two-year-old jasmine plants in a field at Seeragampatty village during September 2017 to February 2018. The experiment was set up in Randomized Block Design (RBD) with nine treatments for both biofertilizers and biopesticides with three replications. The results strongly endorse the integrative approach for the optimum growth and yield of jasmine plants which was produced by the combined inoculation of *Azospirillum* sp. and *Phosphobacterium* sp. along with vermicompost. The infestation of budworms, red mites and white flies were reduced with the application of biopesticides (*Trichoderma* sp., *Bacillus* sp. and *Paecilomyces* sp.) in combination with biofertilizers. It was also found that there was no infestation of budworms during November 2017 and January 2018, and that of red mites in November 2017. The population of white flies was fluctuating throughout the study period. From the findings of present investigation, it has been concluded that the amalgamation of suitable biofertilizers and biopesticides managed the insect pests in a better way and increased the growth and yield of jasmine.

Keywords: Jasmine, Biofertilizers, Biopesticides, Growth, Yield, IPM.

MS History: 09.09.2019 (Received) - 17.09.2019 (Revised) - 18.10.2019 (Accepted).

Citation: Murugan, A. and Ravi, C. 2019. Impact of bio fertilizers and biopesticides on the growth and yield of Jasmine (Jasminumsambac L.). *Journal of Biopesticides,* **12**(2): 224-231.

INTRODUCTION

Biopesticides have been reported to be effective in managing the insect pests, when used as a component of the Integrated Pest Management (IPM) programme. They have been gaining increased attention and interest among those concerned with developing strategies for environment friendly, safe and Integrated Crop Management (ICM) which include compatible approaches and tactics for pest management (Copping and Menn, 2000). In recent times, biofertilizers have emerged as a supplement to mineral fertilizers and hold a promise to improve the yield as well as quality of the crop (Diwivedi *et al*., 2018). Common biofertilizers used in horticultural crops are *Azospirillum* sp., *Phosphobacterium* sp., *Azotobacter* sp. and Vesicular Arbuscular Mycorrhiza (VAM) fungi. *Azospirillum* is a symbiotic N fixing bacterium when inoculated to plants, helps reduce the application of N fertilizers to an extent of 20-25 percentage. Similarly, *Phosphobacterium* is capable of mobilizing nutritive elements like non usable P in to plant usable P through biological processes (Kumar, 2015). In India, jasmine is predominantly cultivated in the states of Tamil Nadu, Karnataka and West Bengal. Jasmine has been cultivated in 8000 ha across the nation with an annual flower production worth Rs. 80 to 100 million (Diwivedi *et al*., 2018). In India, Tamil Nadu has the largest area under jasmine cultivation followed by Karnataka, which together accounts for 98 per cent of the total cultivated area (Ambika, 2012). Jasmine is attacked by around 50 insect pests belonging to more than eight orders harbouring varied microhabitats of jasmine plants (Hemalatha, 2009). The most devastating among them are

budworm (*Hendecasis duplifascialis* Hampson), whiteflies (*Dialeurodes kirkaldyi* Kotinsky), and red spider mite (*Tetranychus* sp.) as stated by Kamala and Kennedy (2017). Severe incidence of budworms reduces the size of the flower buds and imparts dull coloration, which eventually brings down their market value (Roopini *et al*., 2016). In case of severe infestation of mites, the whole plant becomes pale and affect the production and size of the flower buds (Martinez-Ferrer *et al*., 2006). Whitefly causes serious damage to the foliage thereby minimisting the vitality of the plant (Neelima, 2005). Keeping the above facts in mind, the present research work has been carried out to evaluate the efficacy of individual and combined impact of biofertilizers (*Azospirillum*, *Phosphobacterium* and Vermicompost) and biopesticides (*Trichoderma viride*, *Bacillus thuringiensis* and *Paecilomyces lilacinus*) on the insect pest populations such as bud worm, red mites and white flies and the subsequent growth and yield of *Jasminum sambac* for six months from September 2017 to February 2018 at field conditions.

MATERIALS AND METHODS

Experimental site

The present investigation was carried out in cultivated jasmine (*Jasminum sambac*) field at Seeragampatty village (10º 16' 55" N latitude and 77º 85' 25" E longitude) of Dindigul district, Tamil Nadu, Southern India, during September 2017 to February 2018. The altitude of the study area is about 320 m above mean sea level.

Methodology

The field experiment was conducted in completely Randomized Block Design (RBD) method with three replications. The experiments were conducted separately for biofertilizers and biopesticides respectively. In the biopesticides category, there were nine treatments such as: E_0 (untreated control), E_1 (*Trichoderma viride* - 20 g), E_2 (*Bacillus thuringiensis* 0.5 ml), E_3 (*Paecilomyces lilacinus* 20 g), E_4 (*Trichoderma viride* 10 g + *Bacillus thuringiensis* 0.5 ml), E_5 (*Trichoderma viride* 10 g + *Paecilomyces lilacinus* 10 g), E_6 (*Bacillus thuringiensis* 0.5 ml + *Paecilomyces lilacinus* 10 g), E_7 (*Trichoderma viride* 10 g + *Bacillus thuringiensis* 0.5 ml + *Paecilomyces lilacinus* 10 g), E_8 (E_7 + *Azospirillum* 10 g + *Phosphobacterium* 10 g + Vermicompost 10 g) and E_9 (E_7 + Factomfos 10 g) respectively. Similarly in the biofertilizers category also, there were nine treatments as follows: T_0 (untreated control), T_1 (*Azospirillum* 20 g), T_2 (*Phosphobacterium* 20 g), T_3 (Vermicompost 20 g), T_4 (*Azospirillum* 10 g + *Phosphobacterium* 10 g), T_5 (*Azospirillum* 10 g + Vermicompost 10 g), T_6 (*Phosphobacterium* 10 g + Vermicompost 10 g), T_7 (*Azospirillum* 7 g + *Phosphobacterium* 7 g + Vermicompost 7 g), T_8 (*Azospirillum* 7 g + *Phosphobacterium* 7 g + Vermicompost 7 g + Triazophos 0.5 ml) and T_9 (Triazophos 0.5 ml + Factamfos 20 g) respectively.

Growth and yield parameters of jasmine

The growth parameters of jasmine plant such as number of branches and shoot length (cm) and yield parameters such as flower yield (kg), length of flower (cm) and damaged buds (kg) respectively were studied.

Population of the major insect pests of jasmine

The incidence of major insect pests of jasmine *viz*., budworm (*H. duplifascialis* Hampson), red mites (*Tetranychus* sp.) and whiteflies (*D. kirkaldyi* Kotinsky) was also noted and recorded during the investigation period.

Statistical analysis

The treatment means were compared by Duncan Multiple Range Test (DMRT) using SPSS package

RESULTS AND DISCUSSION

Number of branches and shoot length

From the obtained results, it was found that the combined inoculation of biopesticides and biofertilizers promoted the development of branches in all the experimental categories when compared to the untreated control (table 1). Statistically significant (0.001 level) increase in number of branches was observed in E_8 and T_7 for the biopesticides and biofertilizers category respectively. E_8 and T_7 recorded maximum numbers of branches (337.0 and 361.30 respectively) during

October 2017. The jasmine plants treated with biopesticides and biofertilizers also improved the shoot length of jasmine plants. In biopesticides category, maximum shoot length was observed in E_8 (96.30 cm) and for biofertilizers category, it was T_7 (98.40 cm) and it was statistically significant (0.001 level) over the other treatments (table 2). From the obtained results, it was found that the combined inoculation of biopesticides and biofertilizers promoted the development of branches and increased the shoot length. The increase in number of branches was due to beneficial effect of macronutrients already present in the soil, in addition to that, it was also supplied by the microbes present in the inoculums through N fixation and Phosphate solublization, as reported by Satish (1999) and Qasim *et al*. (2003) in *J. sambac*. The inclusive results of the current research work strongly endorses the integrative approach for the overall growth and yield of jasmine by *Azospirillum* and *Phosphobacterium* along with vermicompost and biopesticides like *Trichoderma viride*, *Bacillus thuringiensis* and *Paecilomyces lilacinus*. It was also revealed that better vegetative growth and more productive shoots appeared due to the application of biofertilizers and biopesticides. The results of present investigation coincide with the research work carried out in lily by Gupta *et al*. (2013) and in chrysanthemum by Palagani *et al*. (2013). This phenomenon was also supported by the research evidences of Sujatha *et al.* (2009) and Jennoah (2012) in *J. sambac*.

Table 1. Bioefficacy of biopesticides (I) and biofertilizers (II) on no. of branches in jasmine

T.No	September		October		November		December		January		February	
	I	II	I	II	I	II	I	II	I	II	I	II
T_0/ E_0	224.70^{i}	261.00^{e}	233.30^{g}	251.30^{g}	231.70^{f}	235.70^{de}	238.00^{f}	241.70^{f}	237.662^{a}	229.66^{de}	234.66^{g}	230.00^{f}
T_1/ E_1	262.00^{g}	318.30^{b}	264.30^{ef}	309.00^{cde}	249.00^{e}	252.00^{cd}	249.00^{f}	253.00^{e}	313.33^{a}	241.33^{d}	249.00^{ef}	279.00^{bc}
T_2/ E_2	293.00^{de}	276.70^{d}	299.70^{cd}	273.00^{fg}	282.30^{bc}	227.70^{e}	287.70^{bc}	229.30^{g}	284.66^{a}	214.00^{f}	263.33^{d}	251.00^{e}
T_3 E_3	273.00^{f}	314.30^{bc}	280.30^{de}	320.00^{bcd}	263.30^{d}	263.00^{bc}	270.60^{d}	266.00^{d}	279.33^{a}	259.33^{c}	254.00^{e}	277.66^{cd}
T_4/ E_4	309.30^{bc}	302.00^{c}	312.70^{bc}	303.30^{de}	279.70^{bc}	242.00^{de}	288.30^{bc}	250.00^{e}	282.10^{a}	234.00	278.00^{b}	276.00^{cd}
T_5/ E_5	283.80^{ef}	342.00^{a}	295.70^{cd}	344.30^{ab}	277.70^{c}	282.00^{a}	279.60^{cd}	284.70^{b}	277.66^{a}	281.33^{ab}	260.66^{d}	287.33^{ab}
T_6/ E_6	302.00^{cd}	334.70^{a}	310.30^{bc}	334.30^{bc}	286.70^{abc}	275.00^{ab}	283.30^{bc}	275.70^{c}	285.66^{a}	273.00^{b}	271.00^{c}	284.66^{abc}
T_7/ E_7	322.00^{ab}	348.70^{a}	327.70^{ab}	361.30^{a}	293.70^{ab}	286.00^{a}	293.00^{b}	293.00^{a}	280.66^{a}	291.66^{a}	280.00^{b}	293.33^{a}
T_8/ E_8	328.70^{a}	288.00^{d}	337.00^{a}	293.30^{def}	300.00^{a}	239.70^{de}	303.60^{a}	238.00^{f}	295.66^{a}	229.66^{de}	291.66^{a}	269.00^{d}
T_9/ E_9	245.00^{h}	263.76^{d}	255.30^{f}	284.30^{ef}	239.00^{ef}	233.00^{e}	251.70^{e}	240.70^{f}	244.66^{a}	227.66^{e}	243.33^{f}	259.33^{e}
$F_{9, 29}$	77.82***	61.52***	50.35***	31.60***	51.42***	30.69***	78.58***	177.54***	1.01NS	87.09***	124.78***	79.47***

Significance level @ 0.05* 0.01** 0.001*** or less NS- Not Significant

Table 2. Bioefficacy of biopesticides (I) and biofertilizers (II) on shoot length (cm) of jasmine

T.No	September		October		November		December		January		February	
	I	II	I	II	I	II	I	II	I	II	I	II
T_0/ E_0	57.60^{e}	72.50^{e}	63.36^{d}	73.20^{e}	70.80^{d}	71.50^{g}	70.20^{d}	71.50^{h}	65.66	60.16^{e}	70.10^{g}	68.76^{c}
T_1/ E_1	60.90^{de}	89.10^{a}	87.40^{bc}	89.00^{bcd}	87.60^{c}	90.60^{cd}	86.20^{c}	90.90^{c}	88.13^{bc}	85.73^{c}	84.00^{e}	87.23^{b}
T_2/ E_2	68.90^{c}	81.30^{b}	88.80^{ab}	82.50^{e}	89.20^{bc}	82.40^{f}	90.30^{bc}	83.30^{g}	90.06^{ab}	87.60^{bc}	85.90^{cde}	85.10^{b}
T_3 E_3	61.90^{de}	89.70^{a}	87.70^{bc}	89.90^{abcd}	87.70^{c}	92.40^{c}	88.50^{bc}	93.10^{c}	88.30^{bc}	87.36^{bc}	84.66^{de}	87.40^{b}
T_4/ E_4	77.40^{b}	89.00^{a}	90.30^{ab}	88.50^{cd}	92.00^{ab}	89.80^{d}	90.60^{bc}	89.80^{cd}	89.93^{b}	87.56^{bc}	87.53^{bc}	86.56^{b}
T_5/ E_5	66.20^{c}	93.20^{a}	88.30^{bc}	93.96^{a}	89.40^{bc}	97.20^{a}	92.30^{ab}	97.80^{a}	90.80^{ab}	89.02 ^{ab}	85.83^{cde}	90.06^{ab}
T_6/ E_6	69.90^{c}	91.80^{a}	89.90^{ab}	92.10^{abc}	91.90^{ab}	95.10^{b}	92.80^{ab}	95.40^{b}	91.36^{ab}	89.83^{ab}	86.96^{cd}	89.90^{ab}
T_7/ E_7	89.50^{a}	93.90^{a}	90.60^{ab}	93.16^{ab}	94.20^{a}	97.60^{a}	93.10^{ab}	98.40^{a}	91.90^{ab}	89.83^{ab}	89.36^{b}	92.46^{a}
T_8/ E_8	90.60^{a}	88.70^{a}	92.43^{a}	87.60^{cd}	95.50^{a}	88.55^{de}	96.30^{a}	88.70^{e}	95.13^{a}	91.53^{a}	93.20^{a}	86.10^{b}
T_9/ E_9	59.00^{e}	87.80^{a}	86.20^{c}	86.70^{d}	86.10^{c}	87.40^{e}	86.50^{c}	87.10^{f}	84.40^{c}	81.16^{c}	80.50^{f}	85.63^{b}
$F_{9, 29}$	56.95***	18.10***	94.58***	37.28***	71.61***	224.45***	52.25***	498.45***	55.53***	223.22NS	122.63***	35.39***

Significance level @ 0.05* 0.01** 0.001*** or less NS- Not Significant

Yield parameters

The results of flower yield was superior and statistically significant (0.001 level) in E_8 when compared to the other treatments and was much more during September 2017 (260.66 g). Yield of flowers was significantly influenced by the biofertilizers and statistically high yield was obtained in T_7 (295.70 g) and the results have been presented in table 3. It was evident from the data that in EI, maximum flower length (2.3 cm) was achieved by plants of E_8 during October 2017. In EII, the plants of T_7 displayed maximum (2.6 cm) length of flower during the same month (table 4) and the results are significant at 0.001 level. The findings of EI and EII (table 5) revealed that the untreated plants (E_0 and T_0) yielded more quantity of damaged buds. Maximum damaged buds were obtained during February 2018 (21.00 g and 40.66 g for E_0 and T_0 respectively).

The increase in flower yield with the application of both biopesticides and biofertilizers may be due to increased flower size which is a major contributing factor to flower yield. The flower yield also increased as a result of reduction in insect population due to the application of biopesticides as reported by Harini *et al.* (2018). The pest population in untreated control was high which resulted in low flower yield. Among the growth and yield parameters investigated, the plants belonged to T_0 (untreated control) yielded inferior results when compared with others and this reduction may be due to lack of essential nutrients for the vital metabolic activities related to plant growth (Chamakumari *et al*., 2017). The research work carried by Sumangala (1997) in *J. sambac* has clearly indicated that biofertilizers increased the leaf area which helped to obtain more yield as it formed the site of photosynthetic system.

Incidence of major insect pests

From the findings of present investigation, it was found out that a moderate to heavy population of budworms was observed during the beginning stage of the current study, i.e. in September and October 2017, however, no budworm was observed during January 2018 irrespective of the treatments. Maximum population of budworms might be due to more number of buds resulting in multiplication of pests. During heavy rains (November to January), the population was decreased and this decline was mainly due to the decrease in number of buds per plant. In EI, statistically significant (0.001 level) less population (0.30) of budworms during December 2017 was observed in E_7 and among EII, plants treated with *Azospirillum* alone (T_1) showed minimum population (1.30) in November 2017. In both the experiments, the untreated plants (E_0 and T_0) had more population of budworms (68.30 and 69.30 respectively), during October 2017 (Table 6). These results corroborate with the findings of Vanitha (2001), who also along with Hemalatha (2009) reported maximum budworm infestation during September in Jasmine. On the other hand, the results of Amutha (1994) revealed that the budworms are prevalent throughout the year, which might be due to climatic variations present in that region and the suitability of crop for pest multiplication.

From the obtained data, it was noted that the number of red mites was high in E_9 (74.30) during September 2017. Surprisingly no red mites were observed in all the treatments including the control during November 2017. Thereafter, the population significantly increased with the increase of flower buds irrespective of the treatments (Table 7). Neelima (2005) have reported that *Tetranychus* sp. infest the leaves of *J. sambac* to the maximum during May and minimum during April. She also documented that no infestation was found during July and March. The observations made in current work contradicted with the above findings, wherein the red mite population was very less and not found in October and November respectively. It may be due to the climatic and edaphic factors prevalent in the study site.

Maximum population (103.0) of white fly was observed in E_0 treatment of EI during October 2017 and minimum population (1.66) was noted in T_8 plants of EII during January

Table 3. Bioefficacy of biopesticides (I) and biofertilizers (II) on flower yield (kg) of jasmine

T. No.	September		October		November		December		January		February	
	I	II	I	II	I	II	I	II	I	II	I	II
T_0/ E_0	192.00^{e}	133.70^{g}	8.70^{h}	103.00^{e}	0.00^{c}	0.00^{c}	0.09^{e}	0.18^{e}	0.00	0.00	70.33^{f}	103.33^{e}
T_1/ E_1	203.00^{de}	232.00^{bc}	14.70^{fgh}	36.00^{cd}	0.00^{c}	1.70^{c}	0.22^{cd}	0.46^{bc}	0.00	0.00	103.33^{e}	251.66^{c}
T_2/ E_2	223.30^{c}	186.30^{f}	23.30^{cde}	27.30^{d}	0.00^{c}	0.00^{c}	0.31^{b}	0.33^{d}	0.00	0.00	134.66^{d}	235.66^{d}
T_3 E_3	204.30^{de}	236.70^{b}	17.00^{ef}	38.30^{bcd}	0.00^{c}	3.70^{c}	0.25^{bcd}	0.48^{b}	0.00	0.00	109.66^{e}	267.33^{b}
T_4/ E_4	240.30^{b}	223.70^{bcd}	30.30^{c}	32.00^{d}	4.00^{bc}	1.00^{c}	0.30^{bc}	0.40^{cd}	0.00	0.00	172.00^{c}	243.66^{cd}
T_5/ E_5	215.00^{cd}	292.00^{a}	22.00^{def}	47.60^{ab}	0.00^{c}	12.70^{ab}	0.28^{bcd}	0.63^{a}	0.00	0.00	116.66^{e}	281.33^{a}
T_6/ E_6	222.00^{c}	273.70^{a}	26.30^{cd}	45.00^{bc}	4.30^{bc}	8.30^{bc}	0.29^{bcd}	0.52^{b}	0.00	0.00	136.66^{d}	280.00^{a}
T_7/ E_7	260.30^{a}	295.70^{a}	40.00^{b}	66.70^{a}	5.70^{ab}	18.70^{a}	0.47^{a}	0.68^{a}	0.00	0.00	191.66^{b}	286.00^{a}
T_8/ E_8	260.66^{a}	205.30^{cd}	52.00^{a}	32.30^{d}	10.00^{a}	0.00^{c}	0.50^{a}	0.37^{d}	0.00	0.00	226.20^{a}	239.33^{cd}
T_9/ E_9	202.00^{de}	201.30^{ef}	12.30^{gh}	28.30^{d}	0.00^{c}	0.00^{c}	0.20^{d}	0.40^{cd}	0.00	0.00	102.33^{e}	243.66^{cd}
$F_{9, 29}$	61.05***	63.84***	57.71***	26.84***	9.67***	13.96***	40.21***	69.33***	0.00***	0.00***	166.76***	297.12***

Significance level @ 0.05* 0.01** 0.001*** or less NS- Not Significant

Table 4. Bioefficacy of biopesticides (I) and biofertilizers (II) on damaged buds (kg) of jasmine

T.No.	September		October		November		December		January		February	
	I	II	I	II	I	II	I	II	I	II	I	II
T_0/ E_0	17.60^{a}	31.30^{a}	17.70^{ab}	25.30^{a}	0.00^{b}	0.00	0.43^{a}	0.43^{a}	0.00	0.00	21.00^{a}	40.66^{a}
T_1/ E_1	16.70^{a}	24.70^{abc}	18.30^{a}	21.00^{a}	0.30^{b}	0.00	0.11^{a}	0.12^{a}	0.00	0.00	19.66^{a}	29.33^{c}
T_2/ E_2	13.00^{abc}	31.00^{a}	15.70^{abc}	26.00^{a}	0.00^{b}	0.60	0.50^{a}	0.38^{a}	0.00	0.00	18.66^{a}	41.33^{a}
T_3 E_3	16.00^{ab}	23.30^{bc}	16.70^{ab}	19.30^{a}	0.00^{b}	0.00	0.10^{a}	0.11^{a}	0.00	0.00	19.66^{a}	27.00^{c}
T_4/ E_4	11.00^{cd}	25.00^{abc}	10.00^{c}	25.30^{a}	2.30^{a}	0.00	0.50^{a}	0.37^{a}	0.00	0.00	13.66^{bc}	29.33^{c}
T_5/ E_5	13.30^{abc}	21.30^{bc}	15.00^{abc}	15.30^{a}	0.00^{b}	0.00	0.70^{a}	0.10^{a}	0.00	0.00	18.33^{a}	29.33^{c}
T_6/ E_6	11.70^{bcd}	23.30^{bc}	13.00^{abc}	21.00^{a}	2.00^{ab}	0.00	0.46^{a}	0.80^{a}	0.00	0.00	17.00^{a}	26.00^{c}
T_7/ E_7	10.00^{cd}	18.70^{c}	12.70^{abc}	16.00^{a}	1.30^{ab}	0.00	0.50^{a}	0.60^{a}	0.00	0.00	9.66^{c}	29.00^{c}
T_8/ E_8	7.3.00^{d}	28.30^{ab}	11.30^{bc}	22.30^{a}	1.66^{ab}	0.00	0.37^{a}	0.30^{a}	0.00	0.00	9.66^{c}	28.33^{c}
T_9/ E_9	17.30^{a}	27.30^{ab}	18.30^{a}	24.30^{a}	0.00^{b}	0.00	0.11^{a}	0.90^{a}	0.00	0.00	20.66^{a}	34.66^{b}
$F_{9, 29}$	10.32***	6.97***	4.75**	2.34***	4.79***	.911**NS**	2.70**	2.88**	0.00***	0.00***	18.70***	23.01***

Significance level @ 0.05* 0.01** 0.001*** or less NS- Not Significant

Table 5. Bioefficacy of biopesticides (I) and biofertilizers (II) on flower length (cm) of jasmine

T.No.	September		October		November		December		January		February	
	I	II	I	II	I	II	I	II	I	II	I	II
T_0/ E_0	1.23^{d}	1.60^{c}	0.60^{c}	0.70^{c}	0.00^{a}	0.00^{a}	1.10^{e}	1.20^{cde}	0.00	0.00	1.53^{c}	1.43^{e}
T_1/ E_1	1.56^{cd}	2.10^{abc}	0.60^{c}	1.80^{a}	2.30^{a}	0.00^{a}	1.30^{bc}	1.40^{bc}	0.00	0.00	1.73^{bc}	1.93^{bc}
T_2/ E_2	1.80^{bc}	1.90^{bc}	0.80^{bc}	0.80^{c}	0.00^{a}	0.00^{a}	1.30^{bc}	1.03^{e}	0.00	0.00	1.90^{ab}	1.50^{e}
T_3 E_3	1.70^{bcd}	2.16^{ab}	0.70^{c}	1.70^{ab}	0.00^{a}	0.00^{a}	1.40^{ab}	1.57^{ab}	0.00	0.00	1.80^{abc}	1.90^{bc}
T_4/ E_4	2.03^{ab}	1.90^{bc}	1.20^{b}	1.90^{a}	2.30^{a}	0.00^{a}	1.40^{ab}	1.36^{bc}	0.00	0.00	2.03^{a}	1.73^{cd}
T_5/ E_5	1.50^{cd}	2.50^{a}	0.80^{bc}	1.90^{a}	0.00^{a}	0.30^{a}	1.30^{bc}	1.63^{a}	0.00	0.00	1.80^{abc}	2.03^{ab}
T_6/ E_6	1.80^{bc}	2.23^{ab}	1.16^{b}	1.86^{a}	2.01^{a}	0.20^{a}	1.53^{ab}	1.70^{a}	0.00	0.00	1.93^{ab}	1.93^{bc}
T_7/ E_7	2.03^{ab}	2.63^{a}	1.70^{a}	2.00^{a}	0.00^{a}	0.26^{a}	1.47^{ab}	1.70^{a}	0.00	0.00	2.06^{a}	2.20^{a}
T_8/ E_8	2.30^{a}	1.90^{bc}	1.70^{a}	1.40^{b}	1.30^{a}	0.13^{a}	1.60^{a}	1.30^{cd}	0.00	0.00	2.06^{a}	1.60^{de}
T_9/ E_9	1.30^{d}	1.80^{bc}	0.70^{c}	1.00^{c}	0.00^{a}	0.00^{a}	1.30^{bc}	1.10^{de}	0.00	0.00	1.73^{bc}	1.63^{de}
$F_{9, 29}$	12.69***	8.02***	16.66***	32.92***	4.67***	3.39***	7.14***	2.51***	0.00***	0.00***	8.29***	23.15***

Significance level @ 0.05* 0.01** 0.001*** or less NS- Not Significant

Table6. Bioefficacy of biopesticides (I) and biofertilizers (II) on budworm population in jasmine

T.No.	September		October		November		December		January		February	
	I	II	I	II	I	II	I	II	I	II	I	II
T_0/ E_0	38.00^{a}	33.70^{a}	68.30^{a}	69.30^{a}	0.00^{b}	0.00^{b}	1.70^{b}	1.70^{a}	0.00	0.00	29.00^{a}	43.70^{a}
T_1/ E_1	30.70^{ab}	11.70^{bcd}	65.30^{ab}	58.30^{a}	0.00^{b}	1.30^{b}	1.70^{b}	1.70^{a}	0.00	0.00	16.70^{b}	14.00^{de}
T_2/ E_2	31.70^{ab}	20.70^{abc}	64.70^{ab}	51.30^{a}	0.00^{b}	0.00^{b}	1.30^{b}	2.70^{a}	0.00	0.00	13.70^{dc}	26.30^{b}
T_3 E_3	19.70^{b}	18.30^{abcd}	54.70^{ab}	49.70^{a}	0.00^{b}	0.00^{b}	1.00^{b}	1.70^{a}	0.00	0.00	12.00^{bcd}	12.30^{de}
T_4/ E_4	23.30^{b}	10.70^{bcd}	55.30^{abc}	55.70^{a}	8.30^{a}	0.00^{b}	5..00^{a}	2.30^{a}	0.00	0.00	6.00c^{de}	14.30^{de}
T_5/ E_5	28.30^{ab}	3.70^{d}	54.30^{abc}	56.00^{a}	0.00^{b}	15.70^{a}	0.00^{b}	1.70^{a}	0.00	0.00	12.00^{bcd}	6.30^{e}
T_6/ E_6	29.70^{ab}	3.30^{d}	60.70^{abc}	57.00^{a}	5.00^{ab}	4.70^{b}	1.00^{b}	2.00^{a}	0.00	0.00	9.70^{bcde}	6.00^{e}
T_7/ E_7	22.70^{b}	5.00^{cd}	45.00^{bc}	48.00^{a}	8.00^{a}	19.30^{a}	0.30^{b}	1.30^{a}	0.00	0.00	4.33^{de}	7.30^{e}
T_8/ E_8	23.00^{b}	21.30^{abc}	44.00^{c}	50.00^{a}	6.70^{ab}	0.00^{b}	0.70^{b}	1.30^{a}	0.00	0.00	4.00^{e}	18.00^{cd}
T_9/ E_9	27.70^{ab}	24.30^{ab}	59.70^{abc}	53.00^{a}	0.00^{b}	0.00^{b}	1.00^{b}	2.00^{a}	0.00	0.00	28.30^{a}	23.00^{bc}
$F_{9, 29}$	5.00***	7.88***	3.81***	0.72***	6.22***	16.77***	4.02***	0.55***	0.00***	0.00***	28.01***	39.64***

Significance level @ 0.05* 0.01** 0.001*** or less NS- Not Significant

Table7. Bioefficacy of biopesticides (I) and biofertilizers(II) on red mite population in jasmine

T.No.	September		October		November		December		January		February	
	I	II	I	II	I	II	I	II	I	II	I	II
T_0/ E_0	66.30^{a}	32.00^{a}	2.70^{a}	10.70^{a}	0.00	0.00	3.00^{a}	1.30^{a}	37.30^{a}	33.30^{a}	34.60^{a}	25.30^{a}
T_1/ E_1	47.30^{ab}	5.70^{b}	1.00^{a}	0.00^{b}	0.00	0.00	0.00^{a}	0.30^{a}	32.00^{ab}	13.60^{cd}	31.70^{ab}	14.70^{bc}
T_2/ E_2	10.70^{b}	7.30^{b}	0.00^{a}	0.30^{b}	0.00	0.00	1.30^{a}	0.00^{a}	32.00^{ab}	31.60^{a}	23.70^{bc}	25.70^{a}
T_3 E_3	6.70^{b}	2.30^{b}	0.70^{a}	0.00^{b}	0.00	0.00	0.70^{a}	0.30^{a}	24.00^{bc}	7.30^{de}	29.45^{ab}	14.70^{bc}
T_4/ E_4	7.00^{b}	2.20^{b}	0.00^{a}	0.00^{b}	0.00	0.00	0.00^{a}	0.30^{a}	11.30^{d}	17.70^{bc}	14.70^{de}	14.70^{bc}
T_5/ E_5	9.70^{b}	2.30^{b}	0.70^{a}	0.00^{b}	0.00	0.00	0.00^{a}	0.70^{a}	24.70^{bc}	3.30^{e}	25.70^{bc}	7.00^{c}
T_6/ E_6	9.00^{b}	2.30^{b}	0.70^{a}	0.00^{b}	0.00	0.00	0.70^{a}	1.00^{a}	21.33^{c}	5.70^{de}	19.00^{cd}	11.70^{bc}
T_7/ E_7	7.70^{b}	0.70^{b}	0.00^{a}	0.00^{b}	0.00	0.00	0.30^{a}	0.30^{a}	4.70^{d}	2.30^{e}	14.00^{de}	5.70^{c}
T_8/ E_8	7.70^{b}	8.00^{b}	0.00^{a}	0.00^{b}	0.00	0.00	0.00^{a}	2.00^{a}	3.00^{d}	23.30^{b}	7.70^{e}	6.30^{c}
T_9/ E_9	74.30^{a}	5.00^{b}	1.30^{a}	0.70^{b}	0.00	0.00	0.70^{a}	1.70^{a}	30.30^{ab}	23.00^{b}	31.70^{ab}	21.00^{ab}
$F_{9, 29}$	6.71***	25.54***	2.43***	4.47***	0.00***	0.00***	2.04***	1.74***	35.04***	34.98***	23.69***	10.29***

Significance level @ 0.05* 0.01** 0.001*** or less NS- Not Significant

Table 8. Bioefficacy of biopesticides (I) and biofertilizers (II) on whitefly population in jasmine

T.No.	September		October		November		December		January		February	
	I	II	I	II	I	II	I	II	I	II	I	II
T_0/ E_0	14.66^{a}	31.00^{a}	103.00^{a}	70.30^{a}	82.70^{a}	93.30^{a}	16.30^{c}	29.30^{a}	20.30^{a}	20.30^{ab}	42.70^{b}	31.00^{a}
T_1/ E_1	6.30^{ab}	7.00^{c}	86.00^{ab}	34.70^{b}	62.70^{ab}	68.30^{ab}	18.70^{bc}	23.30^{ab}	12.70^{ab}	11.70^{bca}	32.70^{abc}	15.00^{ad}
T_2/ E_2	4.00^{b}	20.70^{b}	63.70^{abcd}	38.00^{ab}	40.30^{bc}	88.30^{a}	31.30^{ab}	23.30^{ab}	12.00^{ab}	24.00^{a}	15.70^{de}	27.70^{ab}
T_3 E_3	4.00^{b}	6.70^{c}	80.30^{abc}	38.70^{ab}	60.00^{abc}	77.70^{ab}	29.30^{abc}	20.30^{ab}	6.70^{a}	4.7.00^{a}	26.00^{bcd}	11.30^{cd}
T_4/ E_4	3.70^{b}	11.00^{c}	52.70^{bcd}	50.00^{ab}	54.00^{abc}	75.70^{ab}	26.70^{abc}	20.70^{ab}	7.70^{b}	12.30^{bc}	10.00^{e}	17.70^{bc}
T_5/ E_5	3.70^{b}	7.3.00^{c}	74.00^{abcd}	34.00^{b}	65.30^{ab}	37.70^{c}	33.00^{a}	12.70^{ab}	20.70^{ab}	3.30^{cd}	23.30^{cd}	9.70^{cd}
T_6/ E_6	3.00^{b}	9.00^{c}	55.70^{bcd}	43.70^{ab}	52.00^{abc}	54.00^{bc}	29.30^{abc}	21.70^{ab}	7.70^{b}	4.30^{cd}	11.70^{e}	10.70^{cd}
T_7/ E_7	3.00^{b}	7.70^{c}	43.60^{cd}	44.00^{ab}	35.00^{bc}	75.30^{ab}	22.00^{abc}	20.70^{ab}	12.00^{ab}	1.66^{d}	10.00^{e}	21.00^{abc}
T_8/ E_8	4.00^{b}	5.70^{c}	35.00^{d}	26.30^{b}	24.30^{c}	10.00^{bc}	17.30^{c}	10.00^{c}	2.30^{b}	15.00^{ab}	7.00^{e}	6.00^{cd}
T_9/ E_9	15.30^{a}	27.00^{ab}	74.00^{abcd}	51.30^{ab}	64.00^{ab}	80.00^{ab}	36.00^{a}	22.30^{ab}	13.00^{ab}	17.30^{ab}	36.70^{ab}	28.00^{ab}
$F_{9, 29}$	4.52***	18.89***	6.12***	2.90***	4.79***	7.82***	5.93***	2.42***	8.06***	12.59***	23.74***	13.06***

Significance level @ 0.05* 0.01** 0.001*** or less NS- Not Significant

2018 (Table 8) which evidenced the ability of biopesticides in controlling the white flies. The results of present investigation revealed that the combined inoculation of biofertilizers along with Triazophos (T_8 of EII) proved highly effective against whiteflies. Neelima (2005) stated that Triazophos was very effective in controlling whitefly population in jasmine and it was on par with the findings of present study. The data on major insect pest population indicated that the chemical pesticide treatments (T_9) were slightly superior over untreated check (T_0). This might be due to the efficacy of inorganic pesticides on reduction of the population of major insect pest by their capability of penetrating the parts where the insect pests habiting and affect them (Osborne *et al*., 2001). It has been concluded that the combined inoculation of biofertilizers and biopesticides with organic fertilizers like vermicompost are more effective and would be a suitable IPM module for the reduction of insect pest population, better growth and yield of jasmine.

Acknowledgement

The authors are thankful to the authorities of Thiagarajar College, Madurai for the institutional facilities.

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