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Impact of IPM and non-IPM practices on pest complex and natural enemies of tuberose (*Polianthes tuberosa* L.) pests

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Abstract
Studies on the influence of IPM and non-IPM practices were carried out during *Rabi*, 2022-23 at Dr YSRHU- College of Horticulture, Venkataramannagudem, West Godavari District, Andhra Pradesh with an objective of examining their influence on pest complex and natural enemies of tuberose pests.
Studies on integrated pest management of tuberose showed that, the mean population of mealybug/ plant in IPM plot (43.59±31.63) was less compared to that of non-IPM plot (49.58±34.39) and control plot (79.48±48.45) number per plant. Significantly less mean larval population of *H. armigera* was recorded in IPM plot (0.46±0.67) followed by non-IPM plot (0.60±0.84) and control (0.96±1.25). The lowest mean population of red spider mite was observed in IPM (3.36±2.45) compared to non-IPM (5.09±3.54) and control (6.54±4.33). Highest number of natural enemies were recorded in IPM plot (12.29±7.48/ plant) followed by control (8.58±5.23) and non-IPM (3.38±2.39).

Keywords: IPM, non-IPM, pest complex, natural enemies, tuberose, *Polianthes tuberosa* L.

Introduction
Tuberose, *Polianthes tuberosa* L. (Amaryllidaceae) is a bulbous ornamental plant, admired for its flower spikes which carries numerous tubular blooms rich in fragrance. Tuberose is a tropical bulbous semi-hardy perennial. Scales and leaf bases make up bulbs, while stems are hidden inside them. The leaves are long grass-like foliage, linear and bright to dark green in colour, with an adventitious and shallow root system. Around 25±10 pairs of florets open acropetally on a tuberose inflorescence (spike) i.e., from base to top of the spike. Tuberose gets its name Polianthes from the Greek word's "*polios*" (shiny or white) and "*anthos*" (flower). Due to its waxy composition, flowers have high keeping quality (Gorivale *et al*., 2020) [3]. In the commercial world, tuberose flowers are used for garland, religious and ceremonial purposes. As a loose flower, they are in great demand for making garlands and veni in Southern India. It is being used for worshipping, offerings in religious functions and auspicious days (Krishnamoorthy, 2014) [5]. Cut flowers for artistic garlands, floral ornamentals, bouquets and buttonholes are used in both household and social settings. It also has a lot of potential in the essential oil industry for perfume and cosmetics production. Crop fragrance has anti-insomnia, anti-flu and anti-rheumatism properties. Bulbs are rubbed with turmeric and butter and applied as a paste over the red pimples of infants.
Farmers are extensively using insecticides for controlling pest, which may lead to the endangerment of ecosystem. Further, extensive use of insecticides kills the natural enemies which causes outbreak of secondary pests. Indiscriminate use of toxic insecticides leads to increased problems because of their adverse effects on non-target organisms and pollution to environment. Problems like resistance, resurgence, residue and environmental safety have emerged due to continuous use of neuroactive chemical insecticides in pest management (Shitole *et al*., 2002) [10]. Developing an integrated pest management strategy can overcome the harmful effects of excessive use of chemical insecticides safeguarding the environment, nontarget organisms and protecting human health and reducing the costs by the farmers in purchasing the insecticides.

Material and Methods
The experiment was conducted at college farm, Dr. YSRHU - College of Horticulture, Venkataramannagudem to examine the influence of IPM, non-IPM and control practices on pest infestation and natural enemies of tuberose pests during *Rabi*, 2022-23.

Tuberose variety "Arka Prajwal" was sown in IPM, non-IPM and control plots of 6 m x 8 m with a spacing of 30 cm between rows and 30 cm between plants.

The schedule of IPM plot followed was:

1. Deep ploughing was done thoroughly with a tractor drawn cultivator and evenly levelled after removing all the stubbles and weeds.
2. Beds were prepared for the planting of tuberose.
3. Bulbs were planted on beds with the spacing of 30 cm x 30 cm.
4. Low-cost mulches *viz* coconut husk or paddy straw were placed in beds as mulch to conserve moisture, prevent the growth of weeds, inhibit the egg laying place of sucking pests like mealy bugs.
5. Cowpea seedlings were planted as trap crop in between rows to enhance the predators like *Coccinella*.
6. Maize was grown as border crop to prevent pest entry.
7. Installation of yellow and blue sticky traps were done at 15 days after planting of tuberose
8. Need based application of eco-friendly bio-pesticides (Neem oil 10,000 ppm @ 3 ml/lit) and other better performing pesticides were sprayed on sequential basis.

Non-IPM plot

In non-IPM plot of tuberose, application of chemicals was carried out on sequential basis as per the schedule given below

1. Spraying of Thiamethoxam 25 WG @ 2 ml/l.
2. Spraying of Chloropyriphos 50 EC @ 2 ml/l.
3. Spraying of Acephate @ 1.0 g/l.

Control plot

In control plot of tuberose, no chemical was applied in connection to pest control except agronomical practices.

All the three plots were monitored strictly following the pest scouting system. The damage caused by different pests were recorded by visual observation on ten randomly selected plants by counting the life stages of each pest. The observations on mealy bug were recorded on the basis of live mealy bug population on 10 plants randomly selected from the plot and the average mealybug population per plant was calculated. The mean population of *H. armigera* larvae was calculated by recording larval population from 10 randomly selected plants in each of the treatments. The count on the population of the two spotted red spider mite, *Tetranychus utricae* was recorded on three leaves each from top, middle, bottom canopy of each plant and the population was recorded on the three places on each leaf (top, middle, bottom) from 10 selected plants using 1 cm^2 window starting from 15 days after sowing till crop maturity and depicted as population per plant or unit area. Data was also recorded on natural enemy population of tuberose pests *viz*., syrphids, coccinellids (grubs and adults) and spiders at weekly intervals and taken as natural enemy count/plant and categorization was observed by sampling method.

Pest incidence and natural enemy population were recorded from 10 per cent of sampled plants in IPM, non-IPM and control plots of tuberose. The mean population of sucking pests and natural enemies in IPM plot was compared to that of non-IPM and control plots of tuberose and the data was then analyzed by using paired t-test method with SPSS 12.0 version pioneered by Gosset (1908) [4] and later on developed and extended by Prof. R. A. Fisher.

Results and Discussion

Evaluation of integrated pest management in tuberose variety Arka Prajwal was conducted *in-vivo* conditions from 19th December, 2022 to 30th July, 2023. The data on pest population and natural enemies were recorded in the IPM, Non-IPM and control plots of tuberose variety Arka Prajwal. The results on each insect are separately presented under respective headings.

Striped mealybug, *Ferrisia virgata*

The data shown in the table 1 and figure 1 revealed that the population of mealybug (*Ferrisia virgata*) on tuberose grown in IPM plot decreased over the non-IPM plot with respect to standard meteorological week (SMW). The mean population of mealybug was found to be 43.59±31.63 number per plant in IPM plot where as in non-IPM plot the population was 49.58±34.39 mealybug per plant, which was 12.08 per cent higher than the IPM plot. There was a significant difference in number of mealybugs per tuberose plant between IPM and non-IPM plots as per the t-statistical value depicted in the table 4. The pest population observed in control plot was 79.48±48.45 which had significantly higher pest population when compared to IPM and non-IPM plots and there is significant difference between IPM and control plots as per the t-statistical value given in the table 5. The reduction in mealybug population in IPM plot over non-IPM plot is mainly attributed to adoption of various IPM components namely, maize as border crop, and sequential spraying of botanicals *viz.*, Neem oil @ 3 ml/lt at fortnightly intervals, planting of cowpea in between rows as trap crop to enhance the predators like coccinellids and use of coconut husk and paddy straw placed in beds as mulch to conserve moisture, prevent the growth of weeds, inhibited the egg laying place for mealy bugs.

Bud borer, *Helicoverpa armigera*

The data presented in table 2 and fig. 2 reveals that the minimum mean larval population (*Helicoverpa armigera)* was recorded in IPM plot with 0.46±0.67 number per plant as compared to that of non-IPM plot (0.60±0.84). However, there exists a significant difference in bud borer population per tuberose plant between IPM and non-IPM plots as per the t-statistical value given in the table 2. The mean population of bud borer was found 0.96±1.25 number per plant in control plot. However, the larval population was significantly less in IPM and non-IPM plots when compared to control as per the t-statistical value given in the table 4 and 5. In the present investigation, the bud borer population build up was much lesser in the tuberose crop grown in IPM plot than in non-IPM plot which is in conformity with the reports made by Srinivas *et al*. (1997) [12]. Kumar and Krishnayya (1999) [6] also reported that Neem oil 1 per cent was found safe to the predatory coccinellid beetles and at the same time effective against *H. armigera* in groundnut. Srinivas *et al*. (1997) [12] adopted an integrated pest management approach for the control of *H. armigera* in tomato in Andhra Pradesh, India and revealed that the less population of *H. armigera* was found from IPM plot.

Red spider mite, *Tetranychus utricae*

From the table 3 and fig. 3 it is observed that the lowest mean population of red spider mite was observed in IPM (3.36±2.45) compared to non-IPM (5.09±3.54) and control plot (6.54±4.33). The mite population was significantly less in IPM and non-IPM plots when compared to control as per the t-statistical value given in the table 4 and 5. The border crop (maize) has effectively checked the entry of mites into the main plot and the left over population of mites was kept under threshold by sequential spraying of the botanicals which is in accordance with the findings of Tatagar *et al.* (2011) [14] who reported that chilli crop bordered with two rows of maize at every 0.5 acre area (31.2 x 60 sq m.) and spraying with 1 per cent Neemazal @ 2 ml/l at 7 Weeks After Transplanting resulted in minimum damage of mites (0.19 leaf curl index/plant) and found significantly superior to all other treatments and standard check. Further, Sruthi *et al.* (2018) [13] observed minimum incidence of mites in bio intensive module (application of neemcake, vermicompost and root dip with imidachloprid, sprays of azadirachtin, *Lecancillium lecanii*, *Pseudomonas fluorescens*, chilli-garlic extract).

Natural enemies (Syrphids, coccinellids and spiders)

Beneficial insects play an important role in natural pest control and pollination. The use of synthetic pesticides has detrimental effects to both natural enemies and pollinators in agricultural and horticultural fields. The pesticides affect the survival of a range of life cycle (grubs and adults) stages, reducing their reproductive capacity, changes in the suitability of hosts for parasitizing or predation, reduced emergence of parasitoids from sprayed host eggs and cause direct mortality. Hence, in the present study the impact of IPM and non-IPM practices on natural enemy population of tuberose pests *viz*., coccinellid beetles, syrphids and spiders were recorded in IPM, non-IPM and control plots are presented in table 6 and fig.4. Mean population of natural enemies were found to be 12.29±7.48 per plant in IPM plot, 8.58±5.23 in control plot and 3.38±2.39 in non-IPM plot. There was a significant difference in the population of natural enemies as per the t-statistical value in IPM, non-IPM and control plots (Table 7 and 8). The minimal or nil mortality of the natural enemies was recorded in IPM plot and moreover their population was sustained and increased in the IPM plot as suggested by Praveen and Dhandapani (2001) [8] and Dutta *et al.* (2017) [1] which was 1.33 times more than that of non-IPM plot of okra. Whereas, in the non-IPM plot due to sequential spraying of synthetic chemicals the natural enemy population was reduced due to contact and residual toxicity. Mishra and Mishra (2002) [7] and Rao and Raguraman (2005) [9] have also stated that natural enemy population was less in chemical treated plots than that of the plots sprayed with botanicals.

Table 1: Population of mealybugs in IPM, non-IPM and control plots of tuberose.

SMW	Mealybugs/ plant				
	IPM	**Non-IPM**	**Control**	**PR (%) in IPM over non-IPM**	**PR (%) of IPM over control**
51	0.00	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	5.24	7.12	11.48	26.40	54.36
4	6.21	7.84	22.82	20.79	72.79
5	20.77	27.46	42.12	24.36	50.69
6	23.36	25.65	51.38	8.93	54.53
7	29.21	32.54	63.17	10.23	53.76
8	34.85	35.87	72.61	2.84	52.00
9	40.12	45.47	88.39	11.77	54.61
10	45.9	50.31	95.32	8.77	51.85
11	64.71	77.50	103.69	16.50	37.59
12	72.81	82.56	116.98	11.81	37.76
13	81.78	84.45	128.26	3.16	36.24
14	83.09	85.34	135.78	2.64	38.81
15	87.20	91.27	152.21	4.46	42.71
16	90.40	95.12	164.00	4.96	44.88
17	92.32	100.34	152.56	7.99	39.49
18	80.08	91.47	128.54	12.45	37.70
19	78.36	86.64	123.42	9.56	36.51
20	73.10	82.21	108.45	11.08	32.60
21	75.38	90.50	114.33	16.71	34.07
22	70.86	87.53	105.71	19.04	32.97
23	59.42	64.06	100.42	7.24	40.83
24	45.04	60.32	95.24	25.33	52.71
25	32.12	44.92	89.25	28.50	64.01
26	28.72	36.74	80.39	21.83	64.27
27	25.84	35.95	75.24	28.12	65.66
28	23.96	28.45	60.89	15.78	60.65
29	18.20	20.57	42.37	11.52	57.05
30	5.98	8.46	18.63	29.31	67.90
Mean ± S. D	43.59±31.63	49.58±34.39	79.48±49.04	12.08	45.15

Stage of the crop: 52 SMW to 8 SMW (Vegetative phase), 9 SMW to 30 SMW (Flowering phase)

Table 2: Population of bud borer in IPM, non-IPM and control plots of tuberose.

SMW	No of larvae/ plant				
	IPM	Non-IPM	Control	PR (%) in IPM over non-IPM	PR (%) of IPM over control
51	0.00	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00
9	0.35	0.50	1.10	30.00	68.18
10	0.40	0.80	1.40	50.00	71.43
11	0.70	1.00	1.70	30.00	58.82
12	0.80	1.20	2.40	33.33	66.67
13	1.10	2.00	2.50	45.00	56.00
14	1.50	2.00	3.00	25.00	50.00
15	2.00	2.20	3.25	9.09	38.46
16	2.10	2.50	3.70	16.00	43.24
17	2.00	2.30	3.40	13.04	41.18
18	1.20	1.50	2.30	20.00	47.83
19	1.15	1.32	2.00	12.88	42.50
20	0.80	1.00	1.92	20.00	58.33
21	0.70	1.00	1.72	30.00	59.30
22	0.00	0.00	0.60	0.00	100.00
23	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00
Mean ±S. D	0.46±0.67	0.60±0.84	0.96±1.25	23.33	52.08

Stage of the crop: 52 SMW to 8 SMW (Vegetative phase), 9 SMW to 30 SMW (Flowering phase)

Table 3: Population of red spider mite in IPM, non-IPM and control plots of tuberose.

SMW	Number of mites/cm^2				
	IPM	Non-IPM	Control	PR (%) in IPM over non-IPM	PR (%) of IPM over control
51	0.00	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00
5	1.00	2.00	2.50	50.00	60.00
6	1.50	2.50	3.00	40.00	50.00
7	1.50	3.10	3.72	51.61	59.68
8	2.00	4.34	5.12	53.92	60.94
9	3.12	4.50	5.60	30.67	44.29
10	3.54	5.28	6.84	32.95	48.25
11	3.72	5.54	7.06	32.85	47.31
12	3.92	5.98	7.84	34.45	50.00
13	4.50	6.24	8.24	27.88	45.39
14	4.74	6.98	8.64	32.09	45.14
15	5.00	7.32	9.26	31.69	46.00
16	5.25	8.70	10.21	39.66	48.58
17	5.78	8.98	10.5	35.63	44.95
18	5.94	9.00	10.78	34.00	44.90
19	6.00	9.20	11.12	34.78	46.04
20	6.33	9.40	11.56	32.66	45.24
21	6.54	9.72	11.98	32.72	45.41
22	6.78	9.84	12.24	31.10	44.61
23	7.00	10.05	12.85	30.35	45.53

24	7.76	10.3	12.98	24.66	40.22
25	4.48	6.82	9.29	34.31	51.78
26	3.45	5.12	8.12	32.62	57.51
27	3.20	4.50	7.01	28.89	54.35
28	2.12	4.21	6.45	49.64	67.13
29	1.45	2.14	4.00	32.24	63.75
30	1.00	1.25	2.58	20.00	61.24
Mean ±S. D	3.36±2.45	5.09±3.54	6.54±4.33	33.98	48.62

Stage of the crop: 52 SMW to 8 SMW (Vegetative phase), 9 SMW to 30 SMW (Flowering phase)

Table 4: t-statistical values for testing of significance of pests of tuberose in IPM and non-IPM plots of tuberose.

Treatments	No. of mealybugs/ plant	No. of larvae/ plant	No. of mites/ cm^2
IPM (Mean ± S.D)	43.59±31.63	0.46±0.67	3.36±2.45
non-IPM (Mean ± S.D)	49.58±34.39	0.60±0.84	5.09±3.54
t cal.Value	6.89	3.76	8.47
t tab.Value	2.23	2.23	2.23
P value	0.0001 (Significant)	0.00000004 (Significant)	0.0000001 (Significant)

Table 5: t-statistical values for testing of significance of pests in IPM and control plots of tuberose.

Treatments	No. of mealybugs/ plant	No. of larvae/ plant	No. of mites/ cm^2
IPM (Mean ± S.D)	43.59±31.63	0.46±0.67	3.36±2.45
Control (Mean ± S.D)	79.48±49.04	0.96±1.25	6.54±4.33
t cal.Value	10.15	4.63	9.24
t tab.Value	2.13	2.23	2.23
P value	0.0000001 (Significant)	0.0008 (Significant)	0.0000003 (Significant)

Table 6: Population of natural enemies in IPM, non-IPM and control plots of tuberose.

SMW	Natural enemies/ plant													
	IPM				Non-IPM				Control				PI (%) in IPM over non-IPM	PI (%) of IPM over control
	Coccinellids	syrphids	Spiders	Total	Coccinellids	syrphids	Spiders	Total	Coccinellids	syrphids	Spiders	Total		
51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	1.00	0.00	0.54	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.36	1.06	100.00	31.17
5	1.50	1.60	0.96	4.06	0.28	0.20	0.24	0.72	0.92	1.06	0.64	2.62	82.27	35.47
6	3.20	1.86	1.29	6.35	0.43	0.35	0.45	1.23	2.08	1.24	0.86	4.18	80.63	34.17
7	3.50	2.50	1.56	7.56	0.50	0.42	0.70	1.62	2.34	1.78	1.04	5.16	78.57	31.75
8	4.00	3.00	1.86	8.86	0.60	0.50	0.86	1.96	2.60	2.04	1.24	5.88	77.88	33.63
9	4.40	4.00	2.00	10.40	0.70	0.68	0.96	2.34	2.96	3.25	1.46	7.67	77.50	26.25
10	4.70	6.20	2.24	13.14	0.90	0.75	1.06	2.71	3.15	4.31	1.64	9.10	79.38	30.75
11	5.20	6.50	2.56	14.26	1.00	0.90	1.25	3.15	3.47	4.58	2.00	10.05	77.91	29.52
12	5.56	6.80	2.70	15.06	1.20	1.00	1.54	3.74	3.70	4.86	2.34	10.9	75.17	27.62
13	5.80	7.20	3.45	16.45	1.25	1.06	1.62	3.93	3.92	5.09	2.70	11.71	76.11	28.81
14	6.40	7.50	3.80	17.70	1.40	1.30	1.70	4.40	4.26	5.32	3.23	12.81	75.14	27.63
15	6.84	8.30	4.20	19.34	1.50	1.45	1.84	4.79	4.58	5.70	3.59	13.87	75.23	28.28
16	8.64	8.70	4.64	21.98	1.70	1.60	1.92	5.22	5.76	6.52	4.20	16.48	76.25	25.02
17	8.00	9.20	4.92	22.12	1.80	1.74	2.00	5.54	5.42	6.13	3.88	15.43	74.95	30.24
18	7.86	8.45	5.30	21.61	2.00	1.80	2.10	5.90	5.24	5.94	3.54	14.72	72.70	31.88
19	7.60	8.20	5.10	20.90	2.00	1.94	2.38	6.32	5.10	5.75	3.38	14.23	69.76	31.91
20	7.32	8.00	4.85	20.17	2.20	2.00	2.50	6.70	4.88	5.62	3.23	13.73	66.78	31.93
21	6.98	7.98	4.60	19.56	2.40	2.25	2.74	7.39	4.65	5.44	3.02	13.11	62.22	32.98
22	6.80	7.82	4.30	18.92	2.20	2.10	2.48	6.78	4.53	5.32	2.87	12.72	64.16	32.77
23	6.40	7.65	3.74	17.79	2.15	1.98	2.30	6.43	4.32	5.21	2.60	12.13	63.86	31.82
24	6.20	7.42	3.50	17.12	2.10	1.86	2.06	6.02	4.09	5.10	2.48	11.67	64.84	31.83
25	6.00	7.10	3.20	16.30	1.90	1.74	1.60	5.24	3.92	4.95	2.26	11.13	67.85	31.72
26	5.75	6.80	3.00	15.55	1.75	1.54	1.43	4.72	4.20	4.71	2.15	11.06	69.65	28.87
27	5.60	6.48	2.50	14.58	1.50	1.4	1.21	4.11	3.83	4.53	2.00	10.36	71.81	28.94
28	5.45	6.30	1.46	13.21	1.42	1.16	0.75	3.33	3.67	4.39	0.97	9.03	74.79	31.64
29	4.70	5.34	1.60	11.64	1.20	0.94	0.45	2.59	3.15	3.56	0.40	7.11	75.66	33.18
30	4.0	3.20	1.20	8.40	0.90	0.40	0.24	1.54	2.86	3.28	0.80	6.94	81.67	17.38
Mean ± S.D	4.66±2.66	5.12±3.20	2.53±1.71	12.29±7.48	1.15±0.79	1.03±0.74	1.19±0.88	3.38±2.39	3.13±1.78	3.61±2.22	1.84±1.31	8.58±5.23		

Stage of the crop: 52 SMW to 8 SMW (Vegetative phase), 9 SMW to 30 SMW (Flowering phase)

Table 7: t- statistical values for testing of significance of natural enemies in IPM and non- IPM plots of tuberose.

Treatments	No. of natural enemies per plant
IPM (Mean ± S.D)	12.33±7.47
Non-IPM (Mean ± S.D)	3.38±2.39
t cal. Value	9.63
t tab. Value	2.23
P value	0.00000001 (Significant)

Table 8: t- statistical values for testing of significance of natural enemies in IPM and control plots of tuberose.

Treatments	No. of natural enemies per plant
IPM (Mean ± S.D)	12.33±7.47
Control (Mean ± S.D)	8.58±5.23
t cal. Value	9.20
t tab. Value	2.23
P value	0.00000001 (Significant)

SMW - Standard Meteorological Week
IPM - Integrated Pest Management
PI- Per cent Increase

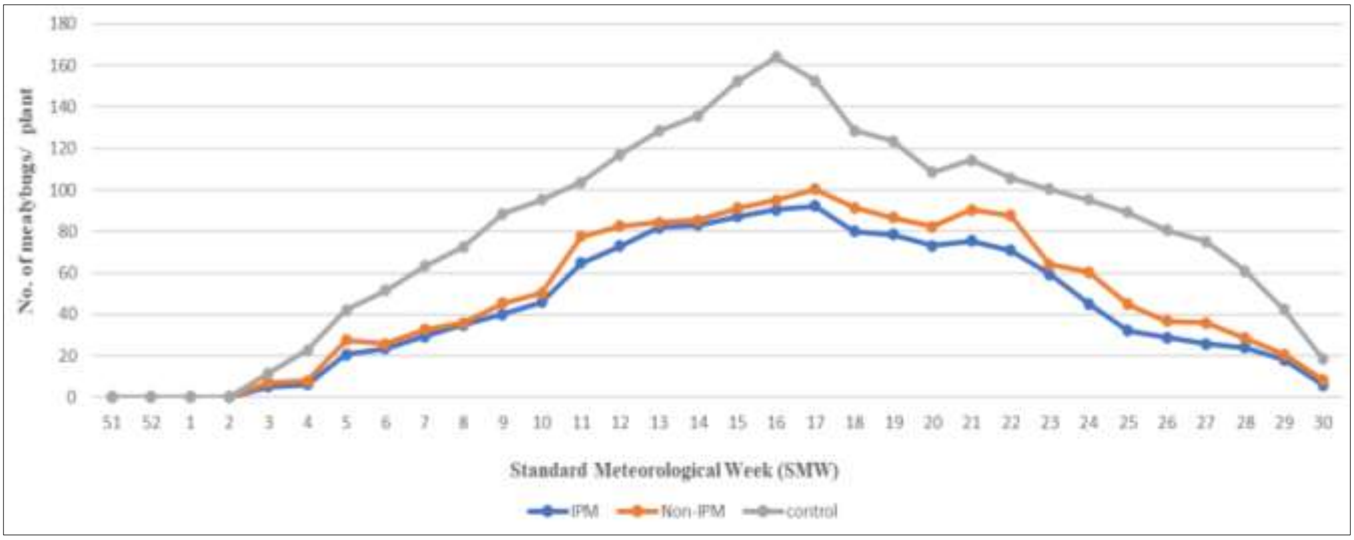

Fig. 1. Population of mealybugs in IPM, non-IPM and control plots

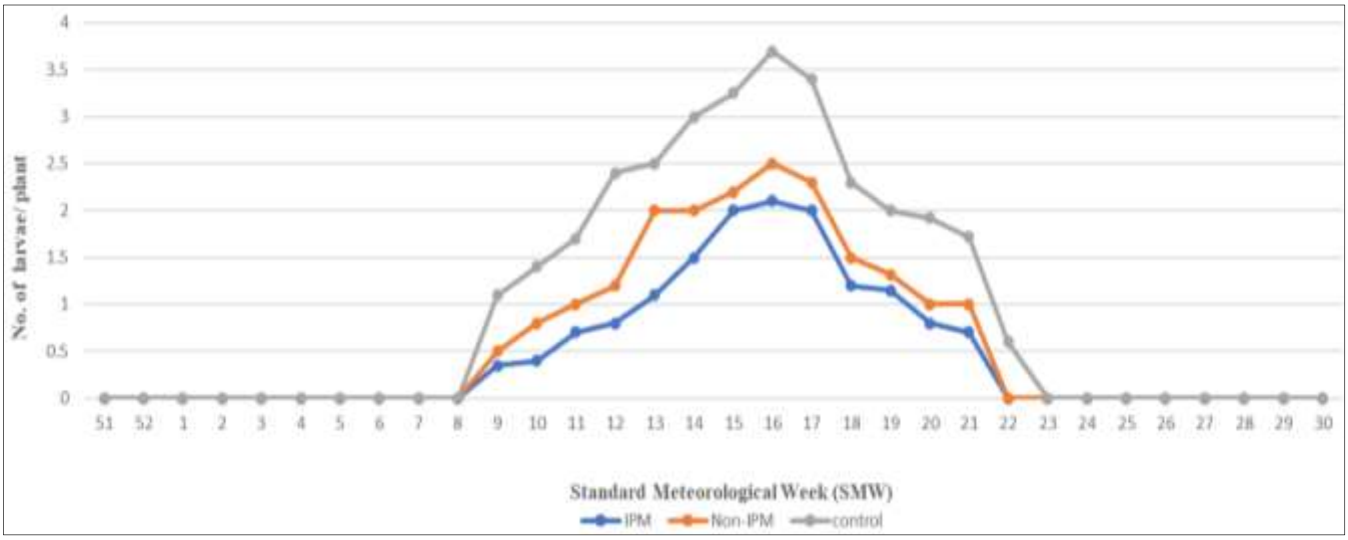

Fig 2: Population of bud borer in IPM, non-IPM and control plots.

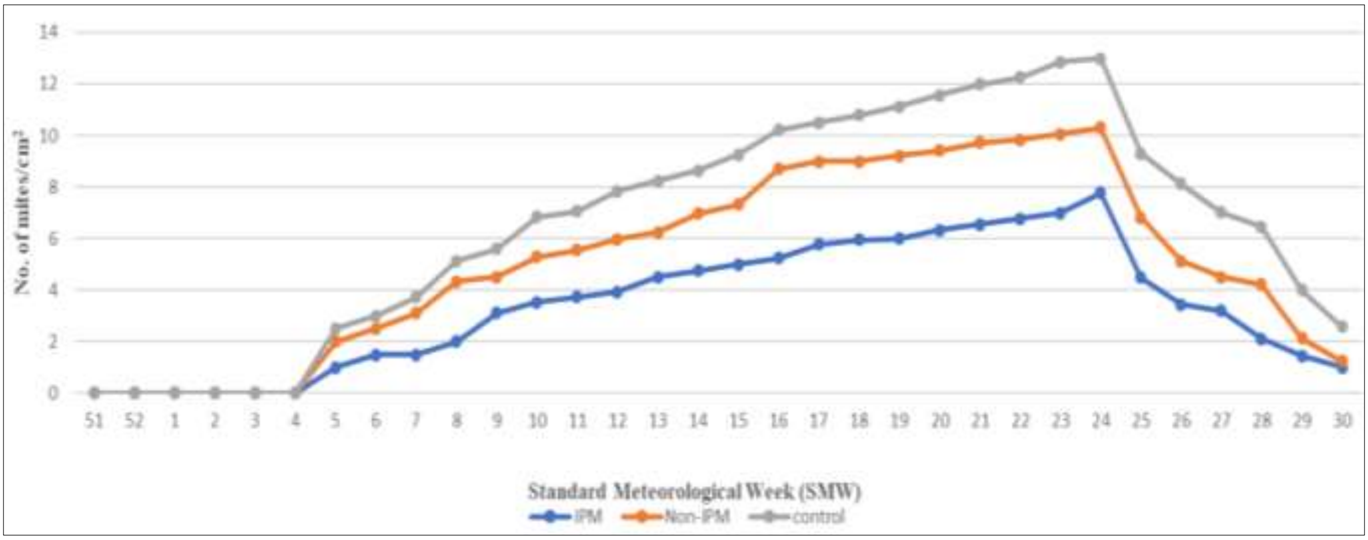

Fig 3: Population of red spider mites in IPM, non-IPM and control plots.

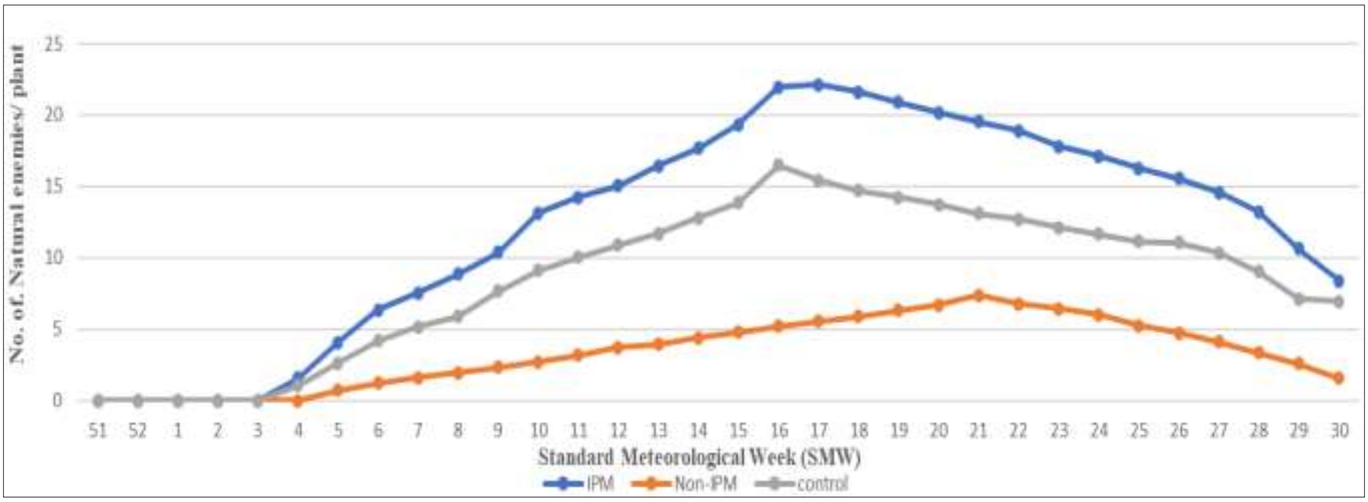

Fig 4: Population of natural enemies in IPM, non-IPM and control plots.

Conclusion

Thus, considering all the aspects of the present study tuberose crop grown in IPM plot was less infested with pests *viz*., mealybugs, bud borer and mites as compared to that of non-IPM and control plots of tuberose. Implementation of IPM in tuberose have played a major role in conserving the natural enemies by improving their survival, reproductive, parasitization and predation ability than in the non-IPM and control plots of tuberose.

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