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Saikumar N
MSc. Scholar, Department of Entomology, Dr. Y.S.R Horticultural University, Andhra Pradesh, India

Emmanuel N
Associate Professor, Department of Entomology, Dr. Y.S.R Horticultural University, Andhra Pradesh, India

Chinnabbai CH
Associate Professor, Department of Entomology, Dr. Y.S.R Horticultural University, Andhra Pradesh, India

Umakrishna K
Professor, Department of Statistics, Dr. Y.S.R Horticultural University, Andhra Pradesh, India

Corresponding Author
Saikumar N
MSc. Scholar, Department of Entomology, Dr. Y.S.R Horticultural University, Andhra Pradesh, India

Impact of IPM and non-IPM practices on population variations, incidence, infestation of major pests and their natural enemies in cabbage

Saikumar N, Emmanuel N, Chinnabbai CH and Umakrishna K

Abstract
The present investigations entitled" Impact of IPM and non-IPM practices on population variations, incidence and infestation of major pests and their natural enemies in Cabbage" was carried out during *rabi*, 2020-21 at College of Horticulture, Venkataramannagudem. Results revealed that the minimum mean average population of *P. xylostella* (DBM) moth was 1.55 + 0.59 number per plant as compared to 5.34 + 1.18.in non-IPM plot. The mean population of diamond back moth larvae in cabbage grown in IPM plot was 1.52 + 0.73per cent which was 52.60 times lesser than that of non-IPM plot with 4.12 + 1.64 per cent. The lowest mean per cent of infestation of head was recorded in IPM plot with 3.88 + 2.12 per cent as compared to that of non-IPM plot (5.09 + 2.54 per cent). However the peak head infestation was noticed in 3rd SMW in IPM plot (60%), non-IPM plot (80%).

Keywords: cabbage, natural enemies, IPM, non-IPM, diamond back moth

Introduction
India is next to china in area and production of vegetables and contributes about 13.00 percent of world vegetable production. Majority of Indians are vegetarians and per capita consumption is 135gm per day as against recommended 300 gm per day. In India, cabbage and cauliflower is grown in an area of 4, 07,000 and 4, 52,000 ha with a production of 89, 71,000 and 84, 99,000 MT. The major constraints for lower production and productivity of cole crops is primarily due to insect pests and among the Lepidopteran pests, diamondback moth (*Plutella xylostella*) is one of the most destructive pest throughout the world. The damage is most serious to cole crops where the larvae penetrate inside the head and destroys it completely and causes an average of 52 per cent loss to marketable yield to cole crops in India (Krishnamurthy *et al*., 2004) [2].

Pest management in cabbage crop is currently based on heavy use of many neurotoxic insecticides. Consequently, it has developed resistance to almost every group of synthetic insecticide including *Bacillus thuringiensis* formulations. The problems caused by pesticides and their residues have amplified the need for effective, biodegradable pesticides with greater selectivity. To minimize the pesticide load in cabbage crop, various IPM modules have been worked out with reference to safety of consumers, producers as well as to ensure food quality and safeguarding horticultural ecosystem (Alam *et al.*, 2016).

Materials and Methods
The experiment was conducted at college farm, College of Horticulture, Venkataramannagudem to examine the impact of IPM, non-IPM practices on population variations, incidence and infestation of major pests and their natural enemies in Cabbage" was carried out during *rabi*, 2020-21. Cabbage seedlings were transplanted in IPM and non-IPM plots of 25m x 20 m size with a spacing of 45 cm between rows and 60 cm between plants.

The schedule of IPM plot followed was
1. Deep summer ploughing was done thoroughly with a tractor drawn cultivator and evenly leveled after removing all the stubbles and weeds.
2. Reflective Plastic Mulch (Sheet gauge) of 25 microns silver black, 4 feet width, and 400 mts long bundle was laid on the beds which reflect sunlight against whitefly enhances crop growth and controls weeds.
3. Hand picking of caterpillars and their mechanical destruction in the early stages of

infestation.
4. Installation of pheromone traps @ 12/acre
5. Installation of yellow sticky traps, @ 12/acre.
6. Erection of bird perches @ 10/acre. For IPM plot 2/450sq.m. was done 45 days after transplanting of crucifers.
7. Need based ecofriendly pesticides were sprayed based on the severity of infestation.

Sequential spraying schedules with bio-pesticides were taken up for pests of Cabbage crop with following bio pesticides:
1. NSKE @ 3 ml/lt at 3 weeks after transplanting.
2. Neem oil @ 3 ml/lt at 5 weeks after transplanting.
3. Metarhizum anisopliae @ 2g/lt ($2x10^9$ conidia/ml) at 7 weeks after transplanting.
4. *Beauveria bassiana* @ 5g/lt ($2x10^9$conidia/ml) at 8 weeks after transplanting.

Bacillus thuringiensis @ 2ml/lt ($1x10^8$conidia/ml) at 9 weeks after transplanting

Non-IPM plot

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

A. Sucking pests
1. Spraying of Imidachloprid 17.8 SL @ 0.25 ml/lt at 3 weeks after transplanting.
2. Spraying of Lambda cyhalothrin 5 EC @1 ml/lt at 4 weeks after transplanting.
3. Spraying of Thiomethoxam 25WG @ 2ml/lt at 5 weeks after transplanting.

B. Borer pests
1. Spraying of Flubendiamide 480 SC @ 1ml/lt at 5, 8 weeks after transplanting.
2. Spraying of Chlorantraniliprole 18.5% SC @ 0.25 ml/lt at 6, 9 weeks after transplanting.
3. Spraying of Buprofezin 25 SC @ 1ml/lit at 7, 10 weeks after transplanting.

Observations recorded

Number of larvae per plant

The count on the population of DBM larvae was recorded by visual observations on both surfaces of the leaf on three randomly selected leaves from top, middle, bottom canopy of the plant from 10 per cent of sampled plants in IPM and non-IPM plots of cabbage crop at weekly intervals starting from 15 days after transplanting till crop maturity.

Head infestation

The data on the number of healthy and infested heads was recorded at two days interval from 10% of sampled plants in IPM and non-IPM plots. The percent infestation of head was calculated by using the formula:

$$\% \text{ infestation of heads} = \frac{\text{Number of infested heads}}{\text{Total number of heads}} \times 100$$

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

Results and Discussion

Studies were carried out during the year 2020-21 to examine the impact of adopting IPM, non-IPM practices for controlling various insect pests as well as predatory activity on cabbage. The results on each insect are separately presented under respective headings.

Effect of IPM and non-IPM practices on population of diamond backmoths (*P. xylostella*) per plant in cabbage

In IPM plots of cabbage, the minimum mean average population of *P. xylostella* moth was 1.55 $\pm$ 0.59 number per plant as compared to 5.34 $\pm$ 1.18.in non-IPM plot However the peak population was noticed in 3rd SMW in IPM plot (2.42 moths / plant), non-IPM (6.02 moths / plant). In comparison to non- IPM plot there was 55.53 per cent reduction of moth in IPM plot given in table 1 and fig 1. There was a significant difference in number of moths per plant between IPM and non-IPM plots as per the t-statistical value depicted in the table 2.

Effect of IPM and non-IPM practices on population of diamond back moth larvae (*P. xylostella*) per plant in cabbage.

The data in the table 3 and fig 2 and indicated that the mean population of diamond back moth larvae in cabbage grown in IPM plot was 1.52 $\pm$ 0.73 per cent which was 52.60 times lesser than that of non-IPM plot with 4.12 $\pm$ 1.64 per cent. However the peak larval population was noticed in 3rd SMW in IPM plot (2.37 larvae / plant), non-IPM plot (6.10 larvae / plant). There exists a significant difference in population of diamond back moth larvae recorded in between IPM and non-IPM plots of cabbage as per the t-statistical value given in table 4.

Effect of IPM and non-IPM practices on head infestation (%) by *P. xylostella* in cabbage.

The minimum mean per cent of infestation of head was recorded in IPM plot with 3.88 $\pm$ 2.12 per cent as compared to that of non-IPM plot (5.09 $\pm$ 2.54 per cent). However the peak head infestation was noticed in 3rd SMW in IPM plot (60%), non-IPM plot (80%). There exists a significant difference in per cent head infestation recorded in between IPM and non-IPM plots as per the t-statistical value depicted in the table 6. In comparison to non- IPM plot there was 28.02 per cent reduction of head infestation in IPM plot as per the t-statistical value given in table 5 and fig 3.

Influence of IPM and non-IPM practices on natural enemies of cabbage pests

The data shown in the table 7 revealed that the cruciferous crop in non- IPM plot was noticed with lower population levels of Natural enemies than in the IPM plot. The mean population of natural enemies was 3.32 + 2.11 number per plant in IPM plot of crucifer as compared to that of non-IPM plot with 3.50 + 2.04 number, which was 30.03 per cent higher than IPM plot. There was a significant difference in natural enemies as compared to that of IPM and non-IPM plot as per the t- statistical value given in the table 8.

Table 1: Number of diamond back moth (*P. xylostella*) per plant in IPM and non-IPM plots of cabbage

SMW (No)	DBM per plant		PR (%) in IPM over non-IPM
	IPM	Non-IPM	
48	0.37	1.32	71.96
49	0.72	2.01	64.17
50	1.40	2.88	51.38
51	1.73	3.81	54.59
52	1.97	4.23	53.42
1	2.03	4.97	59.15
2	2.42	5.62	56.93
3	1.89	6.02	58.60
4	1.72	5.21	59.90
5	1.41	4.33	66.41
6	0.96	3.14	69.40
Mean ± S.D	1.55±0.59	5.34±1.18	55.53

Table 2: t-statistical values for testing of significance of diamond back moth per plant in IPM and non-IPM plots of cabbage.

Treatments	No. of moths per leaf
IPM (Mean ±S.D)	1.55±0.59
NON-IPM (Mean ±S.D)	5.34±1.18
t cal. value	9.46
t tab. value	2.23
P value	0.00000001 (Significant)

Table 3: Number of diamond back moth (*P. xylostella*) larvae per plant in IPM and non-IPM plots of cabbage.

SMW (No)	DBM larvae per plant		PR (%) in IPM over non-IPM
	IPM	Non-IPM	
48	0.12	1.23	90.24
49	0.36	2.10	82.85
50	1.19	2.67	55.43
51	1.31	3.01	56.47
52	1.47	3.87	52.01
1	1.95	4.79	59.29
2	2.12	5.26	59.60
3	2.37	6.10	51.14
4	2.06	5.81	54.54
5	1.96	5.43	53.90
6	1.87	5.14	53.61
Mean ± S.D	1.52±0.73	4.12±1.64	52.60

Table 4: t-statistical values for testing of significance of diamond back moth larvae per plant in IPM and non-IPM plots of cabbage.

Treatments	No. of moths per leaf
IPM (Mean ±S.D)	1.52±0.73
NON-IPM (Mean ±S.D)	4.12±1.64
t cal. value	8.99
t tab. value	2.23
P value	0.00000001 (Significant)

Table 5: Cabbage head infestation (%) by *P. xylostella* in IPM and non-IPM plots.

SMW (NO)	Head infestation (%)		PR (%) in IPM over non-IPM
	IPM	Non-IPM	
48	0.00	0.00	-
49	0.00	0.00	-
50	0.00	0.00	-
51	0.00	0.00	-
52	20.00	40.00	50.00
1	20.00	60.00	66.66
2	40.00	60.00	33.33
3	60.00	80.00	25.00
4	60.00	80.00	50.00
5	60.00	80.00	33.33
6	60.00	100.00	50.00
Mean ± S.D	21.81±20.88	38.18±32.80	28.02

Table 6: t-statistical values for testing of significance of Head infestation (%) in IPM and non-IPM plots of cabbage.

Treatments	No. of moths per leaf
IPM (Mean ±S.D)	21.81±20.88
NON-IPM (Mean ±S.D)	38.18±32.80
t cal. value	3.61
t tab. value	2.23
P value	0.00000004 (Significant)

Table 7: Population of natural enemies in IPM and non-IPM plots of cabbage

SMW (No)	IPM			Non-IPM			PI (%)in IPM over non-IPM
	Spiders	Coccinellids	Total	Spiders	Coccinellids	Total	
48	0.00	0.03	0.03	0.13	0.11	0.24	87.50
49	0.09	0.81	0.9	0.27	0.33	0.60	50.00
50	0.33	0.97	1.30	0.40	0.50	0.90	44.44
51	0.66	1.29	1.95	0.61	0.98	1.59	20.74
52	1.19	1.45	2.64	0.88	1.27	2.15	18.83
1	1.87	2.09	3.96	1.19	1.88	3.07	28.99
2	2.06	2.86	4.92	1.47	2.24	3.71	32.61
3	2.19	3.31	5.50	2.18	2.59	4.77	15.30
4	1.76	3.69	5.45	2.50	3.67	6.17	11.66
5	1.45	4.17	5.62	2.96	3.30	6.26	10.22
6	1.66	3.82	5.48	2.27	2.99	5.26	11.37

7	1.38	2.91	4.29	1.83	2.34	4.17	28.77
Mean ± S.D	1.22±0.76	2.28±1.36	3.50±2.04	1.39±0.95	1.85±2.12	3.32±2.11	30.03

Table 8: t-statistical values for testing of significance of natural enemies per plant in IPM and non-IPM plots of cabbage

Treatments	No. of natural enemies per plant
IPM (Mean ±S.D)	3.50±2.04
NON-IPM (Mean ±S.D)	3.32±2.11
t cal. value	4.58
t tab. value	2.20
P value	0.00000001 (Significant)

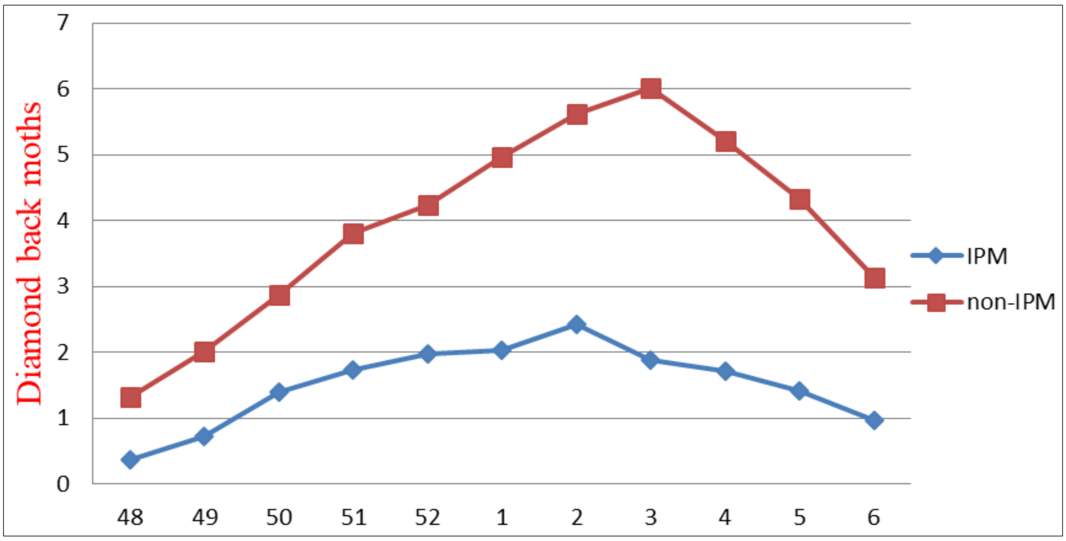

Fig 1: Population of diamond back moth per plant in IPM and non-IPM plots of cabbage

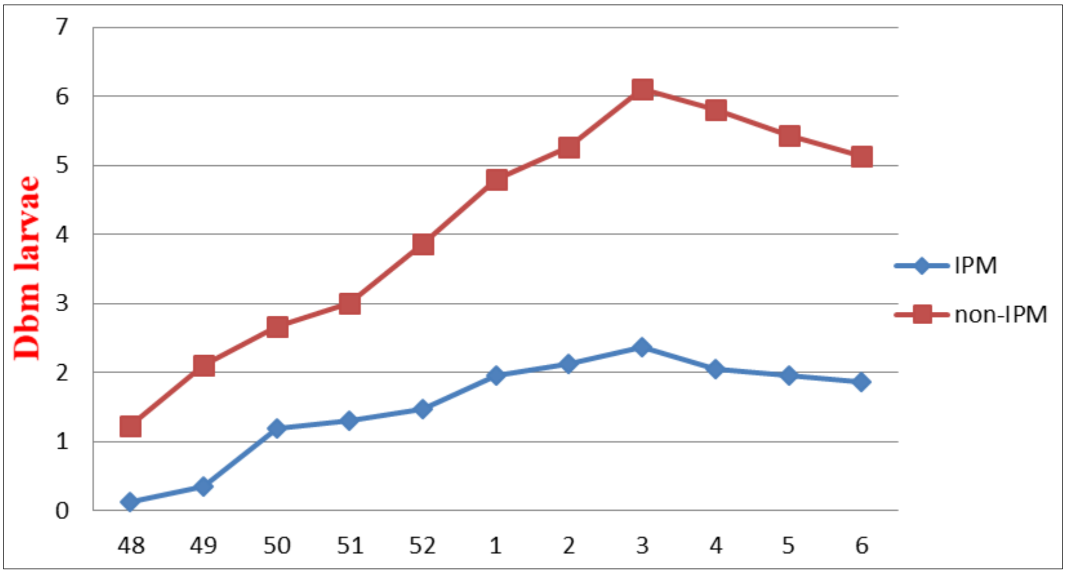

Fig 2: Population of diamond back moth larvae per plant in IPM and non-IPM plots of cabbage.

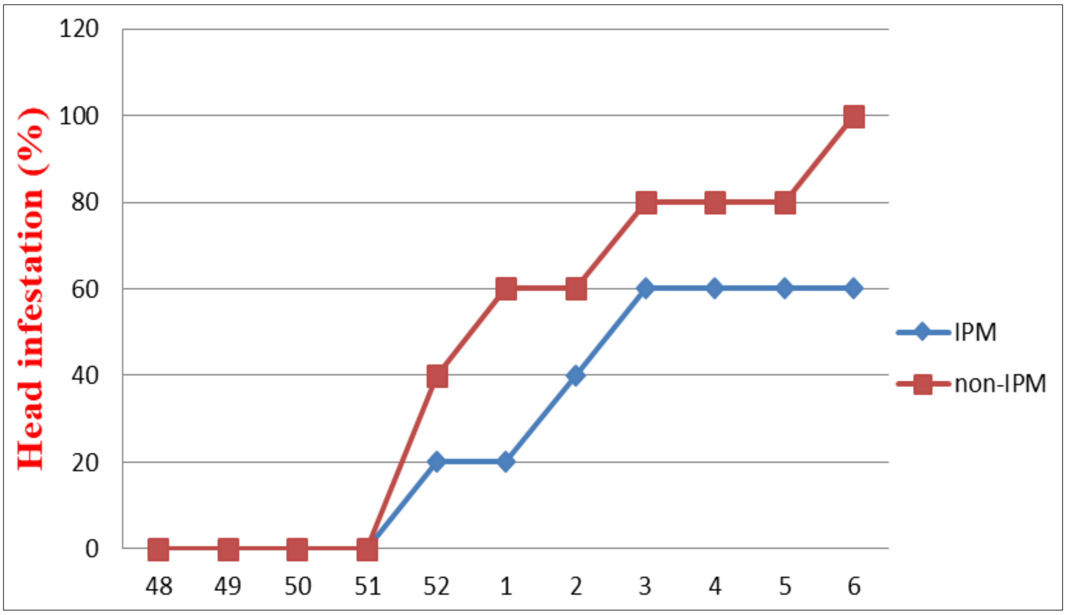

Fig 3: Head Infestation (%) in IPM and non-IPM plots of cabbage

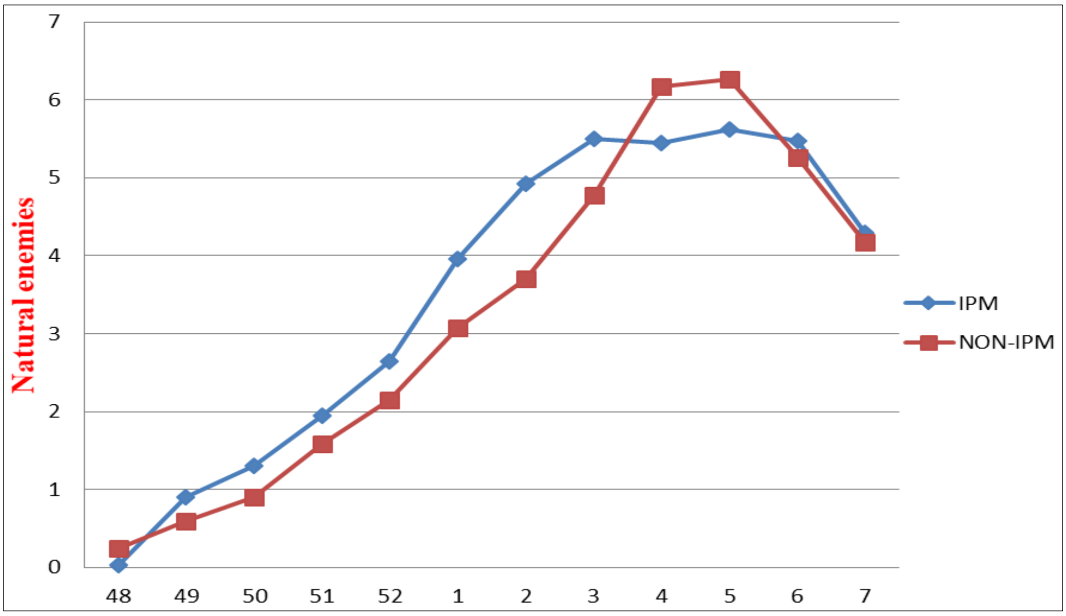

Fig 4: 21 Population of natural enemies in IPM and non-IPM plots of Crucifers.

The reduction in pest population in cabbage grown IPM plot was mainly attributed to various IPM components such as border crop (maize), yellow sticky traps, light trap, pheromone traps and need based application of botanical pesticides *viz*., NSKE 5 percent at 48th SMW, neem oil @ 3ml/l at 50th SMW,. These results are in confirmation with the findings of Sahu *et al.* (2020) [5] and Ashfaque *et al.* (2016) [1] who reported fewer incidences of dbm adults in IPM grown cabbage plots than in non-IPM plots of cabbage. The results are also in agreement with Ashfaque *et al.* (2016) [1] and Sharma and Mane (2021) [3] who reported low incidence of DBM larvae in botanical treated crops. In the present investigation, the per cent head infestation was much lesser in the cabbage crop grown in IPM plot than in non-IPM plots which is in conformity with the reports made by Puja *et al.* (2013) [4].

Conclusion
Thus, considering all the aspects of the present study cabbage crop grown in IPM plot was less infested with DBM larvae and DBM moths as compared to that of non-IPM plots of cabbage. Implementation of IPM in cabbage 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 non-IPM plots of cabbage.

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