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Relationship of diamond back moth, *Plutella xylostella* (L.) catches in pheromone traps, its infestation on cabbage and weather parameters

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Abstract
Studies were made to know the relationship of DBM moth catches in pheromone traps, its infestation and its relationship with weather parameters. The results showed the significant negative relationship (r= -0.989) between DBM moth catches in trap and larvae on plants, and inversely proportional to the number of pupae on cabbage plants. The seasonal incidence of DBM moth catches under field conditions was found in relation to the prevailing weather conditions during the study period. The moth catches in traps gradually increased from 10.38 moths / trap / week at 23rd standard week to maximum of 171.54 moths / trap / week during 27th standard week. The trap catches of DBM moths had a positive association with maximum temperature (r=0.650) and rainfall (r=0.852) and negative association with minimum temperature (r= -0.696), morning RH (r= -0.434), afternoon RH (r= -0.821), evaporation (r= -0.183) and wind speed (r= -0.825). This suggests that combination of all the factors influenced DBM moth catches. Similar results were also obtained with DBM pupae in study plot.

Keywords: *Plutella xylostella*, pheromone traps, cabbage weather

1. Introduction

Diamond back moth (DBM), *Plutella xylostella* (Linnaeus) is a major limiting factor for successful cultivation of cabbage in India (Sexena *et al*., 1989; Srinivasan and Krishnamoorthy, 1991) [12, 14] and is known to cause yield loss from 31 per cent to 100 per cent (Abraham and Padmanabhan, 1968; Cardleron and Hare, 1986) [1, 2]. This insect damages the crop by feeding on the foliage. Attack of a large number of larvae of this pest hinders the health, growth and development of the plant resulting in considerable loss of yields, very young plants may even die.

Cultivation of cabbage commercially has compelled the growers to go for more frequent and injudicious use of insecticides, for better marketable yield. This has resulted in several problems *viz*., pesticide resistance (Tabashnik and Cushing 1987; Sannaveerappanavar and Viraktamath, 1997; Lingappa *et al*., 2000) [15, 11, 5], resurgence (Nemato *et al*., 1984) [8], residue problems, inefficiency of natural enemies due to effect of chemicals and environmental pollution, *etc.* The growing concern about the risk of use of pesticides to the farmers, consumers and environment has resulted in more emphasis on organic farming and sustainable production of vegetables. The search for alternatives to overcome these problems has led extensive research on use of pheromones for pest management. The use of synthetic sex pheromones for manipulating the behaviour of insect pests has captured worldwide attention today. The trapping of moths by synthetic sex pheromones can reduce the infestation and reduces the pesticide load on the crop. Hence, the study was conducted to know the relationship of DBM moth catches in pheromone traps, its infestation on cabbage and weather parameters.

2. Material and Methods

The investigation was carried out under field conditions in cabbage (variety Unnati) fields infested with diamond back moth (DBM), *Plutella xylostella* (L.) at Ekashipura village, North Bangalore. The composition of the pheromone components of *P. xylostella* is Z-11-hexadecenal and Z-11-hexadecenyl acetate. The pheromone impregnated rubber septa used in these studies were manufactured and supplied by M/s Pest Control India Pvt. Ltd., Bio-control Research Laboratories (BCRL), Sreeramanahalli, Arakere post, Bangalore-561 203, Karnataka.

The traps used for study were Wota T™ traps. It is a water trap designed by M/s Pest Control (India) Ltd, Bombay, for mass trapping pests of crops such as sugarcane borers, brinjal shoot and fruit borer, diamondback moth etc. Wota-T™ is easy to assemble on a single pole. The trap consists of a plastic bowl (25cm×10cm diameter); adapter, basin to hold water mixed with oil or detergent and a lure holder with a canopy. About three fourth of the container is filled with water and oil is poured on the surface of water to hold caught moths by the pheromones. The pheromone septa are suspended from the lure holder from the centre of the basin. Moths attracted to the trap are killed when they fall into the water containing oil.

To study the relationship of DBM moth catches in traps and its infestation on cabbage plants, a field trial was conducted consisting of five different densities of traps (8 traps, 16 traps, 24 traps, 32 traps and 40 traps per acre) and a control without traps. This experiment was conducted in Bangalore North region. Six cabbage fields of same age representing different treatments were selected in such a way that there was a minimum distance of 0.5 km between the fields and all the selected fields were within a radius of 5 km. The water traps baited with pheromone septae were set up using eucalyptus pegs at 0.4m above the ground level. In each field, the traps at different densities representing different treatment were installed randomly covering an acre area. Water was served about three fourth of the trap and about 5 ml of engine oil was poured on the surface of water. Control plot was without traps. The observations on the moth catches in traps were made at weekly interval for 7 weeks after trap installation.

These fields were equally divided into four blocks. From each block 12 plants were selected randomly from which visual observations were made at weekly interval, counts were recorded on number of DBM larvae, number of DBM pupae and number of pupae of larval parasitoids of *Plutella i.e., Cotesia* on cabbage plant.

The relationship between the moth catches in the traps and number of larvae and pupae of *P. xylostella* and also *Cotesia* were determined by estimating the correlations between them. The different stages of *P. xylostella* present in the field were also correlated with the weather factors *viz.*, temperature, relative humidity, evaporation, wind speed and rainfall to know the relationship between *P. xylostella* infestation and weather factors.

3. Results and discussion

3.1 Relationship of moth catches in traps and DBM infestation

An attempt was made to know the relationship of moth catches in traps and DBM infestation on cabbage plants (the number of DBM larvae and pupae on the crop). The number of moths catches at different trap densities, number of DBM larvae and pupae recorded at different trap densities are presented in Table 1. In control field, the maximum number of larvae (2.45 larvae / plant) and pupae (1.30 pupae / plant) were found. The number of larvae and pupae was less (0.98 larvae and 0.45 pupae per plant) in fields where 24 traps per acre were installed compared to all other treatments.

Correlation revealed that there was a significant negatively relation (r=-0.989) between the DBM moth catches in water traps and number of larvae on plants. This indicated that as the number of moths in traps increased the one would expect a decrease in the larvae on cabbage plants where the traps were installed. Shelton and Wyman (1979) [13] reported that the potato tuber infestation by tuber moth, where larval populations in the foliage and moth counts in pheromone traps increased during the season and were significantly correlated pheromone trap catches and larval counts in the foliage were significantly correlated with tuber damage. The relationship between the DBM pupae on cabbage crop and moth catches in traps was negatively significant (r=-0.973) i.e. the moth catches in the traps was inversely proportional to the number of pupae on cabbage plants.

Eventually in this study the relationship between the moth catches in traps and DBM population (larvae and pupae) was also established the relationship between the two variables in cabbage fields was statistical and negatively significant (r=-0.998). The moth catches in traps indicated that DBM infestation occurred in study plot when there was more moth catches in pheromone traps there was a reduction in DBM population in the field following trapping. Gabriella (1986) [3] reported positive and significant relationship between moth catches and mean number of larvae and pupae per plant 15-21 days later appear to reflect life history of DBM on cabbage.

In addition to the number of larvae and pupae it was thought worthwhile to record number of parasitoid, *Cotesia plutella* on DBM larvae because this would be eventually have an impact on the DBM population in the test plots under field conditions. The number of larval parasitoid occurred in the cabbage plants vary from 0.52 to 2.14. This is the one factor to be considered while considering assessing DBM population on cabbage plants. Larval parasitoid per plant was highest in control plot (2.14 larval parasitoids per plant), followed by fields with 8 traps per acre (1.90 larval parasitoids per plant). The least number of larval parasitoids were recorded in the fields with 24 traps per acre (0.52 larval parasitoids / plant). These results suggested that the number of larval parasitoids directly depends on its host (DBM larvae) density. An attempt was made to search for documented literature to this effect but published information on this aspect is wanting.

3.2 Influence of weather parameters on DBM

The seasonal incidence of DBM moth catches under field conditions was found in relation to the prevailing weather conditions during the study period is given in Table 2. The moth catches in traps gradually increased from 10.38 moths/trap/week at 23rd standard week to maximum of 171.54 moths/trap/week during 27th standard week.

The trap catches of DBM moths had a positive association with maximum temperature (r=0.650) and rainfall (r=0.852) and negative association with minimum temperature (r=-0.696), morning RH (r=-0.434), afternoon RH (r=-0.821), evaporation (r=-0.183) and wind speed (r=-0.825) (Table 3). This suggests that combination of all the factors influenced DBM moth catches. Maa *et al*. (1983) [6] also reported that optimum RH influenced male DBM moths to an extent of 75 to 85% when the optimum temperature was 19ºC in his experiment humidity had a greater influence than temperature. Maa and Ying (1985) [7] further extended the impact of the weather conditions on response of DBM moths to pheromone under varying temperature and humidity conditions when the plots were applied different insecticides susceptible strains.

The study also revealed that the DBM infestation (number of larvae and pupae) had a positive association with minimum temperature (r=0.069), RH (r=0.554 & 0.625), evaporation (r=0.121) and windspeed (r=0.705) and there was a negative association with maximum temperature (r=-0.023) and rainfall (r=-0.512) (Table 4). Finally it was found that the DBM population in cabbage test fields was influenced by a combination of the parameters *viz.* minimum temperature, RH, evaporation and wind speed. Reddy (1990) [9] reported that weekly trap catches were found to be negatively correlated with the immature stages and weekly maximum and minimum temperature at Hebbal, Bangalore. Rothschild *et al.* (1981) [10] obtained a significant positive relationship between pheromone trap catches of *Heliothis* spp. and temperature. However, Gupta (1981) [4] obtained a significant negative relationship between moth catches of *Spodoptera litura* in light trap and minimum and maximum temperature.

3.3 Influence of weather parameters on larval parasitoid

This study revealed that there was a positive association with maximum temperature (r=0.028), RH (r=0.757 & 0.692) evaporation (r=0.493) and wind speed (r=0.489) and there was a negative association with minimum temperature (r=-0.06) and rainfall (r=-0.538). Interestingly the simple correlation and regression analysis revealed that larval parasitoid was influenced by morning RH to an extent of 63 percent suggesting that it is a critical factor influencing larval parasitoid of DBM (Table 5).

Table 1: Relationship of DBM moth catches with infestation of DBM larvae and pupae in cabbage at Ekashipura, Bangalore North during 2012

Traps per acre	Total moth catches per acre	*No. of larvae per plant	*No. of Pupae per plant	*No. of Larvae and Pupae per Plant	*No. of Parasitoid per plant
8	6868	1.84	0.99	2.83	1.90
16	10686	1.57	0.79	2.36	1.38
24	15394	0.98	0.45	1.43	0.52
32	10598	1.38	0.89	2.27	0.55
40	8711	1.69	0.90	2.59	0.81
Untrapped	0	2.45	1.30	3.75	2.14
Mean	8709.50	1.65	0.89	2.54	1.22
Relationship between DBM moth catches and		r = -0.989*	r = -0.973*	r = -0.998*	r = -0.513*

*Average no. from 48 cabbage plants

Table 2: Relationship of DBM moth catches in traps and infestation of DBM in cabbage with meteorological variables at Ekashipura, Bangalore North during 2012

Standard Week	Moth catches / trap / week	No. of DBM larvae / plant	No. of Parasitoid / plant	Temperature (°c)		Relative humidity (%)		Evaporation (mm)	Wind speed (km / h)	Rainfall (mm)
				Max.	Min.	Morning	Afternoon			
23	10.38	1.73	1.56	33.29	14.29	67.71	35.00	4.73	4.49	26.67
24	44.13	1.29	0.63	32.29	16.14	70.00	37.57	6.11	5.27	5.00
25	85.42	2.25	0.63	33.17	15.00	72.67	41.33	6.95	7.91	0.00
26	110.05	1.31	0.5	33.29	15.14	69.29	41.57	6.20	7.43	0.00
27	171.54	0.73	0.34	33.00	15.14	78.14	53.86	6.07	10.05	0.00
28	146.00	2.32	0.06	29.71	18.71	71.29	57.57	5.57	8.97	5.05
29	30.96	1.49	0.13	29.29	20.43	70.00	50.86	4.67	11.11	0.00

*Mean number of moths for seven days in 24 traps

Table 3: Relationship of DBM moth catches in traps with meteorological variables at Ekashipura, Bangalore North during 2012

Parameters	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Y-Trap Catches	0.650	-0.696	-0.434	-0.821*	-0.183	-0.825*	0.852*
X_1-Max. Temperature (ºC)	1.00	-0.982**	0.123	-0.655	0.51	-0.583	0.235
X_2-Min. Temperature (ºC)		1.00	-0.115	0.624	-0.473	0.641	-0.346
X_3- Morning RH (%)			1.00	0.569	0.447	0.554	-0.516
X_4-Afternoon RH (%)				1.00	-0.098	0.851*	-0.503
X_5- Evaporation (mm)					1.00	-0.053	-0.549
X_6- Wind Speed (Km/h)						1.00	-0.698
X_7-Rainfall (mm)							1.00

N=7; * significant at 5% (p=0.05); ** significant at 1% (p=0.01); $R^2 = 0.9658$

Table 4: Relationship of infestation of DBM (larvae + pupae) with meteorological variables at Ekashipura, Bangalore North during 2012

Parameters	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Y- No. of larvae and pupae	-0.023	0.069	0.554	0.625	0.121	0.705	-0.512
X_1-Max. Temperature (ºC)	1.00	-0.982**	0.123	-0.655	0.51	-0.583	0.235
X_2-Min. Temperature (ºC)		1.00	-0.115	0.624	-0.473	0.641	-0.346
X_3- Morning RH (%)			1.00	0.569	0.447	0.554	-0.516
X_4-Afternoon RH (%)				1.00	-0.098	.851*	-0.503
X_5- Evaporation (mm)					1.00	-0.053	-0.549
X_6- Wind Speed (Km/h)						1.00	-0.698
X_7-Rainfall (mm)							1.00

N=7; * significant at 5% (p=0.05); ** significant at 1% (p=0.01); $R^2 = 0.9833$

Table 5: Relationship of larval parasitoid of DBM with meteorological variables at Ekashipura, Bangalore North during 2012

Parameters	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Y- No. of larval parasitoid	0.028	-0.06	0.757*	0.692	0.493	0.489	-0.538
X_1-Max. Temperature (ºC)	1.00	-0.982**	0.123	-0.655	0.51	-0.583	0.235
X_2-Min. Temperature (ºC)		1.00	-0.115	0.624	-0.473	0.641	-0.346
X_3- Morning RH (%)			1.00	0.569	0.447	0.554	-0.516
X_4-Afternoon RH (%)				1.00	-0.098	0.851*	-0.503
X_5- Evaporation (mm)					1.00	-0.053	-0.549
X_6- Wind Speed (Km/h)						1.00	-0.698
X_7-Rainfall (mm)							1.00

*N=7; * significant at 5% (p=0.05); ** significant at 1% (p=0.01); $R^2 = 0.6328$*

4. Conclusion
DBM moth catches in traps reduces its infestation on cabbage plants and is influenced by the combination of all-weather factors.

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6. References
1. Abraham EV, and Padmanabhan MD. Bionomics and control of the diamondback moth, *Plutella xylostella* Linn. Indian J Agricul. Sci. 1968; 20:513-519.
2. Cardleron JJ, Hare CJ. Control of diamondback moth in South East Asia by profenofos. In: Diamondback Moth Management: Proceedings of the First International Workshop (Eds. N. S. Talekar and T. D. Griggs) AVRDC, Taiwan. 1986; pp. 347-357.
3. Gabriella. Investigations on the potential use of pheromones as a management tool for diamondback moth, *Plutella xylostella* (L.) (Lepidoptera : Plutellidae) in Indonesia. *M. Sc.Thesis*, University of Toranto, 1986.
4. Gupta JPS. Preliminary studies on the light trap catches of selected insect pests with special reference to the moon phase and some weather factors. *M. Sc. (Ag.)Thesis*, University of Agricultural Sciences, Bangalore. 1981; pp. 150.
5. Lingappa S, Basavangouda J, Vastrad AS, Gopali JB. Diamondback moth: A real threat to vegetable production in South India and its integrated management. *In: IPM System in Agriculture* (Upadhayay K. G., Mukerji and Dubey, O. P. Eds.). Aditya Books Private Limited, New Delhi. 2000; pp. 235-248.
6. MAA, CJW, LIN, YM, CHOW YS. Variation of pheromone response and antennal esterase activity of the male diamondback moth, *Plutella xylostella. Monogr.* Inst. Botany, Acad. Sin. 1983; 5:157-165.
7. MAA, CJW, Ying YJ. Relative humidity on male response to synthetic female sex pheromone of *P. xylostella* L. *Bull. Inst. Zool. Acad. Sin.* (Unpublished data), 1985.
8. Nemato H, Kiritani K, ONO H. Enhancement of the intrinsic rate of natural increase induced by treatment of the diamondback moth, *Plutella xylostella* L. with sublethal concentration of methomyl. Japanese J. Appl. Ent. and Zool. 1984; 28:150-155.
9. Reddy GVP. Studies with sex pheromones of diamondback moth, *Plutella xylostella* (L.) (Lepidoptera : Plutellidae) *P.hd. Thesis*, University of Agricultural Sci., Bangalore, 1990.
10. Rothschild GHL, Wilson AGL, Malafani KW. Preliminary studies on the female sex pheromones of *Heliothis* species and their possible use in control programmes in Australia. *In. Proceedings of the International Workshop on Heliothis Management* (Eds. Reed, W., Kumble, V.), ICRISAT Centre, Patancheru, India. 1981; pp. 319-327.
11. Sannaveerappanavar VT, Viraktamath CA. Management of insecticide resistant diamondback moth, *Plutella xylostella* L. (Lepidoptera: Yponomeutidae) on cabbage using some novel insecticides. Mysore J Agricul. Sci. 1997; 31:230-235.
12. Sexena JD, Rai S, Srivastava KM, Sinha SR. Resistance in the field populations of diamondback moth to some commonly used synthetic pyrethroids. Indian J Ent. 1989; 51:265-268.
13. Shelton AM, Wyman JA. Time of tuber infestation and relationships between pheromone catches of adult moths, larval populations and tuber damage by the potato tuber moth. J Econ. Entomol. 1979; 72:599-601.
14. Srinivasan K, Krishnamoorthy PN. Indian mustard as a trap crop for management of major lepidopterous pests of cabbage. *Tropic. Pest Manage.* 1991; 37:26-32.
15. Tabashnik BE, Cushing NL. Leaf residue *Vs* tropical bioassays for assessing insecticide resistance in the diamondback moth. *Plutella xylostella (*L.) *DAO Plant Prot. Bull.* 1987; 35:11-14.