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Seasonal incidence of diamondback moth (*Plutella xylostella)* (Lepidoptera: Plutellidae) and its parasitoids on cabbage

B K CHAUBEY[1] and K SRINIVASA MURTHY[2]

ICAR-National Bureau of Agricultural Insect Resources, HA Farm Post, Bellary Road, Bengaluru, Karnataka 560 024

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ABSTRACT

The seasonal incidence of diamondback moth (*Plutella xylostella)* and its parasitoids in relation to climatological factors was studied with staggered sowings of cabbage during the years 2013 and 2014 at the NBAIR research farm at Attur, Bengaluru. The pest population peaked during the early summer, March-April months (342 and 243/60 plants) followed by post rainy season, August-October (184 and 208/60 plants) and was low during the early winter months December-January (65 and 68/60 plants) followed by July-August (98 and 96/60 plants). A maximum temperature of 30-35°C with a relative humidity of 61-75% favoured the buildup of the pest. The larval incidence had significant positive correlation with maximum temperature (r = 0.837; P = 0.01) and with minimum temperature (r = 0.594; P = 0.05). Rainfall and number of sunshine hours had a negative impact. The larval parasitoid *Cotesia vestalis* and the late larval-pupal parasitoid *Oomyzus sokolowskii* were found to be predominant during both the years of study. Parasitism by *C. vestalis* was maximum during August- September months (64.89-82.2%), was low during December-January months (41.5-47.5%). *O. sokolowskii* prevailed high during December- January months (33.33-37.5%) and low during February - March (8.82-8.75%) and July/August-September (6.25-10.0%). Occurrence of the parasitoids was more at minimum temperature of 16-19°C and maximum temperature of 19-33°C with relative humidity 62.5-73.5%.. Rainfall did not influence the activity of both the parasitoids. The activity of the parasitoids was in accordance with the population density of the pest during the various seasons. Augmentative releases of the parasitoids during the periods of their low incidence would provide for greater suppression of the pest and result in reduced usage of insecticides.

Key words: *Cotesia vestalis, Oomyzus sokolowskii*, *Plutella xylostella*, Seasonal incidencc

Diamondback moth (*Plutella xylostella)* is a cosmopolitan pest of cruciferous crops (cabbage, Chinese cabbage, Chinese kale, cauliflower, broccoli, radish, kohlrabi, turnip, beetroot, pak-choy, mustard and amaranthus) all over the world (Devi *et al*. 2004, Ahmad *et al*. 2009). Among the crucifer crops, cauliflower and cabbage are more preferred by the pest, as these have fleshy succulent leaves that provide both olfactory and gustatory stimuli (Chand and Choudhary 1977, Singh and Singh 1982).

The yield loss in India by the pest varied from 31-100% (Lingappa 2004), 52% (Krishna Kumar *et al*. 1986), 44.6% (Krishnaiah 1980), 80-95% (Dhumale *et al*. 2009), 50% (Uthamasamy *et al*. 2011) and 100% (Cardleron and Hare 1986, Devi *et al*. 2004). The annual cost of managing the pest in India was estimated to be 1 billion US dollar (Zalucki *et al*. 2012). The population buildup of the pest was due to high fecundity, reproductive potential, rapid turnover of generations (Magaro and Edelson 1990), seasonal migration patterns, warm climate, broad host range and availability of alternate weed hosts (Begum *et al.* 1996). In addition, climatological factors play a decisive role on the seasonal occurrence of the pest. Therefore, the seasonal occurrence of the pest and its natural enemies in relation to climatological factors was studied to understand the population dynamics of the pest and suggest sustainable management strategies.

MATERIALS AND METHODS

Staggered sowings of cabbage crop (variety Unnati), was taken up coinciding with rainy (July-September), summer (February-April) and winter (December to February) seasons during the years 2012-13 and 2013-14, to record the seasonal incidence of diamondback moth and its parasitoids. The field experiments were laid out at the Research farm, NBAIR , Attur campus . The crop was sown in a plot of 4 × 5 sq m.

The incidence was recorded from plots that were arbitrarily divided into four quadrants of equal size using the block and row numbers. From each quadrant 15 plants were randomly selected and incidence of the pest was noted at an interval of 10 days (total 60 plants were observed

[1]email: bkchaubey 1965@gmail.com, [2]email: ksm@ rediffmail.com, Division of Molecular Entomology.

from all the quadrants). Each quadrant was considered as a replicate. Care was taken not to select the same plant for further sampling by way of tagging the plants. The number of larvae and pupae obtained from the field collected leaf material was counted in the laboratory.

The climatological factors, viz. maximum and minimum temperatures, relative humidity, rainfall and sunshine hours were recorded during the period of study and the pest incidence was correlated with the factors.

The field collected larvae and pupae of the diamond back moth were segregated and kept in plastic containers covered with muslin cloth and kept for emergence of the parasitoids, under laboratory conditions. Fresh cabbage leaves were provided to the larvae for feeding. Upon emergence of the larval and pupal parasitoids the percent parasitism was recorded. Correlation of the incidence of the parasitoids in relation to the climatological factors was worked out.

RESULTS AND DISCUSSION

Seasonal incidence of diamondback moth

The seasonal incidence studied over a period of two years (2013 and 2014) indicated that the population of the pest was at its zenith during early summer, March-April months (342 and 243/60 plants) followed by post rainy season, August-October (184 and 208/60 plants) and was low during the month of December-January (65 and 68/60 plants) followed by rainy season July-August (98 and 96/60 plants). Significant differences were observed in the incidence of larval population during the various seasons, however the population was par during the summer months February-March and March-April of 2012-13. The pupal population of the pest was also high during early summer months March–April (46/60 plants and 37/60 plants) during the years 2012-13 and 2-013-14, respectively, followed by February-March months. Winter season (December-January) registered the minimum pupal population during both the years (9 and 6/60 plants) (Table 1). The pupal population significantly differed during the winter and summer seasons of 2012-13 and rainy season of 2013-14. The incidence was on par among the other seasons during 2013-14. Population during winter and summer was significantly more than summer and rainy seasons.

Our observations were in conformity with the reports of Sachan and Srivastava (1972) under different agro-climatic conditions of India and Chien (1974) who indicated higher build up of larval populations during February-March and April-August and lowest during June-August, respectively. However, Jayarathnam (1977) and Nagarkatti and Jayanth (1982) from Bengaluru, found significantly high build up of population during July-September compared to other seasons.

Nirmala Devi *et al*. (2004) reported appearance of DBM in February and its population peaked in mid of April at Palampur, Himachal Pradesh, while Ahmed and Ansari (2010) reported higher incidence during 2nd to 4th week of September in Aligarh. Population of the pest was abundant during September-October and March to April at Coimbatore, Ooty, Theni and Thenkasi in Tamil Nadu (Uthamswamy *et al*. 2011). High build up was noticed during February-March (late winter) and April to August (summer and rainy seasons) (Abraham and Padmanabhan 1968).

Table 1 Seasonal incidence of DBM and its parasitoids in the field during 2012-14

Year/Season/Generation	Month	No. of DBM/60 plants		Percent parasitism of larvae pupae		Temperature (°C)		Mean RH (%)	Rain (mm)
		Larvae	Pupae	*C. vestalis*	*O. sokolowskii*	Max.	Min.		
2012-13									
Winter I Gen	Dec-Jan	65	9	41.5	33.33	29	15	70.0	0.4
II Gen	Jan-Feb	126	34	81.0	29.41	29	15	63.5	
Summer I Gen	Feb-Mar	142	16	59.86	18.75	33	16	62.5	
II Gen	Mar-Apr	342	46	56.43	15.22	35	19	61.0	
Rainy I Gen	Jul-Aug	98	10	45.92	10.0	30	19	73.5	46.4
II Gen	Aug-Sept	184	16	54.89	6.25	31	19	75.5	169.2
2013-14									
Winter I Gen	Dec-Jan	68	8	.5	37.5	28	14	69.0	
II Gen	Jan-Feb	104	22	75.96	9.09	30	14	65.5	
Summer I Gen	Feb-Mar	94	34	81.91	8.82	30	18	64.5	10.0
II Gen	Mar-Apr	243	37	76.95	16.22	35	21	51.0	24.4
Rainy I Gen	July- Aug	96	22	82.29	22.73	29	19	73.5	75.0
II Gen	Aug-Sept	208	42	73.5	21.43	30	19	72.5	113.8
SEm	3.894	6.744							
CD (P=0.05)	10.9	18.95							

Table 2 Correlation of incidence of DBM and its parasitoids with weather parameters

Pest/natural enemies	Max temp.	Min temp.	RH (%)	Rainfall	Sunshine
Plutella xylostella larvae	0.837**	0.594*	NS	NS	NS
Plutella xylostella pupae	NS	NS	NS	NS	NS
Cotesia vestalis	0.784**	0.624*	NS	NS	NS
Oomyzus sokolowskii	NS	NS	NS	NS	NS

** Significant at P=0.05; *Significant at P=0.05

Climatological factors influenced the incidence of the pest. Our observations revealed that that a maximum temperature of 30-35 ^{0}C with a relative humidity of 61-75.5% favored the build-up of the pest. High rainfall however, did not influence the pest population. Maximum temperature (r = 0.837; P = 0.01) and minimum temperature (r = 0.594; P = 0.05) had significant positive correlation with the pest incidence, while relative humidity, rainfall and number of sunshine hours had a non significant correlation (Table 2).

Sivapragasam *et al*. (1988) reported that rainfall washed off 38% eggs of the pest. Talekar and Shelton (1993) and Palande *et al*. (2004) reported that decreased temperature lead to increased number of generations per season in Maharashtra. Shelton (2001) and Kobori and Amano (2003) indicated hot and dry season to be conducive for the development of the pest and rainfall decreased the incidence of the pest. Palande *et al*. (2004) reported that higher temperature during summer months was found to be congenial for increase in DBM population in Maharashtra. Ahmad and Ansari (2010) reported that incidence of DBM in Aligarh had a positive correlation with maximum, minimum temperature, sunshine hours and evaporation while rainfall and relative humidity had a negative influence. Talekar and Shelton (1993) suggested that increased temperature can lead to the production of more generations per season. Maximum temperature, minimum RH, wind speed and rainfall had positive non-significant correlation with larval population (Meena and Singhveer 2012) at Ranchi.

Higher incidence of the pest was observed during September and lower incidence during July at Peshawar in Pakistan (Ahmad *et al*. 2015). Maximum temperature and RH had a positive influence and rainfall had a negative effect on population dynamics of the pest. Irrigation can reduce infestation at dusk significantly. It was confirmed by Talekar and Shelton (1993) that rain can dislodge the larvae of *Plutella xylostella* from the plants and can drown the larvae in water. Iga (1985) reported 100% mortality of II instar larvae and with range of 14-71% of III to IV instar larvae due to rain. Sivapragasam *et al*. (1988) found that rainfall washed off 38% of eggs of the pest.

Seasonal incidence of parasitoids

Observations on the incidence of the parasitoids, revealed the occurrence of the early larval parasitoid, *Cotesia vestalis* and late larval –pupal parasitoid*, Oomyzus skolowskii* during the various seasons. *C. vestalis* peaked

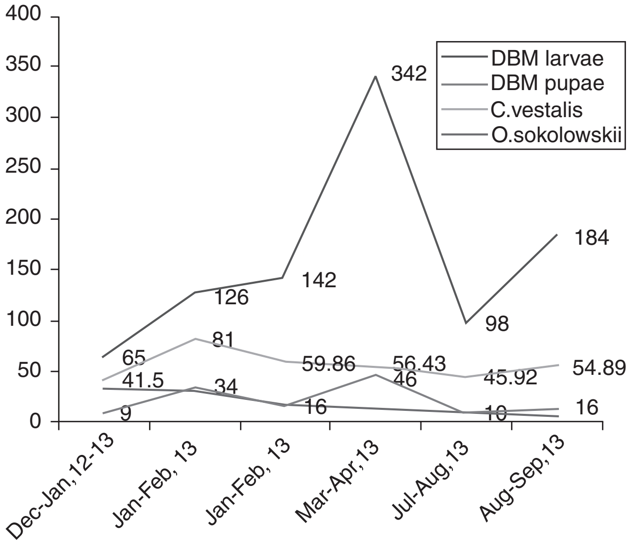

Fig 1 *Plutella xylostella* population and parasitism by *C. vestalis* and *O. sokolowskii* in various seasons during 2012-13

during March-April (187-193/60 plants) and low incidence was recorded during December-January (27-32/60 plants). Similarly *O. sokolowskii* was predominant during March-April (8-15/60 plants) and decreased during the months of July-September (2-3/60 plants) (Table 1). The activity of the parasitoids was in tandem with the population density of the pest during the various seasons. Prevalence of the parasitoids was more at minimum temperature of 16-19°C and maximum temperature of 19-33°C with a relative humidity 62.5-73.5%.

Parasitism by *C.vestalis* was maximum during August-September months (64.89–82.29%) and March-April months (56.43-76.95%). Early summer months, February-March registered 59.86-81.91% (Fig 1). The parasitism significantly differed during the various seasons.

However, during the summer and rainy seasons of both the years, the parasitism was on par**.** The parasitism by larval-pupal parasitoid was higher during winter months, December–January (33.33-37.5%), while the early summer months January-March/April recorded 15.22-29.4% parasitism, during both the years of study (Fig 2). The pupal parasitism was on par during all the seasons of both the years, except during winter of 2013-14, where there was difference in parasitism among the generations (Table 1). Our observations corroborate with reports of Kandoria *et al*. (1996) who indicated the activity of *C. vestalis* to be low during winter months. Ahmed and Ansari (2010) recorded the parasitoid to be dominant during summer months, while higher parasitism during August-September in Aligarh. *C. vestalis* showed highly significant positive correlation with maximum temperature (r = 0.784; P = 0.01) and significant correlation with minimum temperature (r = 0.624; P = 0.05), while the impact of climatological factors on the occurrence of *O. sokolowskii* was not significant (Table 2).

Our studies have established that seasonal incidence of DBM and its natural enemies are influenced by climatological factors that play a decisive role on their population dynamics.

The incidence of the pest population and parasitoid activity was density dependant. Winter season (December – January) and early summer season (February-March) sustained the activity of both. Therefore, augmentative releases of the parasitoids would aid in more effective suppression of the pest. Insecticidal interventions for management of the diamondback moth could be minimized with augmentative releases of the parasitoids when the activity of the parasitoids is at low ebb.

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