Research Article

SEASONAL INCIDENCE OF DIAMONDBACK MOTH FOR SOME CRUCIFEROUS VEGETABLES

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ABSTRACT

The diamondback moth (DBM) *Plutella xylostella* (Linnaeus) is an economically important pest of cruciferous crop in West Bengal, India. An extensive work is carried out at Agricultural Training Centre / State Agricultural Management and Extension Training Institute, Narendrapur, West Bengal regarding study of seasonal incidence of DBM for some cruciferous vegetables viz. green cabbage, red cabbage, Chinese cabbage, cauliflower and broccoli during two seasons i.e. 2013-14 and 2014-15. Early, mid-season and late varieties for all the vegetables were cultivated at institute's farm in three separate plots. The weather parameters such as maximum and minimum temperature, humidity, rainfall etc for the whole season were taken from the local meteorological observatory. The incidence of diamondback moth in all the vegetable plots was correlated with the weather data. The noticed incidence of larval population in terms number per plant was ranging from 0.20 to 5.20, 0.13 to 4.20, 0.13 to 4.66, 0.13 to 4.20 and 0.20 to 0.40 in 2013-14 and 0.13 to 5.60, 0.13 to 4.46, 0.13 to 4.20, 0.20 to 4.00 and 0.40 to 0.60 in 2014-15 for green cabbage, red cabbage, cauliflower, broccoli and Chinese cabbage respectively. Again, the above pests' incidence of larvae per plant was less in case of Chinese cabbage (0.20 to 0.60) than that of broccoli, red cabbage, cauliflower and green cabbage for two consecutive seasons. Hence, green cabbage was considered as preferred host plant for DBM incidence.

INTRODUCTION

In view of different agro climatic condition in the state of West Bengal, large numbers of varied horticultural crops including vegetables are produced. The vegetable crops have been identified as the best nutritive component of our daily diet. Vegetables as the "Food of Future" are being paid special attention to nutritional security. The present production of vegetables in our country and state is of about 178172.00 and 14683.66 ('000) MT out of which the cole crops contribute about 4170.52 and 325.57 ('000) MT in West Bengal and South 24 Paraganas.

A large number of farmers regularly cultivate different vegetables throughout the year. Among them highly grown vegetables are cauliflower, cabbage, exotic vegetables, carrot, radish, chilli, pea, spinach, turnip, fenugreek leaves, beet etc. In the present study the selected crops were green, red and Chinese cabbage, cauliflower and broccoli. The incidence of pests and diseases against these vegetables are very common. Usually they lead to a serious damage to the crop and ultimately reduction in crop yield. Among them, the diamondback moth (DBM) *Plutella xylostella* (Linnaeus) (Plutellidae: Lepidoptera) is the major destructive and damaging pest on cruciferous crops often seen in the farmers field. High build up of larval population has been reported during February and March (late winter) and April –August (Summer and mid rainy season) (Sachan and Srivastava, 1972).

The ideas of controlling this pest by using various techniques in combination with selective use of pesticides are gaining importance towards most effective and eco-friendly measures. In this regard our present paper focuses on the bio-ecology of key pest (DBM) of cole crops for early, mid and late varieties along with environmental situation.

MATERIALS AND METHODS

Field investigation on the incidence of the key pest species diamondback moth in five different cole crops viz. green cabbage, red cabbage , Chinese cabbage, broccoli, cauliflower were carried out in one of the major cole crop growing region located at Narendrapur, South 24 Parganas

, West Bengal from August to April during 2013-2014 and 2014-2015.

General package of practices were followed for all the vegetables throughout the season. Seed bed was prepared and nursery was raised for each crucifer and planted on the respective plot after ploughing, levelling and bed making. Irrigation was applied by furrow method. Necessary weeding was done manually and fertilizers (both organic and inorganic) were applied according to the recommended dose. The produce was harvested at stipulated time. Spraying or dusting of any pesticides was avoided for the entire plot for whole season.

A local meteorological observatory was already established at the institute's farm. Various data on weather parameters like maximum and minimum temperature, humidity and rainfall were taken on regular basis. Observation of diamondback moth on five different cole crops was recorded at seven days interval. In case of diamondback moth, larvae of different growth stages were counted from randomly selected tagged five plants per replication for each crops (green cabbage, red cabbage, Chinese cabbage, broccoli and cauliflower) and the mean number of larvae per plant was recorded. Thus the data obtained from the entire growing period in two different seasons was analyzed and presented graphically to study the pattern of incidence of this pest. The list of cultivated crop cultivars along with their special characters is presented in Table 1.

Table 1. Crop Cultivars

Crop	Cultivars	Characters
Broccoli	**Green Magic :** Sakata Seeds Crops Ltd; Yokohama, Japan	**Plant type**- Medium plant height, very vigorous and good uniformity
Red cabbage	**Red Globe:** Mikado Seed Growers Co Ltd, Japan	**Plant type-** Medium small size Head – Very uniform, deep red, Globular and solid head
Chinese cabbage	**Tropical Delight:** Sakata Seeds Crops Ltd; Yokohama, Japan	**Plant Type-** An extra early type, Medium vigorous plant Head-Compact, smooth, hairless, oval shaped, light green colour
Green cabbage	**Green Express**: Early variety	Heads Compact, dark green, with soft tender leaves
	Rare Ball: Mid and late season	An extremely hardy type, grown in all types of soil, compact, green globe shaped with short core
Cauliflower	**Barshalakshmi**: Early season	Curd compact, dome shaped, pure white, highly lucrative variety, cultivated during rainy season under high land condition
	Improved Japanese: Mid season	Curd compact, medium to large
	Snow ball: Late season	Curd compact, Large, Pure white

Cabbage and Cauliflower seeds were collected from Bharat Nursery Pvt. Ltd.

RESULTS AND DISCUSSION

DBM is the most serious pest of cruciferous crops and causes much more damage than any other insect pest. Attack of this pest leads to total economic loss of the crop at all stages of plant growth. The pest was quite serious on the mid season crop grown from middle of November to early December and caused much more damage from February – March during 2013-2014. The population build up of DBM was not so promising on early crop grown in 2014 -2015 season .The population of DBM gradually increased at the end of November and reached maximum during end of January to early part of February. The pest appeared in the field in September and established itself up to the end of November when the growth stage of the cole crops was at the vegetative phase of early varietal crop. During this period the larval population in term of number per plant was ranging from 0.20 to 1.00 in green cabbage, 0.13 to 0.86 in red cabbage, 0.13 to 1.00 in cauliflower, 0.13 to 0.66 in broccoli, 0.20 to 0.40 in Chinese cabbage. It showed increasing tendency of the larval population from end of September to end of November. After that pest activity showed decreasing tendency with the onset of cold condition from December to middle of January but did not totally exterminate the population from the field. It was mainly vegetative phase of mid varietal crop. The highest population build up in terms of larvae per plant recorded were 5.20, 4.20, 4.60, 4.00 and 0.40 for green cabbage, red cabbage, cauliflower, broccoli and Chinese cabbage respectively during middle of March to end of March in late crop (Table 2., Fig. 1. and Fig. 2.).

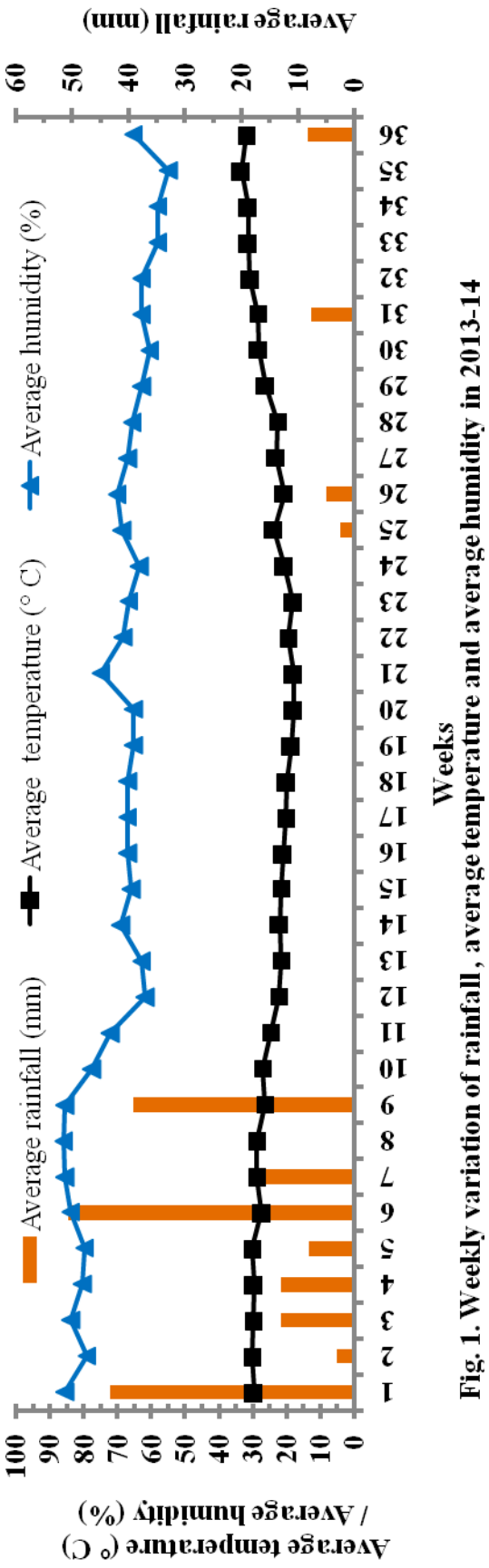

Fig. 1. Weekly variation of rainfall, average temperature and average humidity in 2013-14

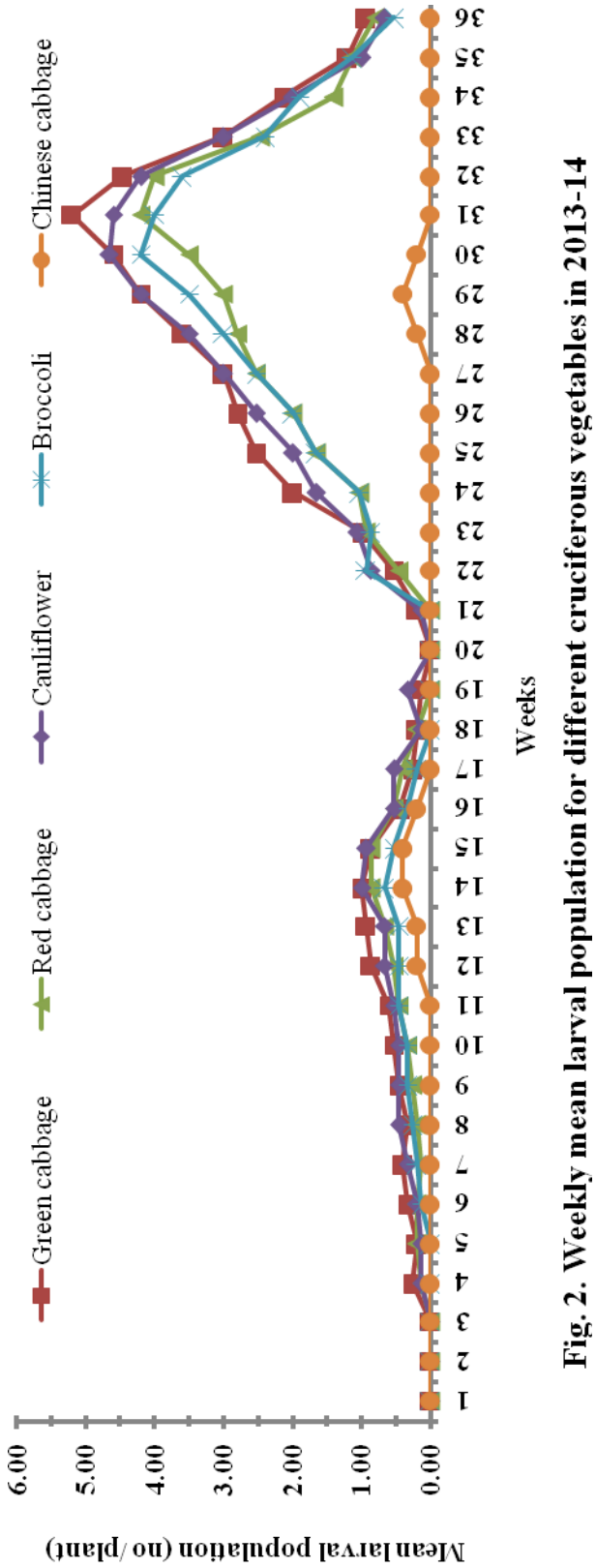

Fig. 2. Weekly mean larval population for different cruciferous vegetables in 2013-14

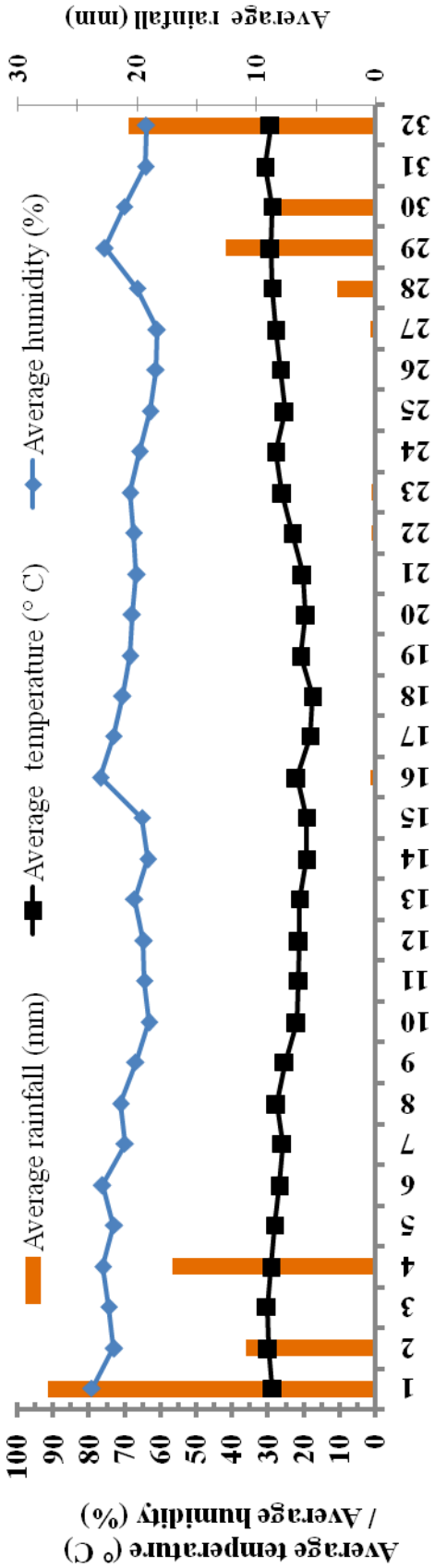

Fig. 3. Weekly variation of rainfall, average temperature and average humidity in 2014-15

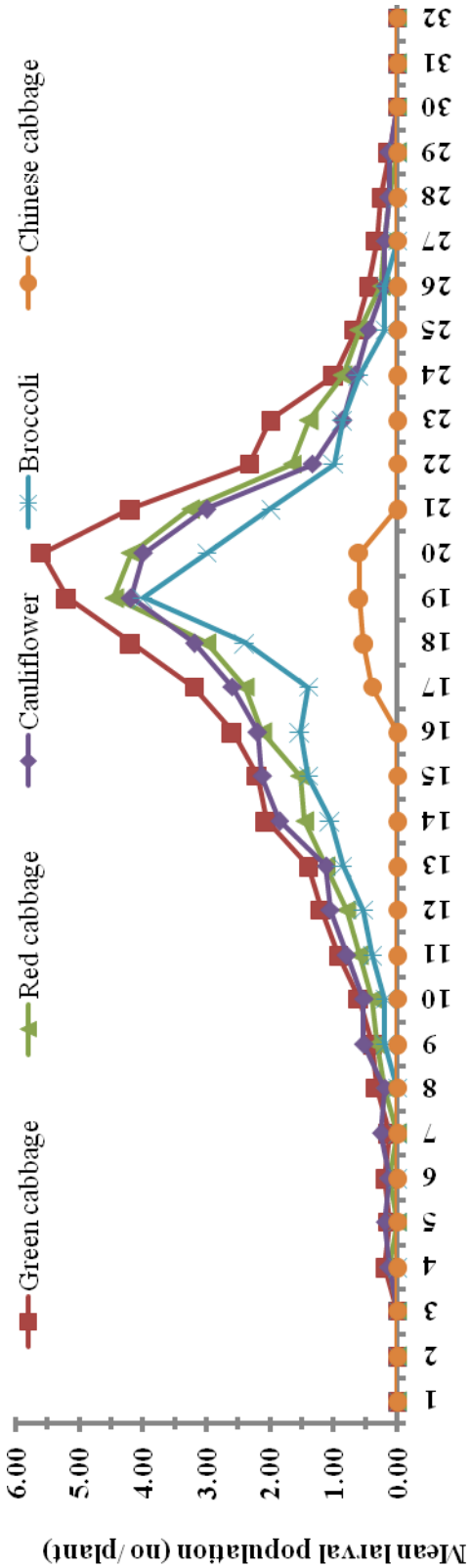

Fig. 4. Weekly mean larval population for different cruciferous vegetables in 2014-15

Table 2. Weekly variation of weather parameters and incidence of DBM for five different crops in 2013-2014

	2013-14						Mean larval population (no /plant)				
WK	Week duration	Av minT	Av maxT	Av min H	Av max H	Av RF	GC	RC	CF	BC	CC
1	26.08.2013-01.09.2013	26.86	32.57	74.29	96.86	43.4	0.00	0.00	0.00	0.00	0.00
2	02.09.2013-08.09.2013	26.29	34.43	64.86	93.71	3.3	0.00	0.00	0.00	0.00	0.00
3	09.09.2013-15.09.2013	26.14	33.86	71.71	96.29	13.0	0.00	0.00	0.00	0.00	0.00
4	16.09.2013-22.09.2013	26.00	33.57	66.29	94.86	13.0	0.26	0.13	0.13	0.00	0.00
5	23.09.2013-29.09.2013	26.00	34.71	66.29	93.71	8.1	0.20	0.20	0.13	0.00	0.00
6	30.09.2013-06.10.2013	24.43	30.57	72.29	96.00	50.9	0.33	0.20	0.20	0.13	0.00
7	07.10.2013-13.10.2013	24.43	33.43	74.57	96.86	17.14	0.40	0.13	0.33	0.20	0.00
8	14.10.2013-20.10.2013	24.43	33.43	75.14	97.14	0	0.33	0.20	0.46	0.26	0.00
9	21.10.2013-27.10.2013	23.57	29.43	74.57	96.57	39.29	0.46	0.26	0.46	0.33	0.00
10	28.10.2013-03.11.2013	22.86	31.57	61.43	94.00	0	0.53	0.33	0.46	0.33	0.00
11	04.11.2013-10.11.2013	19.43	30.14	51.43	93.14	0	0.60	0.46	0.53	0.46	0.00
12	11.11.2013-17.11.2013	16.86	28.00	45.14	78.57	0	0.86	0.53	0.66	0.46	0.20
13	18.11.2013-24.11.2013	15.86	27.71	46.14	80.00	0	0.93	0.66	0.66	0.46	0.20
14	25.11.2013-01.12.2013	16.29	28.29	45.43	92.86	0	1.00	0.86	1.00	0.66	0.40
15	02.12.2013-08.12.2013	15.86	27.71	42.57	89.71	0	0.86	0.86	0.93	0.53	0.40
16	09.12.2013-15.12.2013	14.86	27.43	43.43	90.86	0	0.44	0.53	0.53	0.33	0.20
17	16.12.2013-22.12.2013	14	26.71	42.86	91.71	0	0.26	0.40	0.53	0.20	0.00
18	23.12.2013-29.12.2013	14	26.43	42.86	91.14	0	0.20	0.20	0.13	0.00	0.00
19	30.12.2013-05.01.2014	13.14	24.29	40.29	90.57	0	0.13	0.00	0.33	0.00	0.00
20	06.01.2014-12.01.2014	12.29	23.86	41.14	89.71	0	0.00	0.00	0.00	0.00	0.00
21	13.01.2014-19.01.2014	13.43	22.71	57.71	92.57	0	0.20	0.00	0.13	0.00	0.00
22	20.01.2014-26.01.2014	13.71	25.71	40.57	96.29	0	0.53	0.46	0.86	0.93	0.00
23	27.01.2014-02.02.2014	12.43	24.00	39.43	94.29	0	1.00	0.93	1.06	0.86	0.00
24	03.02.2014-09.02.2014	14	27.57	34.86	92.57	0	2.00	1.03	1.66	1.03	0.00
25	10.02.2014-16.02.2014	16.43	31.43	46.00	91.43	2.57	2.53	1.66	2.00	1.66	0.00
26	17.02.2014-23.02.2014	15.14	26.43	47.71	92.86	5.14	2.80	2.00	2.53	2.00	0.00
27	24.02.2014-02.03.2014	17.43	29.00	40.86	93.14	0	3.00	2.53	3.00	2.53	0.00
28	03.03.2014-09.03.2014	17.14	28.29	39.14	92.57	0	3.60	2.80	3.50	3.00	0.20
29	10.03.2014-16.03.2014	20.29	32.57	36.57	89.43	0	4.20	3.00	4.20	3.50	0.40
30	17.03.2014-23.03.2014	23	34	33.71	87.71	0	4.60	3.50	4.66	4.20	0.20
31	24.03.2014-30.03.2014	23.29	34.00	36.57	89.71	7.71	5.20	4.20	4.60	4.00	0.00
32	31.03.2014-06.04.2014	25	36.86	40.57	85.71	0	4.46	4.00	4.20	3.60	0.00
33	07.04.2014-13.04.2014	25.71	37.29	32.86	83.71	0	3.00	2.46	3.00	2.40	0.00
34	14.04.2014-20.04.2014	24.57	38.29	30.57	86.00	0	2.13	1.40	2.00	1.90	0.00
35	21.04.2014-27.04.2014	26.71	40.43	32.29	78.00	0	1.20	1.13	1.00	1.13	0.00
36	28.04.2014-04.05.2014	26.14	37.86	44.86	86.29	8.29	0.93	0.80	0.66	0.53	0.00

WK- Week, AV min T- Average minimum temperature, AV max T- Average maximum temperature, AV min H- Average minimum humidity, AV max H- Average maximum humidity, AV RF – Average rainfall

GC- Green cabbage, RC- Red cabbage, CF- Cauliflower, BC- Broccoli, CC- Chinese cabbage

Table 3. Weekly variation of weather parameters and incidence of DBM for five different crops in 2014-2015

	2014-15						Mean larval population (no /plant)				
Wk		Av minT	Av maxT	Av min H	Av max H	Av RF	GC	RC	CF	BC	CC
1	18.09.2014-24.09.2014	25.29	32.14	62.86	95.71	27.43	0.00	0.00	0.00	0.00	0.00
2	25.09.2014-01.10.2014	25.71	34.29	51.71	94.57	10.86	0.00	0.00	0.00	0.00	0.00
3	02.10.2014-08.10.2014	26.29	34.14	54.00	95.14	0.00	0.00	0.00	0.00	0.00	0.00
4	09.10.2014-15.10.2014	25.00	33.29	57.14	95.14	17.00	0.20	0.13	0.13	0.00	0.00
5	16.10.2014-22.10.2014	23.00	33.29	53.43	92.86	0.00	0.13	0.00	0.20	0.00	0.00
6	23.10.2014-29.10.2014	23.00	30.57	57.43	95.43	0.00	0.20	0.13	0.13	0.00	0.00
7	30.10.2014-05.11.2014	21.14	30.86	48.86	91.43	0.00	0.13	0.00	0.26	0.00	0.00
8	06.11.2014-12.11.2014	21.86	33.29	52.86	89.71	0.00	0.33	0.20	0.20	0.00	0.00
9	13.112014-19.11.2014	19.71	30.86	46.86	87.43	0.00	0.40	0.33	0.53	0.20	0.00
10	20.11.2014-26.11.2014	15.57	28.57	40.86	85.71	0.00	0.60	0.40	0.53	0.20	0.00
11	27.11.2014-03.12.2014	14.86	28.00	39.71	89.43	0.00	0.93	0.60	0.80	0.40	0.00
12	04.12.2014-10.12.2014	15.71	26.86	39.43	90.29	0.00	1.20	0.80	1.06	0.53	0.00
13	11.12.2014-17.12.2014	15.71	26.57	44.57	90.29	0.00	1.40	1.13	1.13	0.86	0.00
14	18.12.2014-24.12.2014	13.29	25.14	39.71	87.43	0.00	2.06	1.46	1.86	1.06	0.00
15	25.12.2014-31.12.2014	13.29	25.14	41.43	89.14	0.00	2.20	1.53	2.13	1.40	0.00
16	01.01.2015-07.01.2015	17.43	26.71	60.29	93.43	0.43	2.60	2.13	2.20	1.53	0.00
17	08.01.2015-14.01.2015	12.14	24.29	54.29	92.29	0.00	3.20	2.40	2.60	1.40	0.40
18	15.01.2015-21.01.2015	11.57	23.57	50.29	91.29	0.00	4.20	3.00	3.20	2.40	0.53
19	22.01.2015-28.01.2015	14.71	27.00	46.29	90.86	0.00	5.20	4.46	4.20	4.00	0.60
20	29.01.2015-04.02.2015	13.57	25.29	47.43	88.86	0.00	5.60	4.20	4.00	3.00	0.60
21	05.02.2015-11.02.2015	14.43	26.29	42.86	90.86	0.00	4.20	3.26	3.00	2.00	0.00
22	12.02.2015-18.02.2015	18.00	28.29	43.14	92.00	0.29	2.33	1.66	1.33	1.00	0.00
23	19.02.2015-25.02.2015	20.43	31.71	44.00	93.14	0.29	2.00	1.39	0.86	0.86	0.00
24	26.02.2015-04.03.2015	22.00	33.57	39.71	92.29	0.00	1.00	0.86	0.66	0.60	0.00
25	05.03.2015-11.03.2015	18.29	32.43	35.43	90.57	0.00	0.66	0.60	0.46	0.20	0.00
26	12.03.2015-18.03.2015	20.14	32.71	32.29	90.57	0.00	0.46	0.26	0.20	0.20	0.00
27	19.03.2015-25.03.2015	22.14	33.57	32.86	89.43	0.43	0.33	0.20	0.20	0.00	0.00
28	26.03.2015-01.04.2015	24.00	33.57	39.71	93.43	3.14	0.26	0.13	0.13	0.00	0.00
29	02.04.2015-08.04.2015	24.43	34.14	58.57	92.86	12.57	0.13	0.00	0.13	0.00	0.00
30	09.04.2015-15.04.2015	23.71	33.86	47.71	92.86	8.86	0.00	0.00	0.00	0.00	0.00
31	16.04.2015-22.04.2015	26.14	35.43	39.14	89.43	0.00	0.00	0.00	0.00	0.00	0.00
32	23.04.2015-29.04.2015	24.43	34.14	38.57	89.71	20.71	0.00	0.00	0.00	0.00	0.00

WK- Week, AV min T- Average minimum temperature, AV max T- Average maximum temperature, AV min H- Average minimum humidity, AV max H- Average maximum humidity, AV RF – Average rainfall

GC- Green cabbage, RC- Red cabbage, CF- Cauliflower, BC- Broccoli, CC- Chinese cabbage

The weather parameters viz. average minimum and maximum temperature of 17.14-23.9^0 C to 28.29-34^0 C , average minimum and maximum relative humidity of 36.57 - 39.14% to 89.71- 92.57% and average rainfall of 0.00 to 7.71mm favoured rapid multiplication of larval population. It caused sharp increase in the graph of larval population and reached the peak during end of February to end of March. Among the cruciferous crops tested against DBM attack, Chinese cabbage was tolerant to DBM larval feeding. A few larvae were found to feed on the crop during high build up of this pest population occurred on other cruciferous vegetables like green cabbage, cauliflower, red cabbage and broccoli in both the seasons. These findings also matched with that of Das (2003).

Diamondback moth started its feeding activity in September during 2014-2015. It showed moderate increasing trend from mid December to first week of January. Thereafter, the population increased and highest population build up of DBM in terms of larvae per plant was recorded as 5.20 - 5.60, 4.20 -4.46, 4.00- 4.20, 3.00 -4.00, 0.53-0.60 on green cabbage, red cabbage, cauliflower, broccoli and Chinese cabbage from end of January to first week of February (Table 3., Fig. 3. and Fig. 4.). It was mainly harvesting time of mid season crop and early part of late season crop. The activity of pest population showed increasing tendency in terms of their infestation during cold condition of previous season (December –January, 2013-2014), when the average minimum and maximum temperature was 13.57 - 14.71^{0}C and 25.29 - 27^{0}C ,average minimum and maximum humidity was 46.29 - 47.43 % and 88.86 - 90.86 % , average rainfall was 0.00 mm for late season of mid varietal crop.

After that the population build up also declined gradually up to end of late varietal crop when the average minimum and maximum temperature was 24.00 - 24.43^{0}C and 33.57^{0}C - 34.14^{0}C and average minimum and maximum relative humidity was 39.71 - 58.57 % and 92.86 - 93.43 % and average rainfall was 3.4 to 12.57 mm.

Rawat *et al.* (1968) observed the seasonal incidence of DBM at Madhya Pradesh and Kodaikonal of cabbage crop for early, mid and late season crop. Abraham and Padmanabhan (1968) reported high build up of DBM larval population was active during Feb- March (late winter) and April – August (summer and mid rainy season). Nagarkatti (1982) showed high build up of DBM larval population during rainy season (July – September) as compared to other season. Debjani and Singh (1994) assessed field density of *Plutella xylostella* over period of two cropping seasons from January to April and maximum abundance was observed during March. It has some similarity with present seasonal study of DBM on different cole crops (green cabbage, cauliflower, red cabbage, Chinese cabbage and broccoli) from early to late transplanting crop seasons.

Das (2003) observed that DBM *(P. xylostella)* was quite serious on the early crop grown during August -September and late crop from February-March in his investigation on green cabbage, cauliflower, red cabbage, Chinese cabbage respectively which had more or less similarity with present findings.

Ahamad and Ansari (2010) studied that seasonal abundance of *P. xylostella* on cauliflower was significantly affected by temperature, humidity and rainfall as well as parasites in three localities of Aligarh i.e. Mathura Road, G.T. Road and Punjipur Village, Uttar Pradesh from July 2004 to April 2005 and in the same months in 2005-2006. A number of abiotic and biotic mortality factors interacting together and affected by the natural integration population dynamics of *Plutella xylostella* was monitored during rainy seasons (July – September) as compared to other factors (Nagarkatti and Jayanath, 1982). Climatic condition including higher temperature and increased rainfall were observed as major factors which regulate the population dynamics of *P. xylostella* (Harcourt, 1986) while hot and dry condition are known to be conducive for *P. xylostella* (Shelton, 2001). Although egg production and larval survival of *P. xylostella* were inhibited by temperature above 30^{0}C (Yamada and Kawaski, 1983), Kuwahara *et al.* (1995) reported that *P. xylostella* maintained consistently high production density through the year even during hottest season of March to May. High temperature, (Hwang, 1970, Leu and Lee, 1984) food availability and heavy rain (Leu and Lee 1984, Talekar and Lee, 1985) are important factors affecting the DBM population. These types of findings had also some similarity with present results.

CONCLUSIONS

Among the cruciferous crops tested against the attack of DBM, Chinese cabbage was noticed to be tolerant to larval feeding. A few larvae were found to be fed on the crop during high built up of this pest population as compare with other cruciferous vegetables like green cabbage, cauliflower, red cabbage and broccoli.

The remarkable damage was noticed on green cabbage and cauliflower. For broccoli, the damages caused by DBM were not so significant. The field studies also confirmed that among the cruciferous crops, green cabbage was the preferred host plant and Chinese cabbage was the non host crop against diamondback moth.

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