Population dynamics of major insect pests and their natural enemies in Cabbage

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ABSTRACT

Major insect pests, which caused maximum yield losses in cabbage, were mustard aphid, *Lipaphis erysimi*, diamond back moth (DBM), *Plutella xylostella*, Cabbage butterfly, *Pieris brassicae*, Mustard aphid was noticed from last week of December while diamond back moth was observed during first week of February and the cabbage butterfly appeared during 2nd week of January during both *rabi* 2009-2010 and 2010-2011. Peak incidence of mustard aphid (169.9 aphids /plant), diamond back moth (7.9 larvae /plant), cabbage butterfly (27.7 caterpillars /plant) was recorded during 2nd week of March , 1st week of March and 2nd week of March, respectively. Among different abiotic factors, the incidence of mustard aphid, diamond back moth and cabbage butterfly showed significant positive correlation with maximum temperature (r = +0.582,+0.490,+0.572), minimum temperature (r = +0.567, +0.513, +0.570), sunshine hours (r = +0.728, +0.654, +0.726) and evaporation (r = +0.567, +0.372, +0.562), whereas significant negative correlation with morning and evening relative humidity was detected. On the other hand, rainfall was not found to influence aphids, diamond back moth and cabbage butterfly in both years, rainfall (r = + 0.698, +0.779), sunshine hours (r = +0.376, +0.342) and wind (r = +0.291), had significant positive influence on the aphids and DBM larvae while other weather parameters did not have significant influence with aphids and DBM larvae. But maximum temperature (r = + 0.433), minimum temperature (r = +0.352), rainfall (r =+ 0.359), sunshine hours (r = +0.665) and evaporation (r = +0.510) had significant positive influence on the cabbage butterfly caterpillars.

Key words: Abiotic factors, *Brassica olenacea*, Population dynamics.

Cabbage (*Brassica oleracea* var. *capitata* L**.**) is a popular leafy green vegetable. One of the major constraints of not attaining higher yield of crucifers is the damage caused by insect pests. The major insect pests, which cause maximum yield losses in cabbage are Diamond back moth (DBM), *Plutella xylostella* L.; Cabbage butterfly, *Pieris brassicae* L.; leaf webber, *Crocidolomia binotalis*; cabbage borer, *Hellula undalis* Fab., mustard aphid, *Lipaphis erysimi* (Kalt.) and cabbage aphid, *Brevicoryne brassicae* L., The DBM is the most destructive pest in cabbage growing areas of the world. The peak activities were observed during mid February on different brassica genotypes. Therefore, this study was undertaken during the *rabi* crop seasons.

Materials and Methods

Cabbage cv. Golden Acre was sown in 450 m^2 area by adopting 60 × 45 cm spacing, divided into 18 plots each measuring 5×5 m, at Division of Entomology, I.A.R.I., New Delhi during 2009-2010 and 2010-2011. No insecticidal treatment was applied at any stage of the crop growth. Observations on population of major pests and their natural enemies were on 50 randomly selected cabbage plants in experimental field from pest appearance until harvest of crops at weekly interval. It was then, correlated with weather parameters *viz.,* maximum temperature (T_{Max}), minimum temperature (T_{Min}) R.H. morning (RH_{Mor}), R.H. evening (RH_{eve}) rainfall (RF), wind speed (WS) and sunshine hrs (SSH), evaporation (Evp) and biotic factors *viz.,* coccinellids.

Results and Discussion

Aphids (*L. erysimi*) first appeared in 52nd and 51th S.W. during 2009-2010 and 2010-2011, respectively. The population of aphids reached at peak of 169.9 aphids / plant in 10th standard week during 2009-2010, while it was 157.8 / plant in 8th S.W. during 2010-2011 (Table 1 & 2). The results indicated that maximum temperature (r = 0.582), minimum temperature (r = 0.567), wind speed (r = 0.596), sunshine hrs (r = 0.728), and evaporation (r = 0.567) had significant positive influence on the aphids while morning R.H. (r = -0.681) and evening R.H. (r = -0.625) had significant negative influence. On the other hand, rainfall did not influence aphids in two years, rainfall (r = 0.698), wind (r = 0.291), sunshine hrs (r = 0.376) had significant positive effect and morning R.H. (r = -0.313) had significant negative influence on the aphids, while other weather parameters did not influence aphids (Table 3 & 4). Jat *et al.* (2006) reported peak activity was correlated with abiotic factors. Insect population had significantly positive with maximum temperation and rainfall (Kumar *et al.,* 2007).

Table 1. Weather parameters, insect pests and natural enemies population during 2009-2010.

Standard week	Max Temp (^{0}C)	Min Temp (^{0}C)	R.H. (%) Mor.	R.H. (%) Ev.	Rainfall (mm)	Wind speed (km/hr)	Sunshine hours	Evapo-ration (mm)	Aphid	DBM	*Pieris*	*Apanteles*	Coccin-ellids
45	29.7	14.1	89	55	0	2.2	4.5	4.5	0	0	0	0	0
46	25.3	15	89	55	14.2	2.7	2.7	2.9	0	0	0	0	0
47	25	7.5	93	41	0	3.2	7.1	2.4	0	0	0	0	0
48	25.1	7.7	90	44	0	1.7	6	2.3	0	0	0	0	0
49	25.3	8.2	95	48	0	1.8	5.8	2.2	0	0	0	0	0
50	23.3	9.6	91	48	0	1.6	2.4	2	0	0	0	0	0
51	22	5.2	89	37	0	2.7	4.9	1.6	0	0	0	0	0
52	20.8	3.1	93	35	0	2.8	3.9	2	1.1	0	0	0	0
1	16.7	6.4	93	70	0	5.1	1.7	2.3	3.1	0	0	0	0
2	13.8	6.9	91	63	0	3.3	0.7	1.6	6.5	0	1.67	0	0
3	17	6	93	63	0	3.2	2.3	1.5	18.4	0	2.41	0	0
4	20.7	6.6	95	56	0	1.4	3.2	1.5	53.21	0	4.33	0	1
5	23.6	7.2	92	39	0	3.4	6.4	1.5	65.62	0.45	8.32	0	1.4
6	24.7	10.9	90	49	11.8	3.9	4.8	2.7	76.4	1.17	12.39	1	2.8
7	22.2	8.2	92	45	0	3.4	4.9	2.5	84.3	3.33	15.89	2.2	3.6
8	25.4	10.3	88	39	1.2	3.9	7.7	1.7	110.2	6.13	19.94	3	4.2
9	30.3	14.5	87	33	0	4	7.9	3.1	148.5	7.9	25.68	4	5.7
10	29.1	13.4	82	31	0	6	8.8	5.1	169.9	5.2	27.1	3.1	6.6
11	31.8	13.6	87	27	0	3.3	8.9	5.8	138.2	3.44	24.94	2	5.4
12	36.7	16.6	82	23	0	3.7	9	6.1	116.2	2.3	16.5	1	3.4

Table 2. Weather parameters, insect pests and natural enemies population during 2010-2011.

Standard week	Max Temp (^{0}C)	Min Temp (^{0}C)	R.H. (%) Mor.	R.H. (%) Ev.	Rainfall (mm)	Wind speed (km/hr)	Sunshine hours	Evapo-ration (mm)	Aphid	DBM	*Pieris*	*Apanteles*	Coccin-ellids
45	29.2	13.8	95	41	0	0.5	3.7	3.2	0	0	0	0	0
46	26.7	16.2	93	59	9	0.4	0.9	2.3	0	0	0	0	0
47	24	13	91	56	0.8	1.3	3.6	2.9	0	0	0	0	0
48	23.8	8.6	91	38	0	1.1	5.8	2.5	0	0	0	0	0
49	22.3	5.5	90	43	0	0.2	1.5	2.2	0	0	0	0	0
50	21.5	5.3	87	35	0	1.7	3.8	2.2	0	0	0	0	0
51	21.8	5.9	90	41	0	1.5	4.2	2.6	1.1	0	0	0	0
52	18.5	8.3	87	63	0.7	0.7	1.7	1.7	2.02	0	0	0	0
1	13.8	5.4	90	63	0	6.5	1.2	2.2	5.2	0	0	0	0
2	15.9	4.2	87	60	0	3.8	3.1	1.8	16.4	0	1.2	0	1
3	20	5.8	90	29	0	5.8	6.2	3.5	51.22	0	3.5	0	2.6
4	21.2	5.9	90	35	0	3.2	5.2	3.5	72.3	1.5	5.2	0	3.4
5	21.6	6.2	83	38	0	3.1	5.2	3.3	102.41	2.2	8.1	1	4.2
6	24.6	10.3	93	44	6.4	2.8	5.4	3	123.11	5.4	10.3	2.7	4.6
7	22.6	11.3	89	58	21.1	4	3.6	2.9	138.21	6.2	13.6	3.2	6.2
8	22.6	8.5	83	46	15.4	1.3	5.6	2.7	157.8	8.1	17.8	4.2	7.1
9	22.4	10.4	93	58	9.3	2.9	3.8	1.8	101.2	3.2	21.9	2.1	5.3
10	25.5	11.9	89	42	0	3.1	7.2	3.5	54.52	3	22.7	2.2	2.3
11	30.1	12.1	92	37	0	2.3	8.5	4.9	42.23	2.2	26.3	1	2.1
12	32.5	15	95	29	0	2	6.8	5.1	35.24	1	15	0	1.5

The infestation of DBM larvae started from 5th and 4th S.W. during 2009-2010 and 2010-2011, respectively. The larval population reached at peak of 5.8 / plant during 9th standard week during 2009-2010, while it was 8.1 / plant in 8th S.W. during 2010-2011 (Table 1 & 2). The results revealed that maximum temperature (r = 0.490), minimum temperature (r = 0.513), wind (r = 0.553), sunshine hrs (r = 0.654), and evaporation (r = 0.372) had significant positive influence on DBM larvae while morning R.H. (r = -0.600) and evening R.H. (r = -0.543) had significant negative effect on the other hand rainfall did not influence DBM larvae during 2009-2010. The DBM had significant positive relation with rainfall (r = 0.779) and sunshine hrs (r = 0.342) (Table 3 & 4).

Hemchandra and Singh (2007) reported that population dynamics of *P. xylostella* on cabbage agro ecosystem for three cropping seasons in Manipur. Initially the pest density was very low, i.e., 0.10, 0.05 and 0.20 larvae/plant, during first, second and third year, respectively. Their abundance gradually increased reaching the peak values of 16.15, 28.05 and 20.45 larvae/plant with the infestation of 90% (2001-2002), 70% (2002-2003) and 95% (2003-04) during March. Kumar *et al.* (2007) also correlated weather parameters with population build up of insect pests of cabbage.

Table 3. Correlation of insect pests and natural enemies with weather parameters 2009-2010

	T_{Max}	T_{Min}	RH_{Mor}	RH_{eve}	RF	WS	SSH	Evp	*M. Aphid*	*DBM*	*Pieris*	*Apanteles*	*Coccin-ellids*
T_{Max}	1												
T_{Min}	0.813**	1											
RH_{Mor}	-0.717**	-0.760**	1										
RH_{eve}	-0.756**	-0.377**	0.626**	1									
RF	0.041	0.326*	-0.065	0.188	1								
WS	0.105	0.248	-0.515**	-0.178	0.034	1							
SSH	0.831**	0.512**	-0.629**	-0.873**	-0.190	0.320*	1						
Evp	0.815**	0.793**	-0.772**	-0.538**	-0.001	0.341*	0.614**	1					
M.Aphid	0.582**	0.567**	-0.681**	-0.625**	-0.070	0.596**	0.728**	0.567**	1				
DBM	0.490**	0.513**	-0.600**	-0.543**	-0.106	0.553**	0.654**	0.372**	0.873**	1			
Pieris	0.572**	0.570**	-0.679**	-0.624**	-0.061	0.604**	0.726**	0.562**	0.988**	0.911**	1		
Apanteles	0.472**	0.506**	-0.595**	-0.526**	-0.068	0.577**	0.637**	0.396**	0.884**	0.989**	0.927**	1	
Coccinellids	0.583**	0.576**	-0.687**	-0.628**	-0.047	0.611**	0.730**	0.578**	0.983**	0.910**	0.995**	0.934**	1

Table 4. Correlation of insect pests and natural enemies with weather parameters 2010-2011.

	T_{Max}	T_{Min}	RH_{Mor}	RH_{eve}	RF	WS	SSH	Evp	*M. Aphid*	*DBM*	*Pieris*	*Apanteles*	*Coccin-ellids*
T_{Max}	1												
T_{Min}	0.802**	1											
RH_{Mor}	0.563**	0.604**	1										
RH_{eve}	-0.475**	0.065	-0.097	1									
RF	0.037	0.282*	-0.130	0.388**	1								
WS	-0.502**	-0.380**	-0.128	0.052	0.017	1							
SSH	0.511**	0.161	0.043	-0.710**	-0.119	0.140	1						
Evp	0.703**	0.420**	0.314*	-0.674**	-0.172	0.098	0.778**	1					
M.Aphid	0.036	0.028	-0.313*	-0.042	0.698**	0.291*	0.376**	0.177	1				
DBM	0.131	0.158	-0.280*	0.052	0.779**	0.110	0.342*	0.139	0.930**	1			
Pieris	0.433**	0.352*	0.031	-0.156	0.359*	0.157	0.665**	0.510**	0.644**	0.675**	1		
Apanteles	0.097	0.169	-0.286*	0.129	0.777**	0.107	0.305*	0.043	0.886**	0.977**	0.691**	1	
Coccinellids	0.028	0.022	-0.303	-0.031	0.710**	0.298*	0.378**	0.161	0.991**	0.911**	0.670**	0.872**	1

The cabbage butterfly (*P. brassicae*) appeared during 2nd S.W. both during 2009-2010 and 2010-2011. The larval population reached at peak of 27.1 / plant in 11th S.W. during 2009-2010, while it was 26.3 / plant in 11th standard week during 2010-2011 (Table 1 & 2). Maximum temperature (r = 0.572), minimum temperature (r = 0.570), wind speed (r = 0.604), sunshine hrs (r = 0.726), and evaporation (r = 0.562) had significant positive influence on the cabbage butterfly caterpillars while morning R.H. (r = -0.679) and evening R.H. (r = -0.624) was negative effect. Similar results on pod bug was reported by Misra and Das (2001).

Reddy and Kumar (2005) and Rai *et al.* (2000) observed that the pest population had non-significant negative correlation with maximum, minimum and temperatures while R.H. showed significant negative correlation with (r) values. Wind velocity showed non-significant, negative correlation, while sunshine hours showed non significant positive correlation with population of *P. brassicae* L.

The incidence of coccinellids when correlated with meteorological data indicated that maximum temperature (r = 0.583), minimum temperature (r = 0.576), wind speed (r = 0.611), sunshine hrs (r = 0.630), evaporation (r = 0.364) had significant positive influence coccinellids while morning R.H. (r = -0.689) and evening R.H. (r = -0.628) had significant negative influence (Table 4). Patel and Das (2010) attributed the build up of *Coccinellids* population to temperature and host availability.

The aphidophoguous lady bird beetle, *C. septempunctata* L. is one of the potential predators of the mustard aphid, *L. erysimi* (Kalt), a key pest of the rapeseed and mustard. The beetle occupies quite a remarkable place among the naturally occurring biocontrol agents of mustard aphid (Patel & Das 2010).

The first occurrence of *Apanteles plutellae* pupae was found in 6th and 5th standard week during 2009-2010 and 2010-2011, respectively. The pupae number reached at peak of 4 / five plants in 9th S.W. while it was 4.2 / 5 plants in 7th S.W. (Table 1 & 2). The incidence of *A. plutellae* on cabbage was correlated with the meteorological data, followed the same trend as above. The braconid *Cotesia plutellae* (*Apenteles plutellae*) and the ichneumonid *Diadegma insularies* were the predominant parasitoids reared from larvae. Parasitism of *P. xylostella* by *Cotesia plulellac* was host and temperature dependent. Similar results were also observed by Kumar *et al.* (2008).

Monitoring of pests and natural enemies is first and foremost step in IPM programme. The population dynamics of major insect pests and their natural enemies in cabbage in two consecutive years showed the incidence and peak time of the pests and natural enemies were observed. Mustard Aphid first appeared in the 52nd and 51th standard week, the infestation of DBM larvae started from 5th and 4th standard week and cabbage butterfly appeared during 2nd standard week during both 2009-2010 and 2010-2011, respectively. The population of aphids reached at peak of 169.9 aphids / plant in 10th standard week, 157.8 per plan in 8th standard week, The DBM larval population reached at peak of 5.8 / plant in 8th standard week, 8.1 / plant during 9th standard week and The cabbage butterfly larval population reached at peak of 27.1 / plant in 11th standard week and 26.3 / plant in 11th standard week during 2009-2010 and 2010-2011 respectively, Among different abiotic factors, the incidence of mustard aphid, diamond back moth and cabbage butterfly showed significant positive correlation with maximum temperature (r = +0.582,+0.490,+0.572), minimum temperature (r = +0.567, +0.513, +0.570), sunshine hours (r = +0.728, +0.654, +0.726) and evaporation (r = +0.567, +0.372, +0.562), whereas significant negative correlation with morning and evening R.H. was detected. Hansan and Singh (2011) also reported similar results on *L. erysimi.* The population dynamics of cabbage crop helped to plan the pest management strategies in advance and to take the timely control measures. Hence, as a result, the crop losses can be minimized and elevate the production.

References

Hasan, Wajid and C.P. Singh (2011). Field assessment of mustard aphid, *Lipaphis erysimi* on cultivars of Indian mustard. *Ann. Pl. Protec. Sci.* **19**: 51-54.

Jat, D.S., M.C. Jat and M.M. Sharma (2006). Seasonal incidence of insect pests of mustard in relation to abiotic factors. *Ann. Pl. Protec. Sci.* **14**: 475-476.

Kumar, Prashant, C.S. Prasad and G.N. Tiwari (2007). Population intensity of insect pests of cabbage in relation to weather parameters. *Ann. Pl. Protec. Sci.* **15**: 245-246.

Kumar, Rakesh, S. Ali and Umesh Chandra (2007). Seasonal incidence of insect pest on *Vigna mungo* and its correlation with abiotic factors. *Ann. Pl. Protec. Sci.* **15**: 366-369.

Kumar, Suneel, M.A. Khan, Arvind Kumar and Kuldeep Sharma (2008). Biodiversity of natural enemies in paddy ecosystem and their seasonal dominance. *Ann. Pl. Protec. Sci.* **16**: 381-383.

Misra, H.P. and D.D. Das (2001). Seasonal activity of the pod bug on pigeon pea and its correlation with weather parametes. *Ann. Pl. Protec. Sci.* **9**: 47-50.

Patel, Yogesh and S.D. Das (2010). Effect of insecticides on population of *Coccinella septumpunctata* and *Chrysoperla carnea* in cotton field. *Ann. Pl. Protec. Sci.* **18**: 362-365.

Rai, A.K., R.B.P. Sinha and A.K. Singh (2000). Effect of abiotic factors on the population of rice leaf folder. *Ann. Pl. Protec. Sci.* **13**: 41-43.

Reddy, N.A. and C.T. Ashok Kumar (2005). Influence of weather factors on abundance and management of serpentine leaf minor on tomato. *Ann. Pl. Protec. Sci.* **13**: 315-318.