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IMPACT OF AGRO-CLIMATIC DIVERSITY ON DIAMONDBACK MOTH IN WEST BENGAL

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ABSTRACT : Study was undertaken in quest of impact of agro-climatic condition on the morphometric and biological variations of diamondback moth populations in six distinct agro-climatic regions, viz., Hilly Region, Tarai Region, Bindhya Alluvial Region, Gangetic Alluvial Region and Coastal Region of West Bengal, India. Morphometry of DBM populations from the different agro-climatic regions of West Bengal explicitly unveiled existence of heterogeneity in the insect populations which was maintained through the successive developmental stages of the same generation as well as through the successive generations. Study on various biological parameters of the DBM populations from the above mentioned regions was also undertaken for successive four generations under constant temperature and humidity regime and same food materials. It was recorded that with regard to fecundity and mating duration in all the four generations, populations of Tarai Region, Gangetic Alluvial Region, Bindhya Alluvial Region and Coastal Region were quite congruent to each other whereas populations of the Hilly Region and Lateritic Region were heterogeneous to the formers but close to each other.

Keywords : *Diamondback moth, cabbage, morphometric variation, biological variation.*

Among the major cabbage producing states, namely, Uttar Pradesh, Orissa, Bihar, Assam, West Bengal, Maharashtra and Karnataka, West Bengal contributes 1.929 M million tonnes of cabbage from 65,000 ha area with an average productivity of 29.6 mt/ha (Anon, 1). As diamondback moth is distributed all over West Bengal, farmers are facing very serious problem due to this insect. Extended interaction with abiotic and biotic environmental factors have immense influence on insects. Warm-adapted species and cold-adapted species vary in their temperature optima for vital processes such as growth and reproduction and when exposed to variation in environmental temperatures or other climatic factors undergo substantial changes in metabolic rate, even while inactive. Variation in agro-climatic condition exerted pronounced influence on crop pests which could be transmitted through successive generations. The state of West Bengal, enjoys a unique position by having six distinct agro-climatic regions, viz., Hilly Region, Tarai Region, Bindhya Alluvial Region, Gangetic Alluvial Region and Coastal Region. Therefore, the study was undertaken in quest of impact of agro-climatic condition on the morphometric and biological variations of diamondback moth populations from the above six distinct agro-climatic regions.

MATERIALS AND METHODS

During 2008-2009, surveys were carried out in various locations under the different agro-climatic regions (ACRs) of West Bengal. Larvae and pupae of diamondback moth were collected very carefully from the different agro-climatic regions to study on DBM's morphometry. Measurements of several morphometric parameters of different stages of DBM were taken on 50 samples of each population for each agro-climatic region. Parameters considered for morphometry study were length and width of all immature and mature stages of the insect including width of head capsule and wing expanse of both sexes of the adults. Biological variation of the DBM population collected from different ACRs was also studied rearing separately under 20-32°C temperature and 55-92% relative humidity in laboratory through four successive generations. The parameters noted during progress of each generation were- mating duration, fecundity, hatching percentage, incubation period, duration of different larval instars, pupal stage, longevity of adults (male and female), duration of total life cycle and sex ratio. All the data were subjected to statistical analysis.

RESULTS AND DISCUSSION

Study on the morphometric parameters of diamondback moth populations collected from different mentioned agro-climatic regions of West Bengal explicitly unveiled that the insect populations of the Hilly Region and Lateritic Region were heterogeneous with the population of the Gangetic Alluvial Region, Bindhya Alluvial Region and Coastal

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Table 1: SD's and CV's of the characters of different stages of DBM within the regional populations collected from different agro-climatic regions of West Bengal.

Regions	SD's																				
	Characters studied																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
HR	0.014	0.009	0.005	0.013	0.011	0.130	0.011	0.007	0.055	0.011	0.011	0.089	0.038	0.004	0.130	0.023	0.134	0.055	0.071	0.089	0.134	0.217
TR	0.011	0.010	0.008	0.019	0.011	0.089	0.014	0.007	0.114	0.013	0.009	0.261	0.057	0.009	0.182	0.017	0.164	0.045	0.114	0.122	0.084	0.192
GAR	0.009	0.017	0.010	0.017	0.008	0.114	0.011	0.004	0.055	0.008	0.010	0.110	0.061	0.005	0.134	0.015	0.507	0.084	0.071	0.084	0.110	0.167
BAR	0.015	0.015	0.005	0.027	0.005	0.164	0.005	0.008	0.187	0.015	0.005	0.164	0.071	0.008	0.173	0.018	0.187	0.071	0.164	0.055	0.114	0.195
LR	0.009	0.018	0.011	0.007	0.004	0.089	0.010	0.011	0.084	0.011	0.008	0.089	0.034	0.027	0.084	0.009	0.084	0.055	0.045	0.114	0.110	0.228
CR	0.019	0.015	0.005	0.032	0.013	0.130	0.005	0.012	0.055	0.020	0.008	0.391	0.076	0.007	0.152	0.033	0.515	0.055	0.055	0.130	0.179	0.327
Regions	CV's																				
	Characters studied																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
HR	3.449	3.958	0.433	7.580	7.404	4.233	3.221	3.074	0.954	1.946	3.203	1.327	3.431	0.796	2.130	3.086	1.484	4.347	1.198	1.389	1.323	1.974
TR	2.321	3.571	0.663	8.134	6.478	2.585	3.289	2.716	1.946	2.202	2.444	3.284	4.673	1.558	2.573	2.051	1.624	3.388	1.827	1.750	0.769	1.705
GAR	1.811	5.653	0.794	6.338	4.358	3.132	2.568	1.803	0.922	1.390	2.632	1.301	4.536	0.919	1.823	1.755	4.884	5.892	1.071	1.128	0.985	1.438
BAR	3.133	4.911	0.433	10.554	2.823	4.347	1.201	3.193	2.970	2.385	1.383	1.906	5.439	1.423	2.373	2.122	1.782	4.714	2.460	0.725	1.004	1.660
LR	2.270	8.438	0.909	4.419	3.022	3.042	3.030	5.328	1.516	2.051	2.404	1.347	3.283	4.948	1.413	1.215	0.975	4.417	0.768	1.793	1.104	2.108
CR	3.898	5.340	0.433	**13.715**	6.935	3.505	1.228	4.711	0.878	3.295	2.156	4.570	5.745	1.198	2.118	3.839	5.047	4.027	0.835	1.767	1.600	2.849

HR= Hilly Region; TR=Tarai Region; GAR= Gangetic Alluvial Region; BAR=Bindhya Alluvial Rigion, LR= Lateritic Region; CR= Coastal Region; SD= Standard Deviation; CV=Coefficient of variation; 1=Length of egg (mm); 2=Width of egg (mm); 3, 4, 5 =Body length (mm), body width (mm) and width of head capsule (mm), respectively of 1st instar larva.; 6, 7, 8 =Body length (mm), body width (mm) and width of head capsule (mm), respectively of 2nd instar larva; 9, 10, 11=Body length (mm), body width (mm) and width of head capsule (mm), respectively of 3rd instar larva;12, 13, 14=Body length (mm), body width (mm) and width of head capsule (mm), respectively of 4th instar larva;15=Length (mm) of pupa; 16= Width (mm) of pupa; 17=Length (mm) of cocoon; 18= Width (mm) of cocoon; 19=Length (mm) of adult (male); 20=Width (mm) of adult (female); 21=Wing expanse (mm) of the adult (male); 22= Wing expanse (mm) of the adult (female).

Table 2: Average durations of different stages of DBM irrespective of regions and their correlation with mean laboratory temperature and relative humidity during the year 2009.

Generations		Mating duration (min)	Fecundity	Incubation period (days)	Larval durations				Total life cycle (days)	Pupal duration (days)	Adult longevity		Total life cycle (days)
					1st	2nd	3rd	4th			Male	Female	
1st generation (16th February to 10th March)	Range	62.86-81.43	103.57-145.29	3.44-3.86	2.90-3.00	2.45-2.54	2.60-2.80	3.34-3.50	11.35-11.70	6.50-6.80	5.90-7.00	15.90-16.40	21.40-22.36
	Mean	69.65	130.64	3.54	2.94	2.50	2.68	3.41	11.52	6.62	6.53	16.13	21.68
	SD±	8.41	20.19	0.16	0.04	0.03	0.08	0.06	0.15	0.12	0.38	0.20	0.35
2nd generatiion (14th March to 1st April)	Range	64.29-82.14	109.86-147.14	2.87-3.29	2.66-2.76	2.09-2.18	2.16-2.36	2.80-2.96	2.76-10.12	5.80-6.10	5.70-6.80	15.46-15.96	18.65-19.09
	Mean	71.29	134.43	2.97	2.70	2.14	2.24	2.87	9.95	5.92	6.33	15.69	18.84
	SD±	8.01	17.55	0.16	0.04	0.03	0.08	0.06	2.94	0.12	0.38	0.20	0.17
3rd generation (4th April to 20th April)	Range	58.57-73.57	93.43-138.86	2.76-2.99	2.32-2.42	1.97-2.06	1.96-2.16	2.36-2.52	8.67-9.02	5.30-5.60	5.36-6.46	14.92-15.42	16.88-17.38
	Mean	64.17	121.41	2.89	2.36	2.02	2.04	2.43	8.84	5.42	5.99	15.15	17.16
	SD±	6.57	21.43	0.10	0.04	0.03	0.08	0.06	0.15	0.12	0.38	0.20	0.18
4th generation (22nd April to 7th May)	Range	57.43-66.14	87.29-135.71	2.74-2.94	2.18 2.28	1.85-1.94	1.80-2.00	2.20-2.36	8.09-8.44	5.06-5.36	5.06-6.16	14.70-15.20	16.03-16.54
	Mean	60.55	118.29	2.86	2.22	1.90	1.88	2.27	8.26	5.18	5.69	14.93	16.30
	SD±	3.71	23.48	0.09	0.04	0.03	0.08	0.06	0.15	0.12	0.38	0.20	0.18
Correlation with mean temperature (°C)		-0.50	-0.45	-0.89	-0.83	-0.89	-0.90	-0.90	-0.99*	-0.91	-0.76	-0.85	-0.92
Correlation with mean relative humidity (%)		-0.70	-0.72	-0.82	-0.90	-0.87	-0.86	-0.93	-0.82	-0.88	-0.81	-0.91	-0.90

Best suited equations:

$(Y_1=131.36+0.70X_1-1.22X_2)$; $(Y_2=2.7.21+1.70X_1-2.28X_2)$; $(Y_3=6.28-0.094X_1-0.008X_2)$; $(Y_4=6.97-0.019X_1-0.056X_2)$

$(Y_5=4.59-0.06X_1-0.016X_2)$; $(Y_6=6.17-0.070X_1-0.029X_2)$; $(Y_7=9.40-0.06X_1-0.07X_2)$; $(Y_8=20.98-0.54X_1+0.05X_2)$

$(Y_9=13.79-0.09X_1-0.078X_2)$; $(Y_{10}=10.58-0.025X_1-0.054X_2)$; $(Y_{11}=22.73-0.04X_1-0.088X_2)$; $(Y_{12}=47.53-0.40X_1-0.25X_2)$

Y_1= Mating duration(min) ;Y_2= Fecundity; Y_3= Incubation period (days) ; Y_4,Y_5,Y_6,Y_7= Larval durations of 1st ,2nd , 3rd and 4th instar larvae ; Y_8= Total larval duration ; Y_9= Pupal duration(days) ; Y_{10} and Y_{11}= Adult longevity of male and female; Y_{12}= Total life cycle (days) ; X_1=mean temperature during the generations; X_2= Relative humidity (%).

Region. Populations of the Tarai Region in some cases expressed a kind of proximity of characters to the population of later regions. Consistency of this heterogeneity in respect to six characters namely, body length (mm) of 3rd and 4th instar larvae, width of head capsule of 4th instar larvae, length of cocoon (mm), length (mm) and wing expanse (mm) of adult female was maintained through the successive developmental stages of the same generation as well as through the successive generations. Standard deviations (SD) and coefficient of variations (CV) in the results pertaining to the variations in morphometric parameters of different stages of DBM (*P. xylostella*) in (Table 1) revealed that maximum CV was 13.715%. Rests of the CV's were below 10% which indicated that the reliability of the analysis was higher.

Region wise comparative morphometric study on DBM had never been done in West Bengal. Chacko and Narayanasamy (3) conducted an experiment which was almost similar to the work done by the present authors. The study under discussion also corroborates many finding on DBM recorded by Bhalla and Dubey (2) and Das (4).

In respect to the study on various biological parameters of the DBM populations it was recorded that with regard to fecundity and mating duration in all the four generations, populations of Tarai Region, Gangetic Alluvial Region, Bindhya Alluvial Region and Coastal Region were quite congruent to each other whereas populations of the Hilly Region and Lateritic Region were heterogeneous to the formers but close to each other (Table 2).

The present study on morphometric and biological parameters of the DBM populations of six agro-climatic regions of West Bengal supported the hypothesis of existence of a stable heterogeneity between two geographical groups of the insect. One group is consisted of the populations of Hilly Region and the Lateritic Region whereas the other group is distributed over the Bindhya Alluvial Region, Gangetic, Alluvial Region and Coastal Region. However, to confirm the hypothesis, these populations need to be evaluated further at molecular level.

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