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Role of Climatic Factors on Population Fluctuation of Aphids (*Brevicoryne Brassicae*, *Myzus persicae* and *Lipaphis erysimi*) on Canola (*Brassica napus*) in Punjab, Pakistan

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Abstract: A field study was carried out to determine the role of weather factors on canola aphids population. Aim of this study was to investigate, how meteorological factors play a role in fluctuating aphid population. The experiment was conducted on canola crop grown under three farming systems i.e., synthetic fertilizer, farm yard manure and untreated control. Aphid population was recorded from 1st week of February to 2nd week of March during 2009 and 2010 and weather data was collected from metrological observatory during the same period. The results revealed that a peak aphid population was recorded during the beginning of 2nd week of March in both years of the study. Aphid density was positively associated with maximum as well as minimum temperature while it showed a negative correlation with relative humidity. The rainfall during 2009 showed significant and negative correlation with aphid population while during 2nd year of studies (2010) it showed non significant correlation. On division of aphid infestation period into different phases of infestation, it was observed that during the establishment phase, the rainfall and relative humidity were negatively correlated, whereas, temperature was positively correlated while, during the declining phase temperature had negative relationship with aphid population build up.

Key words: Aphids, canola, weather factors, farming systems, Punjab, Pakistan

INTRODUCTION

Canola refers to cultivars of rapeseed and mustard (*Brassica* spp. Cruciferae), that is the second most important source of edible oil (PARC, 1998) with low levels of erucic acid and aliphatic glucosinolates (Raymer, 2002) after cottonseed. It's oil is widely used in cooking and for making salad dressing and margarines while the meal is usually used in animal feeds. It is also used as a source of biodiesel. In Pakistan, during the year 2012-13, it was cultivated on an area of 30 thousand acres with the annual oil production of 10 thousand tones (Anonymous, 2013). This crop is attacked by a number of insect pests all over the world (Lamb, 1989). More than 30 different types of pests have been recorded on this crop that varies with crop stage and production area (Stanley and Marcroft, 1999; Micic, 2005a). Among these, aphids are considered to be the most destructive pest (Rehman *et al*., 1987). Three major aphids species are known to infest the canola crop, i.e., the cabbage aphid, *Brevicoryne brassicae* (L.), the green peach aphid, Myzus persicae (Sulzer) and the turnip aphid, Lipaphis erysimi Kalt (Hemiptera: Aphididae) (Rehman *et al*., 1987). Across all production regions aphids usually attacks on flowers and pods. But, in warm and dry autumns, it can also be observed on crowns and undersides of the leaves at vegetative stage (Kelm and Gadomski, 1995). Sing and Lal (1999) recorded inconsistent occurrence and severity of pest infestations during different cropping seasons.

Host-plant, microclimate and natural enemies are the important factors that affects the growth rate and migration of pests (Dixon, 1987). Insect development and distribution is directly influenced by weather factors viz., temperature, relative humidity and rainfall. Among these factors, the temperature plays significant part in determining the insect growth rate. Wind and rain are also importance for survival as well as disposal of insect pest population. Temperature is positively correlated with aphid population while relative humidity plays a negative role in fluctuating pest density (Nasir and Ahmad, 2001; Aheer *et al*., 2008). Significant negative correlation between aphid population and rainfall was also reported by Wains *et al*. (2008). The objective of the present study was to determine the trend in population fluctuation of canola aphids at various dates of observation corresponding to the respective weather factors during 2009 and 2010.

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MATERIALS AND METHODS

This experiment was conducted in experimental field plots at the University of Agriculture Faisalabad with three treatments: (1) Synthetic fertilizers, (2) Farm yard manure and (3) Controls which received no inputs. Each treatment was replicated three times with 2.5 x 5 m plot size. In treatment 1, the recommended dose of fertilizers i.e., Nitrogen, Phosphorous and Potash were applied at the rate of 32, 23 and 25 kg/acre, respectively (Phosphorous and Potash were applied at time of sowing while Nitrogen was applied in two splits), while in the second plot (treatment) farm yard manure (20 t/ha) was applied once before planting. The third treatment was untreated control. Two cultural practices, weeding twice and irrigation thrice during the whole cropping season, were performed uniformly in all the plots but no aphid management practices were carried out. To determine the population dynamics of aphids, observations were started at the seedling stage of the crop and repeated every 7 days until crop maturity. Ten plants were selected randomly and tagged to record aphid population in each replication. The population was recorded from a 15 cm long top portion of central twig on a plant causing least possible disturbance as suggested by Singh *et al*., 2007.

RESULTS

Population fluctuation of canola aphids with weather factors during 2009 and 2010: The results regarding population fluctuation of canola aphids due to weather factors during 2009 and 2010 are presented in the Fig. 1 and 2. It revealed that population of canola aphids appeared during the 1st week of February, it increased through out subsequent dates of observation and reached its peak on March 8. Weather factor on March included a maximum temperature of 26°C with minimum temperature 13.5°C, average temperature 19.8°C and 41% relative humidity. Population level declined after the date. In both of farming systems studied (organic and conventional) weather factor had similar effects of aphids populations during both years of the studies.

Impact of weather factors on aphids population: The data were processed for simple correlation and multiple linear regression models with the objective to find the impact of these factors on the population fluctuation of pest.

Simple correlation between weather factors and population of aphids on canola: Table 1 and 2 shows the correlation coefficient values for each weather factors versus canola aphid population comparison. The results indicate that there was a significant correlation between weather factors and aphid populations. The temperature was positively correlated with population while relative humidity and rainfall were negatively correlated during 2009. The farm yard manure application and control conditions the maximum and minimum temperatures and relative humidity significantly affected aphids population while under synthetic fertilizer application all abiotic factors affects no weather factor was significantly correlated with aphid population growth. During 2010 none of abiotic factors were significantly correlated with aphid population except for minimum under organic farm yard manure and control.

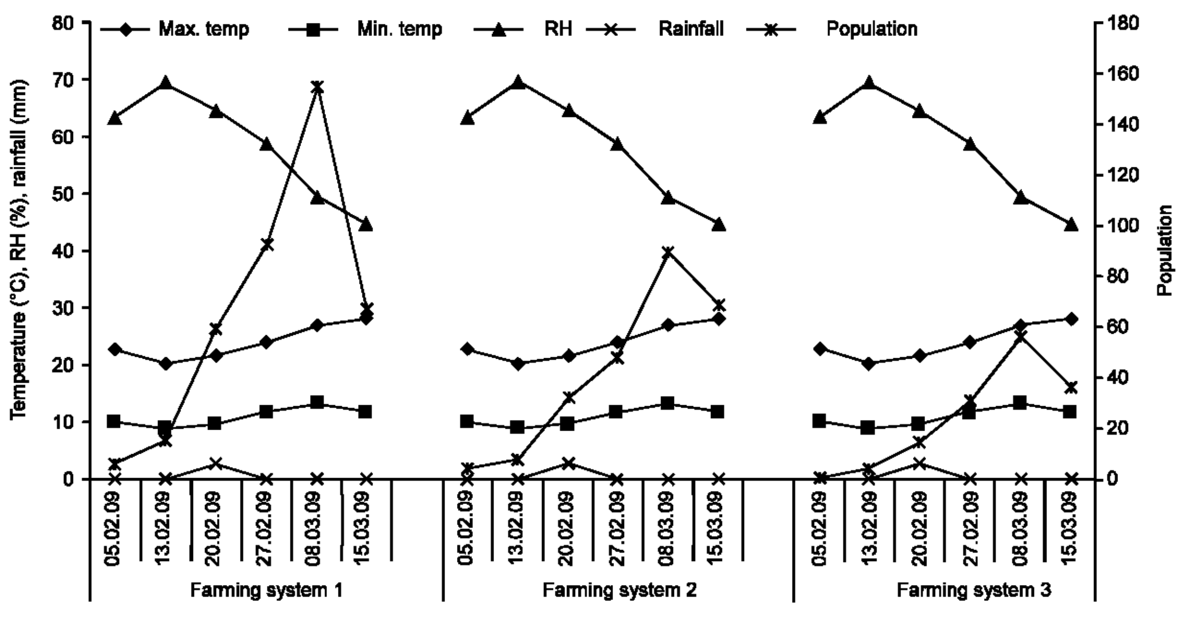

Fig. 1: Graphical representation of impact of weather factors on population fluctuation of canola aphids during 2009

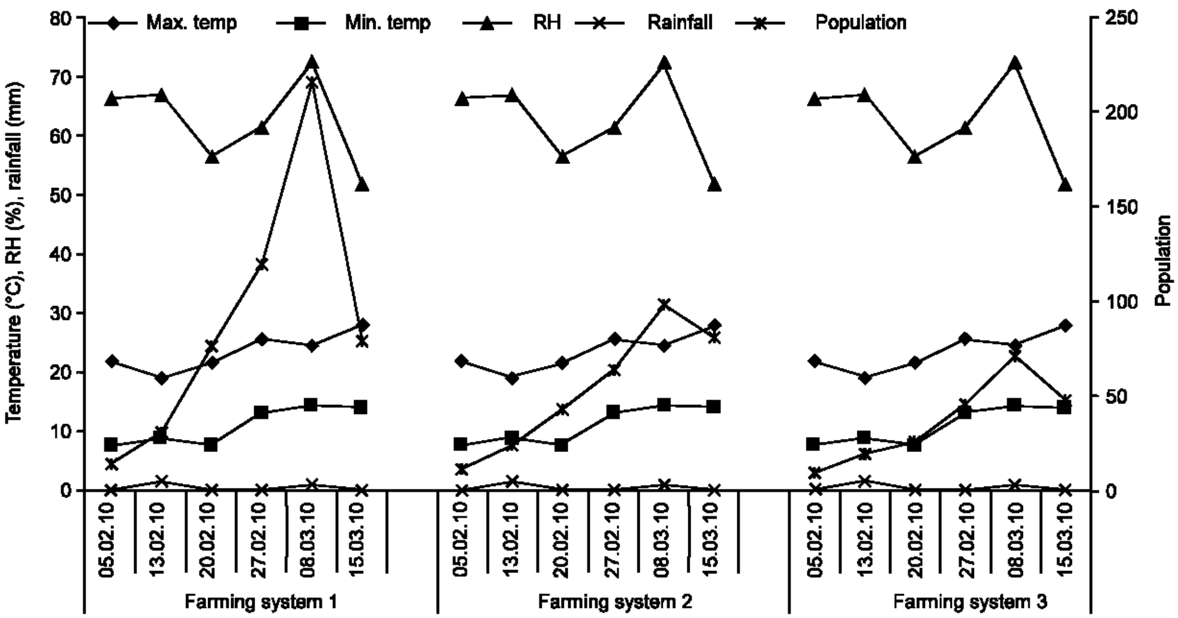

Fig. 2: Graphical representation of the impact of weather factors on population fluctuation of canola aphids during 2010

Table 1: Correlation between weather factors and Aphids population during 2009

	-------------- Temperature (°C) ---------------			
Farming system	Maximum	Minimum	Relative humidity (%)	Rain fall (mm)
FS1	0.632	0.884*	-0.661	-0.077
	0.178	0.019	0.153	0.885
FS2	0.845*	0.923**	-0.879*	-0.151
	0.034	0.009	0.021	0.776
FS3	0.814*	0.947**	-0.838*	-0.228
	0.049	0.004	0.037	0.665
Overall	0.617**	0.765**	-0.642**	-0.108
	0.006	0.000	0.004	0.668

*: Significant ($p<0.05$); **: Highly significant ($p<0.01$)

Table 2: Correlation between weather factors and Aphids population during 2010

	-------------- Temperature (°C) ---------------			
Farming system	Maximum	Minimum	Relative humidity (%)	Rain fall (mm)
FS1	0.496	0.761	0.313	0.196
	0.317	0.079	0.545	0.710
FS2	0.777	0.919*	-0.074	0.032
	0.069	0.010	0.890	0.952
FS3	0.691	0.915*	0.112	0.149
	0.129	0.011	0.833	0.779
Overall	0.482*	0.663**	0.142	0.116
	0.043	0.003	0.575	0.647

*: Significant ($p<0.05$); **: Highly significant ($p<0.01$)

Multiple linear regression models: Role of weather in population fluctuations of the canola aphids was determined by processing the data for multiple linear regression analysis. The results relating to the Multiple Linear Regression Models along with coefficient of determination values between weather factors and population of canola aphids during 2009 and 2010 are given in Table 3 and 4, the results revealed that maximum temperature did not affect on population fluctuations of canola aphids. The effect of minimum temperature was found to be significant under synthetic fertilizer, farm yard application and control during 2009. However, in 2010 none of the abiotic factor showed a significant effect on aphid population growth.

DISCUSSION

A study was conducted to determine the role of weather in population fluctuation of aphids. The data were

Table 3: Multiple linear regression models between population of canola aphids and weather factors during 2009

		--------- Regression coefficients ---------			
Farming system	Model	B	SE	t-value	R² (%)
FS1	(Constant)	2007.473	542.485	3.70	99.7
	Max	-63.679	13.100	-4.86	
	Min	49.078	3.756	13.07*	
	RH	-16.247	3.981	-4.08	
	Rain	0.426	4.739	0.09	
FS2	(Constant)	2043.734	257.419	7.94*	99.7
	Max	-64.546	6.285	-10.27**	
	Min	49.070	2.666	18.41**	
	RH	-16.508	1.932	-8.54*	
FS3	(Constant)	1555.042	345.941	4.50	99.7
	Max	-39.467	8.354	-4.72	
	Min	16.916	2.395	7.06	
	RH	-12.863	2.539	-5.07	
	Rain	-2.363	3.022	-0.78	
FS4	(Constant)	1353.823	207.550	6.52*	99.5
	Max	-34.651	5.068	-6.84*	
	Min	16.956	2.150	7.89*	
	RH	-11.414	1.558	-7.33*	
FS5	(Constant)	935.817	219.760	4.26	99.8
	Max	-25.373	5.307	-4.78	
	Min	13.383	1.522	8.80	
	RH	-7.678	1.613	-4.76	
	Rain	-3.239	1.920	-1.69	
FS6	(Constant)	660.025	203.701	3.24#	99.4
	Max	-18.773	4.974	-3.77#	
	Min	13.438	2.110	6.37*	
	RH	-5.692	1.529	-3.72#	

#: Significant (p<0.10) *: Significant (p<0.05) **: Highly significant (p<0.01)

Table 4: Multiple linear regression models between population of canola aphids and weather factors during 2010

		--------- Regression coefficients ---------			
Farming system	Model	B	SE	t-value	R² (%)
FS1	(Constant)	411.910	1724.134	0.24	74.5
	Max	-40.640	91.149	-0.45	
	Min	51.040	77.045	0.66	
	RH	1.845	7.995	0.23	
	Rain	-111.050	232.379	-0.48	
FS2	(Constant)	709.915	829.233	0.86	73.2
	Max	-52.828	53.918	-0.98	
	Min	61.075	46.159	1.32	
	Rain	-130.064	157.685	-0.82	
FS3	(Constant)	5.754	615.479	0.01	84.8
	Max	-1.770	32.538	-0.05	
	Min	10.786	27.504	0.39	
	RH	-0.438	2.854	-0.15	
	Rain	-2.289	82.954	-0.03	
FS4	(Constant)	-8.855	222.107	-0.04	84.8
	Max	-0.927	7.975	-0.12	
	Min	10.078	7.016	1.44	
	RH	-0.410	1.888	-0.22	
FS5	(Constant)	32.322	395.749	0.08	86.1
	Max	-4.676	20.922	-0.22	
	Min	10.173	17.685	0.58	
	RH	0.107	1.835	0.06	
	Rain	-10.344	53.339	-0.19	
FS6	(Constant)	49.532	185.774	0.27	86.1
	Max	-5.380	12.079	-0.45	
	Min	10.753	10.341	1.04	
	Rain	-11.442	35.326	-0.32	

#: Significant (p<0.10) *: Significant (p<0.05) **: Highly significant (p<0.01) processed for simple correlation and multiple linear regression models with the objective to find the impact of these factors on the population fluctuation of pest. The results indicated that all predetermined abiotic factors (temperature, relative humidity and rainfall) had significant effects on aphid population. The maximum and minimum temperatures both showed positive correlation with population while relative humidity and rainfall showed negative correlation. Aphid population, more or less, was observed on canola between lower and upper most range of temperature during the study period (17-30°C). From results it is concluded that aphids survive in a narrow range of temperature. When temperature decreases and crosses the lower limits aphid's population also decreases, however, when temperature shows an increase from lower limits to higher limits the aphid population also increases but when temperature crosses the higher limits aphids population shows abrupt decrease. Our findings are similar with Srivastav *et al.* (1995), who reported that a range of maximum temperature was (15.8-24.7°C) and relative humidity (61-65%) prevailing in February was favorable for aphid multiplication. However, Bishoni *et al.* (1992) studied the effect of temperature, relative humidity and cloud cover on the infestation by *Lipaphis erysimi*. He found that temperature in the range of 10-13.5°C and 72-85% RH was optimal for population build up of aphids. An increase in cloudiness resulted in increased population of aphid. These results also confirm the results of present findings. Our results are also in conformity with Singh *et al.* (1999) who observed the positive effect of the temperature (maximum and minimum), RH (morning and evening) and sunlight on the population of L. erysimi, whereas, negative effect by wind speed and rainfall.

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