Validation of degree day based forewarning model of mustard aphid in Bundelkhand agro-climatic zone of Madhya Pradesh

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ABSTARCT

To validate the temperature based aphid forewarning model of Chakravarty and Gautam (2002), data on aphid population were collected from mustard crop grown on farmer's field during two *rabi* seasons of 2009-10 and 2010-11 in Tikamgarh district of Bundelkhand Agro-climatic zone. The growing degree day (GDD) was calculated from 1st to 25th January in both the seasons. It was observed that GDD accumulation from 1st to 15th January in both the seasons has capability to forewarn the peak aphid population in Bundelkhand Agro-climatic zone. The correlation coefficients between maximum, minimum and mean temperature and aphid population were found to be marginally higher in case of late sown conditions. The rainfall affected aphid population but it was not significantly related with aphid population.

Key words : Aphid population, growing degree days, mustard, forewarning model .

Pest infestation in crops is highly influenced by meteorological factors. The weather based modeling for early warning of pest infestation may provide appropriate tool for investigating and predicting pest status. More than three dozen insect pests are found associated with rapeseed and mustard crops in India of which mustard aphid (*Lipaphis erysimi* Kalt.) is the most harmful, which even after best management reduces the yield and oil content (Bakhetia and Sekhon, 1984). The incidence and spread of aphid is largely influenced by weather conditions. Temperature and moisture have direct influence on aphid distribution and development. Temperature plays the most important role in determining the growth rate of the insect. Drought has been is a recurring feature of Bundelkhand agro-climatic zone during last several years and mustard crop is gaining wide acceptance among the Bundelkhand farmers mainly because of its suitability in *rainfed* conditions and low water requirement.

A number of regression models for aphid forecast were developed in India, through correlation analysis between aphid population and weather parameters. These models are location specific and failed to forecast the high and low aphid infestation. Prasad and Chakravarty (2000) developed regression models for aphid forecast in Delhi region. This equation is based on correlation between aphid population and weather parameters, but its constants need calibration for a particular location.

Chakravarty and Gautam (2002) developed a degree days based mustard aphid forewarning model and validated it for Delhi region. The model has not been validated at other stations in India for its wider application. Hence, this study was undertaken to validate this model in central part of India.

MATERIALS AND METHODS

Chakravarty and Gautam (2002) had proposed a GDD based mustard aphid forewarning model. The hypothesis states that "aphid population may be more in a year when the degree-day accumulation (accumulated from 1st to 25th January) is slower and *vice-versa*". The same hypothesis was taken for validation work in Bundelkhand agro-climatic zone for peak aphid population forewarning. For this purpose the field surveys were conducted through KVK, Tikamgarh to obtain the aphid (*Lipaphis erysimi)* infestation data in timely (41 SMW) as well as late sown (45 SMW) mustard crop. The data were collected from the farmer's field on *Brassica juncea* variety Pusa bold from two blocks namely, Tikamgarh and Prithivipur. The aphid data were taken at weekly intervals starting from 45th standard meteorological week (SMW) to 10th SMW during the year 2009-10 and 2010-2011. The data for the aphid population was recorded in the field under their natural incidence without any insecticidal intervention. Ten tagged plants were selected randomly and aphid (nymphs and adults) population per 10 cm apical central shoot was counted as per the method described by Singh and Singh (1994) manually at weekly interval and mean values were calculated for the analysis. The weather data was collected from the IMD temporary observatory located at Tikamgarh (24° 40' North latitude,77° 80' East longitude and 324 meter height above m.s.l.) district head quarter .

Table 1: Weekly weather data and aphid population during 2009-10 and 2010-11 at Tikamgarh.

Standard Met. Weeks		Rain (mm)	Tmax.	Tmin.	Tmean	RH (%)	Rain (mm)	Tmax.	Tmin.	Tmean	RH (%)	2009 -10	2010 -11
		2009-10					**2010-11**					**Aphid population**	
Nov.	45	0.0	31.7	17.1	24.4	59	0.0	30.4	14.9	22.6	64	3	4
	46	41.5	23.8	17.5	20.7	85	5.6	31.6	20.8	26.2	70	6	8
	47	0.0	25.8	9.9	17.9	66	0.0	27.5	16.2	21.9	68	2	5
	48	0.0	29.2	10.5	19.8	61	10.0	26.4	15.7	21.1	72	13	22
Dec.	49	0.0	28.1	12.1	20.1	64	0.0	23.7	10.3	17.0	66	36	16
	50	0.0	27.8	13.2	20.5	70	0.0	24.4	9.0	16.7	63	65	43
	51	2.3	24.9	10.3	17.6	72	0.0	25.8	6.9	16.3	59	104	98
	52	0.0	25.2	9.7	17.5	66	1.5	25.7	10.6	18.2	57	108	109
Jan.	01	0.0	23.9	6.3	15.1	69	0.0	18.2	1.2	9.7	76	130	156
	02	0.0	20.9	7.2	14.0	84	0.0	22.8	3.6	13.2	62	147	224
	03	0.0	21.1	5.1	13.1	78	0.0	23.3	5.3	14.3	60	150	257
	04	0.0	27.8	7.9	17.9	54	0.0	24.7	7.6	16.2	52	137	345
	05	0.0	28.3	10.0	19.2	51	0.0	24.3	6.6	15.4	53	116	330
Feb.	06	2.1	28.8	12.6	20.7	62	0.0	28.7	9.9	19.3	45	89	293
	07	14.9	24.6	13.1	18.8	68	6.7	27.0	11.7	19.4	59	60	183
	08	0.6	29.7	12.4	21.1	53	0.6	26.6	10.0	18.3	50	23	106
	09	0.0	33.9	16.5	25.2	40	0.0	27.9	12.6	20.2	47	7	52
Mar.	10	0.0	33.4	16.1	24.8	43	0.0	31.1	13.9	22.5	42	3	11
	Mean	61.4*	27.2	11.5	19.4	64	24.4*	26.1	10.4	18.3	60	67	126
	SD	10.1	3.7	3.7	3.4	12.4	2.9	3.3	4.9	3.9	9.6	56.2	119.3
	CV(%)	16.4	13.6	32.2	17.5	19.4	11.9	12.6	47.1	21.3	16	83.9	94.7

*=Total

Table 2 : Correlation coefficients between weather parameters and aphid population under early and late sown conditions.

Year	Weak of sowing	Tmax.	Tmin.	Tmean	Mean RH	RF.
2009-10	41 (8-14 Oct.)	-0.50*	-0.70*	-0.67*	0.24	-0.27
	45 (5-11 Nov.)	-0.84**	-0.87**	-0.89**	0.65*	-0.06
2010-11	41 (8-14 Oct.)	-0.62*	-0.77*	-0.74*	-0.14	-0.29
	45 (5-11 Nov.)	0.06	-0.25	-0.12	-0.41*	-0.16
Pooled data	-0.51*		-0.68*	-0.64*	-0.09	-0.19

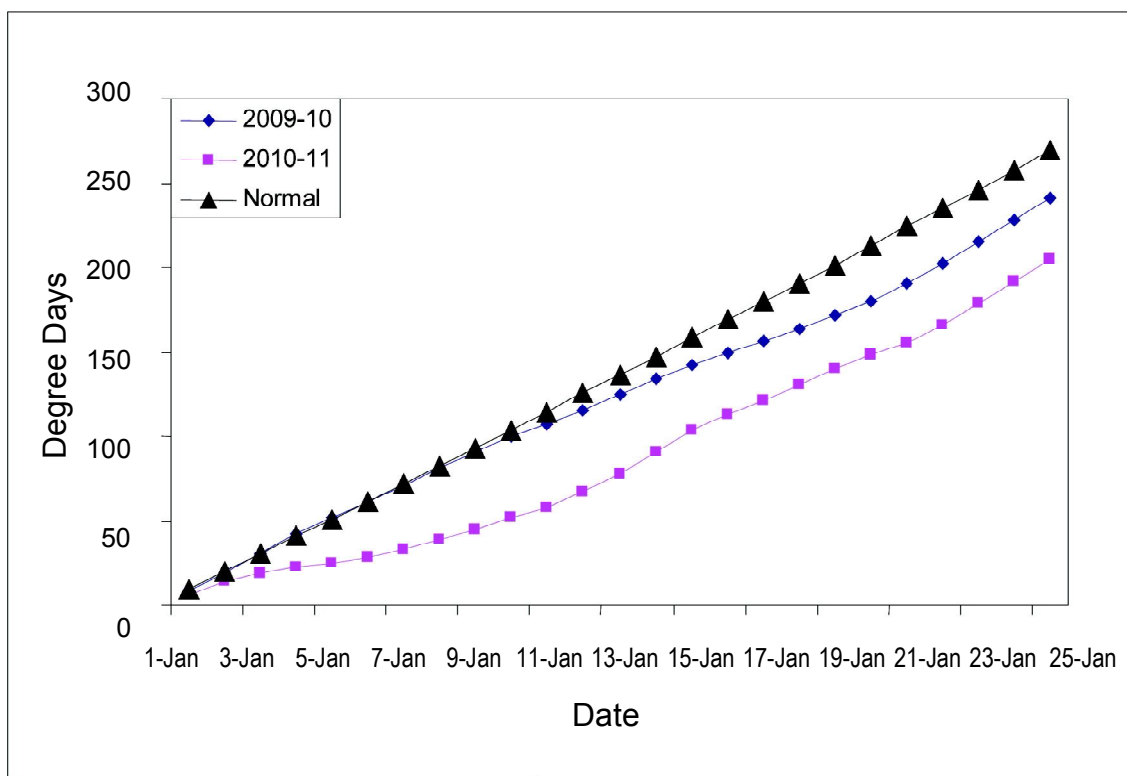* Significant at 5% level ** Significant at 1% level

Fig. 1 : Degree days pattern at Tikamgarh during 1 to 25 January

The degree day was expressed in terms of GDD with a base temperature of 5°C (Chakravarty and Gautam, 2002). They have proposed that when GDD accumulation (1 to 25th January) is 150 then there was high infestation of aphid and when the GDD accumulation was 245 degree day aphid population was low in Delhi region. In the present study, GDD accumulation was calculated for two intervals from 1st to 15th and 1st to 25th January. The correlation between weather parameters and aphid population were computed and its significance was tested following the t test for timely as well as late sown condition respectively.

RESULTS AND DISCUSSION

Weather conditions during the crop season

The weekly values of weather parameters and mean aphid population during both the crop seasons are presented in Table 1. The maximum temperatures during crop seasons (45 to 10 SMW) of 2009-10 varied between 20.9 and 33.9°C while during the crop season 2010-11 it varied between 18.2 and 31.6°C. The minimum temperature varied between 5.1 and 17.5°C during 2009-10 and 1.2 and 20.8°C during 2010-11. The lower temperature conditions prevailed during January 2010-11 than the 2009-10. The relative humidity (RH) varied from 40 to 85 per cent in the first season and it ranged from 42 to 76 per cent during second

crop season. During the first crop season the total rainfall was 61.4 mm while in the second crop season the crop received 24.4 mm rainfall.

Distribution of aphid population during the crop period

The aphids remained active through out the crop growth period and had been observed feeding on foliage, inflorescence and pods of mustard crop. In the timely sown crop aphid incidence was started from 45th SMW where as the incidence of aphid started on 49th SMW in late sown crop during both the years

Correlation between weather parameters and aphid population

Correlation between aphid population and weather parameters has been worked out for two sowing dates in two seasons and presented in Table 2. The analysis showed negative correlation between temperatures (maximum, minimum and mean) and aphid population. Highly significant relationship with temperature for late sown crop was observed during 2009-10. The correlation of aphid population with rainfall was negative and non-significant during both the years. In case of mean relative humidity positive as well as negative association was observed respectively. Rains in February affected the aphid population during both the years. Narang *et. al.* (1994) reported that rainfall can cause reduction in aphid population.

The aphid population was the highest during second year under late sown conditions. The correlation coefficients were very low and almost non significant during the second season. Hence, it is inferred that regression based models may fail to predict the heavy infestation, because the parameters of the regression models are worked out and chosen on the basis of high correlation coefficient value ; which is not the highest aphid population year.

Validation of degree day based forewarning

The GDD values from 1 to 25th January of 2009-10 and 2010-11 and the normal GDD (Fig.1) showed that degree day accumulation rate was similar between 17th to 25th January during both the years. The normal cumulative GDD value was 103 for year 2010-11 and 142 for year 2009-10. Charavarty and Goutam (2002) also calculated the GDD for three dates in January from 1 to 15th, 1 to 20th and 1 to 25th January and reported the values for all the three dates for aphid forewarning purpose. They proposed that in a year when GDD value during 1 to 15th January remained around 90 the aphid infestation was high; in year when the GDD value reached around 140 the aphid infestation was low. Similar values of GDD (103) and aphid population were found in the year 2010-11 with a high aphid population and 142 in the year 2009-10 with low aphid population at Tikamgarh. Thus the GDD based forewarning model is valid for Tikamgarh and can be used for peak aphid population forewarning.

CONCLUSIONS

The degree day based forewarning model for peak aphid population is useful for Bundelkhand agroclimatic zone. This model may be used in management of mustard aphid which is one of the limiting factors for yield in this region. The degree day model may be used in operational and tactical measures to alter the prophylactic/calendar based insecticide spraying and spot the judicious application of insecticide against mustard aphid.

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