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Predictive model for mustard aphid infestation for eastern plains of Rajasthan

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ABSTRACT

An attempt has been made here to predict the appearance and development of aphids on mustard crop using data collected from a field experiment conducted during *rabi* seasons of 2001-2005 with c.v. *Varuna* and 10 dates of sowing. Minimum temperature and maximum temperature showed significant negative correlation whereas morning RH and rainfall showed positive correlation with aphid population. The afternoon relative humidity did not show any association with aphids. Aphid population build up, decline and thermal time were found to be non-linearly related. Functional relations with different lead periods involving maximum, minimum and mean temperatures were developed which may be utilized in the development of DSS for eastern plains of Rajasthan.

Key words : Mustard, aphids, prediction model.

In India the rapeseed mustard is grown in an area of 6.19 million hectares of land with a total production of 7.37 million tonnes and average yield of 1100 kg ha^{-1}. Aggarwal *et al*., (2008) quantified the yield gap relative to simulated potential yield for mustard under rainfed conditions as 860 kg ha^{-1}. This wide gap needs to be addressed to achieve self sufficiency in oilseed production of the country.

Mustard yields are stated to be low mainly because of its cultivation under rainfed conditions and the aphid, Lipaphis erysimi (Kaltenbach) infestation. The avoidable yield losses due to aphids are anywhere between 20 to 50 per cent and the yield losses could be as high as 78 per cent and in extreme conditions, it might be around 90 per cent (Prasad and Phadke, 1983). Several studies have indicated that weather has a very important role to play on the aphid appearance, multiplication and disappearance (Srivastava and Srivastava, 1972; Roy, 1975; Vekaria and Patel, 2000; Jitendra Kumar *et al*. 1999 and Srivastava, 1999). Though identified as a major production constraint in several areas, the development of a forewarning system of aphid using weather information failed to get the attention of the scientists. Thus, an attempt has been made here to predict the appearance and development of aphids on mustard crop for the eastern plains of Rajasthan agro-climatic conditions which ultimately may culminate into a Decision Support System (DSS) for the management of aphids.

MATERIALS AND METHODS

The data utilized in this present investigation comes from field experimentation conducted during four rabi seasons of 2001-2005 at the Directorate of Rapeseed-Mustard Research, Bharatpur, Rajasthan with c.v. Varuna sown on 10 dates starting from October 1st with seven days intervals. Standard management except plant protection practices were followed to ensure optimum plant vigour during the experimental period. The appearance of the aphids and its subsequent development, population were recorded per 10 cm shoot length on 10 plants in each replication at 3- day interval (twice a week i.e., Tuesday and Friday) and were averaged to arrive at the mean value for each date of sowing. The data were then subjected to log transformation. Daily meteorological data was collected from the meteorological observatory which is very nearby. The periodic aphid population data (Log transformed values) since the first appearance of the pest till harvest were correlated with the mean values of different meteorological parameters of the corresponding period i.e., three-day mean values to know the relationship between weather parameters and aphid incidence and its development on mustard. The regression analysis was carried out to develop a functional relationship between weather parameters and the aphid. The thermal time required to attain peak incidence was calculated using 5°C as the base temperature or developmental threshold for mustard aphid. Regression studies were also carried out between different weather parameters and aphid development rate with lead period ranging from three to seven days. The aphids incidence, growth and decline in the present investigation appear to be dependent mainly

Table 1: No of days and thermal time required to first appearance and attainment of peak population of mustard aphids.

Date of sowing	No of days taken to first appearance	No of days to attain peak population	Mean peak aphid population	Thermal time requirement (0 days)	
				Initial	Peak
1-Oct	68	89	0.0	1227.5	1442.3
8-Oct	61	89	0.0	1059.5	1328.2
15-Oct	74	94	5.25	2217.6	2580.8
22-Oct	92	118	36.4	2235.1	2696.5
29-Oct	85	109	119.4	1958.0	2375.1
5-Nov	78	111	158.8	1683.5	2316.0
12-Nov	77	102	156.0	2476.1	3189.6
19-Nov	70	96	147.3	2136.8	2892.2
26-Nov	72	93	184.0	1833.8	2797.2
3-Dec	68	86	228.0	1574.6	2538.0
Mean	74.5	98.7	103.52	1840.2	2415.6
S.D.				434.1	568.7

Table 2 : Multiple regression for different lead periods (Pooled data)

Lead period (l)	**Equation**	**R^2**
3 DAYS	$A = 0.880 + 0.823(At-1) - 2.051(T_{max}) - 2.031(T_{min}) + 4.086 (T_{mean})$	0.71
4 DAYS	$A = 0.884 + 0.821(At-1) + 0.009566(T_{min}) - 0.0109 (T_{mean})$	0.70
5 DAYS	$A = 0.698 + 0.821(At-1) - 2.051(T_{max}) - 2.057(T_{min}) + 4.113(T_{mean})$	0.71
6 DAYS	$A = 0.982 + 0.825(At-1) + 2.445(T_{max}) - 2.471(T_{min}) -4.915(T_{mean})$	0.76
7 DAYS	$A = 0.694 + 0.823(At-1)-2.033(T_{max}) -2.060(T_{min}) + 4.088(T_{mean})$	0.77

on the temperature and relative humidity. Based on these results, a decision support system that could be used as a forewarning model of aphid infestation and peak attainment is attempted here.

RESULTS AND DISCUSSION

The first appearance of the aphid and number of days taken to attain peak values in different dates of sowing, peak aphid population and accumulated thermal time as mean of four rabi seasons of 2001-2005 is presented in Table 1. The mean values include those dates of sowings where the pest was not noticed. The aphids appeared around 75 days after sowing the mustard crop. Across the sowings, the aphids took about 24 days to build up the population to the maximum number.

Negligible or no infestation was noticed in the early sown dates i.e., 1st and 8th October sown crop and low infestation was noticed in 15th and 22nd October sown crops. Crop sown on 29th October (119 aphids/10 cm) and 5th November (158 aphids/10 cm) suffered from moderate to severe aphid infestation. Apart from the phonological events, a sudden drop in the maximum temperature by 1.9 ^{0}C and minimum temperature by 1.1 ^{0}C in one to two days during the month of January was found to trigger the incidence of aphids on mustard crop.

The accumulated thermal time required for the first appearance of aphid and its peak attainment as a mean of four years in different dates of sowing is presented in Table 1. The pest took about 1840 ± 434 degree-days to appear and 2416 ± 568 degree-days to attain the peak population across different dates of sowing.

Influence of weather on aphids

The influence of different weather parameters on mustard aphids is assessed by correlating these variables. Minimum temperature (r=-0.49*) and maximum temperature (r=-0.32*) showed significant negative correlation whereas morning relative humidity (r=0.33*) and rainfall showed positive correlation (r=0.14) with aphid population. The afternoon relative humidity (r=0.032) did not show any association with aphids.

Development of a decision support system (DSS)

Empirical approaches are often used to quantify economic threshold levels in many of the decision support systems for pest management. These empirical damage functions are generally derived by regression analysis relating aphids severity at a given crop stage (Chakravarthy and Gautam, 2002). This has prompted the present investigators to attempt and develop an aphid forewarning model. Regression studies were carried out between different weather parameters and aphid development rate with lead period ranging from three to seven days (Table 3). The high coefficient of determination values suggest that these account for larger variability (> 70%) in the aphid population build up. The At-l parameter in the relations presented in the Table 3 is the initial aphid number for different lag periods. A lead time of 5 to 7 days on the aphid development will assist in the issue of agro advisories on the control measures to be taken up so that economic losses could be avoided. A lead time of 5 to 7 days would suffice in planning the management aspects. However, these relations require data on initial aphid population which may become a limitation for their wider adoptability. This could be overcome by developing more reliable functional relations based on thermal time that predicts the incidence.

CONCLUSIONS

The thermal requirement of mustard aphid to infest the crop and to attain peak number was found to be 1840 ± 434 and 2416 ± 568 degree-days, respectively. Aphid population was found to have a significant negative correlation with minimum and maximum temperatures, whereas positive correlation was found to exist with morning RH. Functional relations with different lead periods involving maximum, minimum and mean temperatures proposed may be utilized in the development of DSS for eastern plains of Rajasthan.

Legend: A is the aphid population on any given dayi (Log transformed values); l is the lead period (days, varies between 3 to 7); At-l is the aphid population l days prior to dayi ; Tmax is the mean maximum temperature during the period i-l; Tmin is the mean minimum temperature during the period i-l; Tmean is the mean of Tmax + Tmin during the period i-l

REFERENCES

Aggarwal, P. K., Hebbar, K. B., Venugopalan, M., Rani, S., Bala, A., Biswal, A. and Wani, S. P. (2008), Quantification of Yield Gaps in Rain-fed Rice, Wheat, Cotton and Mustard in India. Global Theme on Agroecosystems Report no. 43. Patancheru -502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics, 36 pages.

Chakravarthy, N.V.K., and Gautam, R. D. (2002). Forewarning mustard aphid. NATP project report. Division of Agricultural Physics, IARI, New Delhi, 63 pages.

Jitendra Kumar, Malik, Y. P. and Singh, S.V. (1999). Forecasting models for outbreak of Lipaphis erysimi on some cultivars of mustard, Brassica juncea. *Ind. J Entomol.,* 61 (1): 59-64.

Prasad Y. K. and Phadke K. G. (1984). Effect of mustard aphid (Lipaphis erysimi Kalt.) infestation on the seed yield of different varieties of Brassica species (In) The Aphids (ed.) B K Behura (Bhubneswar: Utkal University) pp 283-287.

Roy, Pranab. (1975). Population dynamics of mustard aphid, Lipaphis erysimi Kaltenbach (Aphididae: Hemiptera) in West Bengal. *Indian J. Ent.*, 37 (3): 318-321.

Srivatsava, A. (1999). Effect of date of sowing and varieties on the incidence of mustard aphid, Lipaphis erysimi (Kalt.) on rapeseed mustard. *J. Oilseeds Res.*, 16(2): 380-381.

Srivatsava, A. S. and Srivatsava, J. L. (1972). Ecological studies on aphid, painted bug and saw fly attacking mustard and rape in India. *F.A.O. Plant Prot. Bull.,* 20: 136-140.

Vekaria, M. V. and Patel, G. M. (2000). Screening of promising Brassica and allied genotypes for resistance against mustard aphid, Lipaphis erysimi Kalt. (Homoptera: Aphididae). *Applied Biol. Res.*, 4 (1-2): 75-77.

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