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RELATIONSHIP BETWEEN MUSTARD YIELD AND APHID INFESTATION UNDER VARIED ENVIRONMENTAL CONDITION OF MIDDLE GUJARAT

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ABSTRACT

The field experiment on mustard (cv. GM-2) for assessment of yield-pest-weather interaction were conducted in randomized block design for twelve consecutive years (2002-0304 to 2013-14) with four different environments (viz. D_1 - 10^{th} October, D_2 - 20^{th} October, D_3 - 30^{th} October and D_4 - 10^{th} November) at AAU, Anand, (Lat. 22° 35'N; Long 72° 55'E and altitude of 45.1 m) Gujarat. Significantly highest seed yield (1781 kg/ha) of mustard was obtained under D_1 (10th Oct.) sowing on pooled basis. The wide variability in seed yield was observed under different dates of sowing. The maximum yield reduction of 41 % was observed in late sown mustard (D_4) as compared to D_1 sowing. However, in certain individual years the yield reductions was more than 70 % (2004-05 and 2013-14). The yield reduction was mainly due to higher temperature encountered by crop during reproductive phase under late sown condition, compounded by high aphid incidence. The mean first aphid initiation in D_1, D_2, D_3 and D_4 sowing was observed at 8 weeks. Similarly the mean peak and mean aphid intensity were observed as 0.86,1.31,1.79,2.25 and 0.5, 0.58,0.72,0.92 under D_1 to D_4 sowing respectively. Under late sown condition peak and mean aphid intensity were found higher as compared to early and normal sown condition. Significantly highest positive association was observed with aphid first initiation and mean relative humidity under D_1 sowing. Mean relative humidity >55 % was found most congenial for outbreak of aphid. Nearly more than seventy one percent aphid first initiation variation can be explained only by mean relative humidity. The developed regression model can be used for management of prophylactic spray schedule of aphid management. Based on relationship of yield and aphid

intensity it was concluded that for higher yield with low aphid infestation D_1 and D_2 sowing were found most suitable as compared to D_3 and D_4 sowing.

Key words: Mustard aphid, agro-meteorological parameters, correlation and regression, forewarning model

INTRODUCTION

Mustard is one of the important oilseed crops of Gujarat. Owing to good remunerative price of mustard, many farmers have switched over to mustard from potato in north Gujarat during last four years. Damage due to insect-pests is one of the major limiting factors influencing the mustard production and on the basis of economic losses mustard aphid is considered to be the key pest causing yield losses ranging from 35.4 to 91.3% (Brar *et al*., 1987). The weather conditions play important role for rapid multiplication of aphid (Sinha *et al*., 1989; Rana *et al.*, 1993; Singh and Malik, 1998). Intensive studies aimed at quantifying the relationship between thermal time (growing degree days) and mustard aphid incidence, its multiplication were made by Kar and Chakravarty (2000); Chakravarty et al. (2002). Keeping this in view, the present work was undertaken to study the population dynamics of mustard aphid in relation to varied environmental condition, so as to devise a simple pest management module for advance warning on aphid infestation for its timely management at lesser cost and help farmers in achieving good harvest.

MATERIALS AND METHODS

The field experiment on mustard (cv. GM-2) for assessment of mustard aphid-weather interaction was carried out in randomized block design (RBD) for nine consecutive crop seasons (2002-03 to 2013-14) with four different environments (viz. D_1 - 10th October, D_2 - 20th October, D_3 - 30th October and D_4 - 10th November) at Anand, (Lat. 22° 35'N; Long 72° 55'E and Altitude of 45.1 m) Gujarat. The soil of the experimental site was sandy loam in texture. A fertilizer dose of 50 kg N, 50 kg P_2O_5 and 20 kg S ha^{-1} was given to all the treatments uniformly. Half of the N and entire quantity of P and S were applied at the time of sowing with remaining N given 35 days after sowing. Three irrigations were given to the crop *viz.*, at rosette, 50% flowering and pod filling stages.

Aphid index measurement procedure:

The weekly aphid intensity was measured as per the given Table 1 criteria. Total five plants were randomly selected before observation per replication. On each plant three observations were made from bottom, mid and top portion of plant. For counting aphid intensity average of five observation per six replication was taken into consideration.

Table 1: Aphid intensity scale (0-5)

Aphid intensity (Scale)	Particulars	Average number of Aphid per plant
0	No population	0
1	Few aphid per plant	1-25
2	Small colonies per plant	25-75
3	Big Aphid colonies per plant	>100
4	High population on stem, pod, inflorences, plant has stunted growth, leaf curling, yellowing	>250
5	Drying of plant, Very high population, Whole plant covered by Aphid	Not countable

RESULTS AND DISCUSSION

Seed yield of mustard:

The results of seed yield of mustard on a pooled basis (2002-03 to 2013-14) is presented in Table 2. Results showed that seed yield of mustard was found to very significantly with dates of sowing as well as with year. Early sown (D_1- 10th Oct.) crop produced significantly highest yield (1781 kg/ha). With delay in sowing the seed yield of mustard decreased. The highest seed yield under D_1 was obtained 2774 kg/ha in 2002-03 followed by 2553 kg/ha in 2005-06 and 2403 kg/ha in 2010-11, while the lowest yield of just 411 kg/ha was recorded in 2008-09 under same dates of sowing (D_1). The wide variability in seed yield was observed under all the dates of sowing. Over mean basis, the maximum yield reduction of 41 % was observed in late sown mustard (D_4- 10th Nov.). However, in certain years the yield reductions are more than 70 % (2004-05 and 2013-14). The yield reduction was mainly due to higher temperature encountered by crop during reproductive phase under late sown condition, compounded by high aphid incidence also.

First initiation, peak and mean intensity of aphid under different environmental condition:

The first aphid initiation DAS, peak and mean intensity during crop growing period is presented in Table 3. Results showed that mean first aphid initiation in D_1, D_2, D_3 and D_4 sowing were observed as 58, 58, 56 and 57 DAS. This shows that mean first aphid initiation stats at 8 weeks onwards. Similarly the mean peak aphid intensity and mean aphid intensity were recorded as 0.86,1.31,1.79,2.25 and 0.5, 0.58,0.72,0.92 under D_1 to D_4 sowing respectively. Under late sown condition peak aphid intensity and mean intensity was found higher as compared to early and normal sown condition. This results clearly suggests that

mustard aphid infestation was found lowest under early and optimum sowing as compared to late sown condition.

Aphid-weather relationship:

The weekly mustard aphid intensity in the scale of 0-5 were correlated with weekly weather parameters (three days before aphid incidence and three days after incidence) and various agro meteorological indices. The values of correlation coefficients are presented in Table 4. Under D_1, only humidity temperature index (MRH/Tmean: HTI) was found significant. Under D_2 sowing wind speed and accumulated growing degree days (AGDD) were found highly significant, whereas maximum temperature showed negative significance. In case of D_3 and D_4 sowing (10th Nov.) AGDD were found positively significant. Similarly for combined data sets (D_1 - D_4) for all the years EP, Tmax., Tmean,VP1, VP2 and AGDD were found significant. This shows that under D_2, D_3 and D_4 sowing there was strong association of AGDD with aphid intensity. For development of aphid forewarning model only aphid first initiation under D_1 sowing was considered for entire data set. The results showed that RH_1, RH2 and MRH were found highly positive and significant. Based on this relationship stepwise regression study was carried out for development of model. The developed regression model was Y=0.0152(MRH)-0.7473 R^2: 0.71.The developed regression model was valid starting from 8WAS up to 11th WAS. The input parameter is only weekly MRH. The relationship is also depicted in Fig.1. Nearly more than seventy one percent aphid first initial variation in aphid intensity can be explained only by mean relative humidity.

Relationship between mustard yield and weather:

The prevailed weather during pod development phase of the mustard under different dates of sowing was correlated with mustard yield. The values of correlation coefficients are presented in Table 5. Results show that there was negative significant influence of temperature and vapour pressure on yield under D_1 and D_2 sowing. This shows that lower mean temperature in the range of 20 to 22 ^{0}C during pod development phase is helpful in getting higher mustard yield under D_1 sowing as compared to other dates of sowing.

Relationship between mustard yield and aphid intensity:

The average yield and mean aphid intensity relationship was depicted in Fig.2. Under D_1 and D_2 sowing there was less aphid infestation as compared to D_3 and D_4 sowing and it is clearly reflected in getting higher yield. Based on this inferences it is concluded that for higher yield with low aphid infestation D_1 and D_2 sowing are most suitable as compared to D_3

and D_4 sowing. Results also showed that D_1 has lowest aphid intensity as compared to D_2, D_3 and D_4 sowing in all the years.

CONCLUSIONS

1. Mean relative humidity (MRH) was found most significant weather parameter for first aphid initiation. The developed regression model was Y=0.0152(MRH)-0.7473 R^2: 0.71. The developed regression model was valid starting from 8 WAS up to 11th WAS. The input parameter is only weekly MRH. Early information of aphid intensity can help in efficient management of prophylactic spray schedule for aphid control.
2. The mean aphid initiation dates were 57, 58, 55 and 57 DAS under D_1, D_2, D_3 and D_4 sowing respectively.
3. There was negative significant association between mustard yield and aphid intensity. Based on this inferences it is concluded that for higher yield with low aphid infestation D_1 and D_2 sowing are most suitable as compared to D_3 and D_4 sowing.

Table 2: Seed yield of mustard as influenced by different treatments

Dates of sowing	Year												Pooled
	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	
D_1	2774	2089	1564	2553	1634	2243	411	1953	2403	1220	1404	1129	1781
D_2	2490	2079	1069	2245	826	2356	195	1415	2347	1257	1202	1042	1544
D_3	2397	1881	846	2099	842	2146	306	1170	2792	996	595	512	1382
D_4	1482	1341	459	2010	650	1893	379	1057	1698	793	504	265	1045
SEm	67.5	53.5	55.7	99.1	46.7	73.1	24.2	68.3	95.1	33.5	37.8	45.5	66.25
CD	203.	161.	168.	298.	140.	220.	73.1	206.	286.	101.	113.	137.	190.7
CV%	7.24	7.10	13.8	10.9	11.5	8.30	18.4	11.9	10.0	7.71	9.97	15.1	10.65

Table3:First aphid initiation and peak aphid intensity under different dates of sowing and year

Year	D_1(10th Oct.)			D_2(20th Oct.)			D_3(30th Oct.)			D_4(10th Nov.)		
	First initiation (DAS)	Aphid intensity		First initiation (DAS)	Aphid intensity		First initiation (DAS)	Aphid intensity		First initiation (DAS)	Aphid intensity	
		Peak	Mean		Peak	Mean		Peak	Mean		Peak	Mean
2002-03	57	0.2	0.10	54	0.2	0.39	43	1.4	0.99	47	3.9	1.34
2003-04	72	0.1	0.07	68	0.2	0.14	68	2.3	0.99	71	0.9	1.40
2004-05	61	0.2	0.09	51	1.1	0.52	55	0.8	1.13	55	3.6	2.68
2005-06	71	0.1	0.09	54	1.1	0.51	58	3.3	0.42	61	0.6	0.65
2006-07	70	0.6	0.46	53	3.0	1.52	50	0.2	2.18	57	2.5	2.69
2007-08	0	0	0.00	77	0.1	0.05	63	2.2	0.12	54	3.9	0.31
2008-09	60	0.5	0.30	59	1.1	0.80	61	3.7	1.7	59	2.1	1.98
2009-10	66	3.1	1.66	52	3.0	1.99	60	1.4	2.55	67	1.2	2.96
2010-11	76	0.8	0.50	69	1.2	0.50	55	1.3	0.60	55	2.3	0.94
2011-12	65	1.3	0.36	55	2.3	0.55	59	2.1	0.77	63	1.2	0.70
2012-13	42	2.1	1.14	53	1.0	1.22	43	1.4	1.00	46	3.9	0.96

2013-14	50	1.3	0.44	54	1.4	0.42	51	1.4	0.55	54	0.9	0.67
Mean	58	0.86	0.43	58	1.31	0.72	56	1.79	1.08	57	2.25	1.44
SD	20.54	0.95	0.50	8.39	0.99	0.58	7.66	0.99	0.72	7.37	1.30	0.92
CV %	35.41	110.	115.2	14.46	75.88	80.06	13.67	55.38	66.91	12.92	57.87	63.63

Table : 4 Correlation coefficients between weekly aphid intensity and weather parameters

Weather parameters and Agromet. indices	D_1	D_2	D_3	D_4	D_1toD_4	D_1 First initiation	D_1D_2 first initiation	All data 0-1 AI
EP	-0.04	0.11	0.09	0.12	**0.15***	-0.21	-0.28	-0.01
BSS	-0.06	0.09	0.05	0.10	0.08	-0.37	**-0.47***	-0.15
WS	0.22	**.34****	0.00	-0.21	0.11	0.34	0.04	**0.17***
Tmax.	-0.20	**-.32***	-0.03	0.19	**-0.13***	-0.37	-0.08	**-0.25****
Tmin.	-0.16	-0.13	-0.03	0.09	-0.11	0.01	0.20	-0.08
Tmean	-0.20	-0.26	-0.04	0.16	**-0.14***	-0.18	0.07	**-0.19***
Trange	-0.04	-0.18	-0.01	0.11	-0.03	-0.56	-0.35	**-0.17***
RH1	0.16	-0.02	-0.03	-0.15	-0.09	**0.61***	**0.43***	**0.21***
RH2	0.25	0.05	0.04	-0.15	-0.01	**0.80****	0.26	0.16
MeanRH	0.25	0.03	0.00	-0.17	-0.06	**0.84****	0.40	**0.21***
VP1	-0.06	-0.13	-0.11	-0.07	**-0.18****	0.03	0.33	0.00
VP2	0.05	-0.16	-0.07	-0.04	**-0.13***	0.56	0.33	-0.05
VPmean	0.05	-0.04	-0.07	-0.10	-0.12	0.40	0.38	0.04
AGDD	0.12	**0.36****	**0.46****	**0.54****	**0.13***	0.14	-0.14	0.07
HTI	**0.30***	0.22	0.04	-0.26	0.04	0.59	0.17	**0.28****

*: Significant at 5 % level, **: Significant at 1 % level

Table : 5 Correlation coefficient between yield and weather parameters during pod development under different dates of sowing

Dates of sowing	Tmax.	Tmin.	Tmean	RH_1	RH_2	MeanRH	VP_1	VP_2	MeanVP	GDD
D1	-0.25	**-0.58***	**-0.59***	-0.42	-0.14	-0.37	**-0.62***	0.12	-0.15	0.05
D2	0.06	**-0.59***	-0.50	-0.43	-0.46	-0.46	**-0.61***	-0.23	-0.40	-0.14
D3	0.31	-0.53	-0.20	-0.02	-0.51	-0.23	-0.42	-0.31	-0.39	0.10
D4	-0.14	-0.34	-0.26	-0.48	-0.43	-0.53	-0.54	-0.52	**-0.65***	-0.19

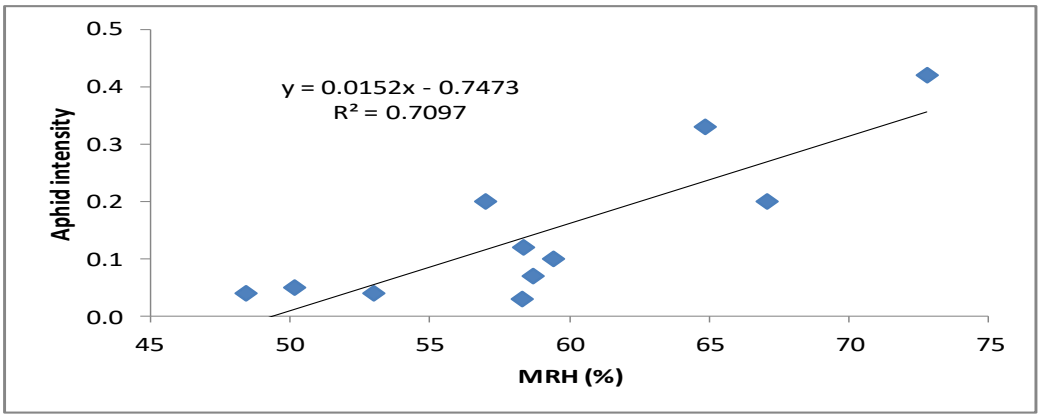

Fig. 1: Relationship between first aphid incidence and mean relative humidity under D_1 sowing

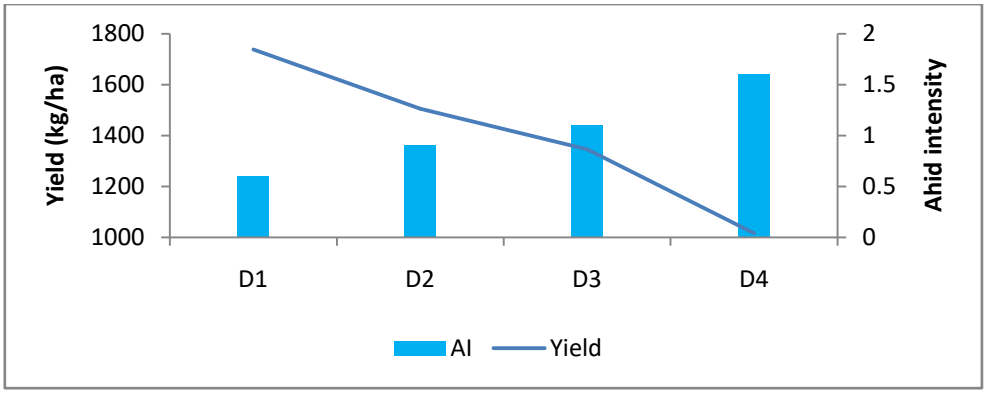

Fig. 2: Relationship between average yield and average aphid intensity under different dates of sowing

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