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Diversity and Population Dynamics of Insect Pests of Mustard Crop in Hot Arid Region of Rajasthan

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Abstract: An investigation was carried out on the diversity of insect pests of mustard and influence of weather parameters. Survey and surveillance data were recorded from the 10 fields under mustard cultivation located in a radius of 80 km in Jaisalmer district during Rabi 2019-20 and 2020-21. Mustard in these fields was grown either as rainfed (three fields) or irrigated (four with tube well and three with canal water) crop. The data from one site was also used to find out correlation between mustard aphid population and weather parameters. Data on different insects infesting the mustard crop, namely aphid, painted bug, cabbage looper, leaf miner, diamond back moth, white fly, jassid, black flea beetle, mustard saw fly and flower weevil were recorded. Appearance of winged aphid started after one month of sowing [45th-46th Standard Week (SW)]. The aphid population on crop remained negligible up to second fortnight of December. Population buildup started in first fortnight of January and peaked in February. It was observed that in rainfed areas the aphid reached to peak population of 54.58 aphids plant^{-1} in second fortnight of February (8th - 9th SW) while in tube well and canal irrigated area the peak population was nearly double of the rainfed areas. In tube well irrigated areas the peak reached earlier than in rainfed areas while in canal irrigated areas population peaked at the same time as in rainfed areas. Relative density was highest (41.47%) in canal area followed by tube well (36.91%) and rainfed area (21.62%). The aphid population showed significant positive correlation with maximum temperature and positive correlation with minimum temperature, sunshine hours and rainfall. Although rainfall showed positive correlation but remained of minor significance. Aphid population showed negative and significant negative correlation with minimum and maximum relative humidity.

Key words: Arid Rajasthan, mustard, insect-pests, *Lipaphis erysimi*.

Rajasthan has diverse agro climatic conditions ranging from humid to hyper arid, suitable for high water requiring crops to rainfed crops. Arid western zone covers the districts of Barmer, Jodhpur, Churu, Jaisalmer of Rajasthan state

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(Anonymous, 2022). Jaisalmer is the hot arid region falling under Agro-climatic zone Ic (hyper arid partially irrigated western plain) of western Rajasthan. Mustard (*Brassica juncea* L.) is a major winter crop grown in this region.

Mustard is the important oilseed crop under the *Brassicaceae* family cultivated almost in all parts of the country as irrigated (74% area) as well as rainfed crop (26% area). It accounts about 27.19% of total oilseeds production in India. Rajasthan state contributes 41.44% (3.076 mha) and 45.03% (42.02 mt) of the national acreage and production, respectively under mustard as well as rapeseed. Productivity ranges from 1366 to 1709 kg ha^{-1} (Anonymous, 2021). Mustard is one of the major oilseed crops grown in Jaisalmer.

Insect-pests are one of the most important factors in reducing its yield. As many as 24 insect pests of rapeseed and mustard were reported by Rai (1976). Out of many insect pests, sawfly (*Athalia lugens proxima* Klug.), leaf miner (*Chromatomyia horticola* Gorreau), painted bug (*Bagrada cruciferarum* Kirk.), flea beetle (*Phyllotreta cruciferae* Goeze), diamond back moth (*Plutella xylostella* L.) (DBM), cabbage butterfly (*Pieris brassicae* L.), mustard aphid (*Lipaphis erysimi* Kalt.), cabbage aphid (*Brevicoryne brassicae* L.), green peach aphid (*Myzus persicae* Sulzer), whitefly, (*Bemisia tabaci* Genn.), thrip (*Thrips tabaci* Lind.), jassid, (*Amrasca devastans* Dist.), aphid (*Aphis gossypii* Glover), American bollworm (*Helicoverpa armigera* Hb.), spotted bollworm, (*Earias* spp.) are considered important, which cause considerable yield losses (Patel *et al*., 2019; Rakha *et al*., 2017). Mustard aphids, thrips and whitefly are the major and most destructive, causing 15.0 to 73.3% reduction in seed yield (Bhati *et al*., 2015; Rakha *et al*., 2017). The loss caused by mustard aphid, alone is estimated to the tune of 69.61% (Singh and Sachan, 1994). The nymphal feeding results in secretion of honeydew leading to the development of sooty mould disease (Bhati *et al*., 2015). The best way to control the pests is to destroy them at initial stage of the life cycle. This is possible with timely prediction of their occurrence. Hence, an investigation on incidence of insect-pests on mustard in relation to the different meteorological parameters was carried out.

Materials and Methods

Study locations and sampling

The study was undertaken in the Jaisalmer which falls under western dry region agro climatic zone of India (http://mowr.gov.in/agro-climaticzones). A total of 10 fields were selected from rainfed, tube well and canal irrigated areas in Jaisalmer district located in a radius of 80 km. The selected plots were farmers owned; therefore, mixture of crop varieties and staggered sowing dates were observed. Fixed plot survey approach was adopted and observations were taken at fortnightly intervals from five spots of each field. From each spot, three plants in one m^2 were randomly examined for the incidence of different insect pests.

Data analysis

Mean density (MD), relative density (RD%) and diversity [Shannon-Weiner index (H')] index of insect species between the habitats surveyed was calculated using the formula mentioned below.

$$\text{Shannon diversity index (H)} = \sum_{i=1}^{s} -(P_i \times \ln P_i)$$

where, H - Shannon diversity index; pi - Proportion of individuals of i-th species in a whole community:

pi = n / N

where, n - Individuals of a given species; and N - Total number of individuals in a community.

Data from one experimental site located at Chandan was also used to find out the correlation of aphid incidence with weather parameters. Weather parameters data were taken from the agro-meteorology unit located at the experimental area Chandan of ICAR-Central Arid Zone Research Institute- Regional Research Station, Jaisalmer

Results and Discussion

Diversity and abundance

Study on the diversity and abundance in rainfed, tube well and canal irrigated area in Jaisalmer district revealed the presence of different insects on mustard i.e., aphid, painted bug, cabbage looper, leaf miner, diamond back moth, white fly, jassid, black flea beetle, mustard saw fly, flower weevil (Table 1). Aphids were the major pest and their highest

population, 317 aphids plant^{-1}, was recorded in Mohangarh area. Painted bugs were found in first 4-8 weeks old crop and again towards maturity stage. Mustard saw fly grubs were observed in one location only out of 10 surveyed locations when the crop was about 45 days old [47th-48th Standard Week (SW)]. Flower weevils were observed at the time of flowering in November only (45th-48th SW). Appearance of winged forms of aphids (Table 2) started after one month of sowing (45th-46th SW) of the crop which remained negligible up to second fortnight of December (51st-52nd SW). Population buildup started in first fortnight of January (1st-2nd SW) and attained peak in February (6th-8th SW) during 2019-20 to 2020-21 at different sites. It was observed that in rainfed area the aphids reached to peak (54.58 aphids plant^{-1}) in second fortnight of February (8th-9th SW) while in tube well (111.11 aphids plant^{-1}) and canal (127.13 aphids plant^{-1}) area during first (6th-7th SW) and second fortnight of February (8th-9th SW), respectively. Relative density was highest (41.47%) in canal area as compared to tube well (36.91) and rainfed area (21.62%). Initial infestation of mustard leaf miner was seen in first fortnight of November (45th- 46th SW) and continued up to first fortnight of March (Table 3) depending upon the sowing and maturity time of the crop. However, the maximum number (27.60 plant^{-1}) was recorded in Bhagu ka gaon village under rainfed area. Shannon wiener diversity index was 0.76, 0.23 and 0.13 for the mustard grown in the rainfed, tube well and canal area, respectively.

Insect pests such as sawfly, leaf miner, painted bug, flea beetle, diamond back moth, cabbage butterfly, mustard aphid, cabbage aphid, green peach aphid, whitefly, thrips, jassid, aphid, American bollworm, spotted bollworm are recorded pests of mustard crop (Patel *et al*., 2019; Rakha *et al*., 2017). Singh *et al*. (2009) reported that incidence commenced from the 3rd week of December and reached to peak in 2nd to 3rd week of February. The population started decreasing and vanished to the 1st week of March. Present findings get support from Verma *et al*. (2010) who found peak population between the second and fourth weeks of February in the range of 18.88-320.35 five^{-1} plants during the 1999-20 to 2000-01. Khan and Jha (2010) reported that initial incidence of aphid varied from 19 November to 3 December, depending upon dates of sowing. Number of aphids plant^{-1} was consistently greater in crops grown under irrigated condition than under rainfed condition and the same was observed in the present investigation also. Incidence of aphid was noted (Ahuja, 1990; Kulkarni and Patel, 2001) high during first week of February as was also observed in the present study (6th-9th SW). Patel *et al*. (2019) reported that the leaf miner infestation commenced during the mid-October and ended in last week of March-April.

Incidence of mustard aphid and impact of weather parameters

Periodic change in the aphid population has been detailed in the preceding paragraphs. The aphid population showed significant positive correlation with mean maximum temperature and positive correlation with mean minimum temperature, mean sunshine hours and mean rainfall. Although rainfall showed positive correlation but was of minor significance as only 0.9 mm rain was received during first fortnight of March. Aphid population showed negative correlation with mean minimum relative humidity and significant negative with maximum relative humidity (Table 4; Fig. 1).

Singh *et al*. (2009) found the peak aphid population when the maximum temperature was 24.7°C and minimum 10.6°C with relative humidity of 83.6-94.7% in the morning and 40.0-67.3% during the evening. Intermittent rain showed the conducive effect for the aphid multiplication. In accordance of present study, a positive correlation of aphid population with maximum temperature, humidity, rainfall, sunshine and negative correlation with minimum temperature was recorded (Singh and Lal, 2012; Sahoo and Saha, 2018). However, some studies (Pawar *et al*., 2010; Mandal *et al*., 2018) are in disagreement of the present findings showing negatively correlation of evening relative humidity and sunshine hours and highly significant negative correlation of maximum and minimum temperature and morning relative humidity with aphid population.

Conclusion

The study has clearly shown that a number of insects damage the mustard crop but of them aphids are the major ones. Their, population showed significant positive correlation with

Table 1. Density of different insects-pests on mustard crop

Name of insects	(Mean number of insects plant^{-1} location^{-1})										Insects in one plant (Min-max)
	Basanpeer	Bhagu gaon	Jhabra	Mohan garh	Mohangarh mathar khan	Dalle khan	Chandan	Karmo ki dhani1	Chutar dhani2	Sodakaur	
Aphid	0.07 - 74.20	0.07- 101.07	0.27- 117.47	0.07 - 317.80	0.07 - 117.33	0.07 - 121.80	0.40-139.20	0.07 - 224.93	0.13 - 251.60	0.07- 187.40	0-920
Painted bug	0.07 - 0.27	0.07 - 0.20	-	1.73 - 1.73	0.27 - 0.27	0.13-0.20	0.20 - 0.27	0.07-0.20	0.07-0.20	0.13 - 0.27	0-21
Flower weevil	-	-	-	0.33 - 0.33	0.07 - 0.07	0.07- 0.07	-	-	-	1.00 - 4.27	0-14
Leaf miner	0.20 - 2.80	0.07 - 5.20	3.13- 3.13	0.13 - 4.60	0.73 - 2.00	0.07- 0.27	0.20- 14.27	0.07- 1.00	0.13- 4.93	0.07- 3.00	0-168
Mustard saw fly	-	-	-	-	-	-	-	-	0.07-0.60	-	0-2
Flea beetle	-	0.07 - 0.07	0.07-0.47	0.13 - 0.20	0.27 - 0.40	-	0.07-2.20	0.07-0.07	0.13-0.20	0.07-0.20	0-17
Cabbage looper	-	0.07 - 0.07	-	0.07 - 0.13	0.13 - 0.13	0.07- 0.27	0.40 -0.60	-	0.07- 0.07-	-	0-4
DBM	0.07 - 0.07	0.07 - 0.07	-	0.07 - 0.07	-	0.07-0.07	0.07-0.33	-	0.13- 0.13	-	0-2
White fly	0.80 - 3.73	3.20- 3.20	1.20- 1.20	0.07 - 1.53	0.20 - 1.07	0.07- 2.67	0.07- 0.60	0.07- 0.40	0.07- 1.73	0.07- 5.07	0-22
Jassid	0.07 - 0.27	-	0.07-0.07	0.13 - 0.13	0.07 - 0.07	0.13- 0.13	0.13- 0.13	-	0.07-0.07	0.07-0.07	0-3

Table 2. Mean population of aphid at different locations in rainfed, canal and tube well area on mustard crop

Observation period	Rainfed (mean of 2019 and 2020)				Canal (mean of 2019 and 2020)				Tubewell (mean of 2019 and 2020)			
	Basan peer	Bhagu gaon	Jhabra	Grand Mean	Mohan garh 1	Mathar khan house	Dalle khan	Grand Mean	Karmo ki dhani1	Chutar dhani2	Soda kaur	Grand Mean
Nov I Fortnight	0.20	-	0.43	0.21	-	0.73	-	0.24	-	-	-	-
Nov II Fortnight	0.00	0.03	1.90	0.64	0.03	1.00	-	0.34	-	-	-	-
Dec I Fortnight	0.03	2.07	3.13	1.74	0.00	1.43	-	0.48	-	-	0.37	0.12
Dec II Fortnight	0.00	2.60	4.40	2.33	0.33	1.57	0.17	0.69	-	0.07	1.10	0.39
Jan I Fortnight	1.20	2.33	4.33	2.62	0.50	3.73	0.93	1.72	0.50	0.57	1.17	0.74
Jan II Fortnight	13.43	11.63	12.73	12.60	8.97	9.93	8.87	9.26	12.77	9.33	22.37	14.82
Feb I Fortnight	7.07	48.53	38.70	31.43	17.37	53.27	63.37	44.67	112.83	126.27	94.23	111.11
Feb II Fortnight	37.10	67.57	59.07	54.58	265.30	66.60	49.50	127.13	55.00	30.30	69.37	51.56
March I Fortnight	4.37	25.70	20.13	16.73	129.03	14.63	10.07	51.24	38.33	28.50	26.50	31.11
R D%	17.20	43.52	39.28	21.62	59.59	21.62	18.79	41.47	34.85	30.98	34.17	36.91
Mean Density	7.04	17.83	16.09	13.66	46.84	16.99	14.77	26.20	24.38	21.67	23.90	23.32

Table 3. Mean population of leaf miner at different locations in rainfed, canal and tube well area on mustard crop

Observation period	Rainfed (mean of 2019 and 2020)				Canal (mean of 2019 and 2020)				Tube well (mean of 2019 and 2020)			
	Basan peer	Bhagu gaon	Jhabra	Grand Mean	Mohan garh1	Mathar khan house	Dalle khan	Grand Mean	Karmo ki dhani1	Chutar dhani2	Sodakaur	Grand Mean
Nov I Fortnight	-	-	-	-	-	-	-	-	0.03	-	0.03	0.02
Nov II Fortnight	-	-	-	-	-	-	-	-	0.10	-	0.00	0.03
Dec I Fortnight	0.10	0.03	-	0.04	-	-	-	-	0.00	-	0.13	0.04
Dec II Fortnight	0.17	0.00	-	0.06	-	-	-	0.00	0.00	-	0.13	0.04
Jan I Fortnight	0.57	0.27	-	0.28	-	-	0.13	0.04	0.20	0.07	0.13	0.13
Jan II Fortnight	0.20	0.03	-	0.08	-	-	0.00	0.00	2.40	0.10	0.17	0.89
Feb I Fortnight	1.50	3.20	1.57	2.09	0.07	0.37	0.67	0.37	3.30	1.73	2.17	2.40
Feb II Fortnight	0.70	27.60	0.00	9.43	1.30	1.00	0.53	0.94	5.50	2.47	0.00	2.66
March I Fortnight	-	-	-	-	2.53	-	-	0.84	-	-	-	-
R D%	9.00	86.64	4.36	58.71	59.09	20.71	20.20	10.78	61.79	23.39	14.82	30.50
Mean Density	0.36	3.46	0.17	1.33	0.43	0.15	0.15	0.24	1.28	0.49	0.31	0.69

Table 4. Correlation of mustard aphid population with weather parameters

	2019-20	2020-21	Pooled
Correlation Coefficient (r) for aphid and mean max temperature	0.46	0.74	0.64
Correlation Coefficient (r) for aphid and mean min temperature	0.46	0.37	0.47
Correlation Coefficient (r) for aphid and mean max relative humidity	-0.37	-0.81	-0.71
Correlation Coefficient (r) for aphid and mean min relative humidity	0.26	-0.67	-0.30
Correlation Coefficient (r) for aphid and Sunshine (Hrs)	0.32	0.36	0.37
Correlation Coefficient (r) for aphid and rainfall	0.92	-	0.89

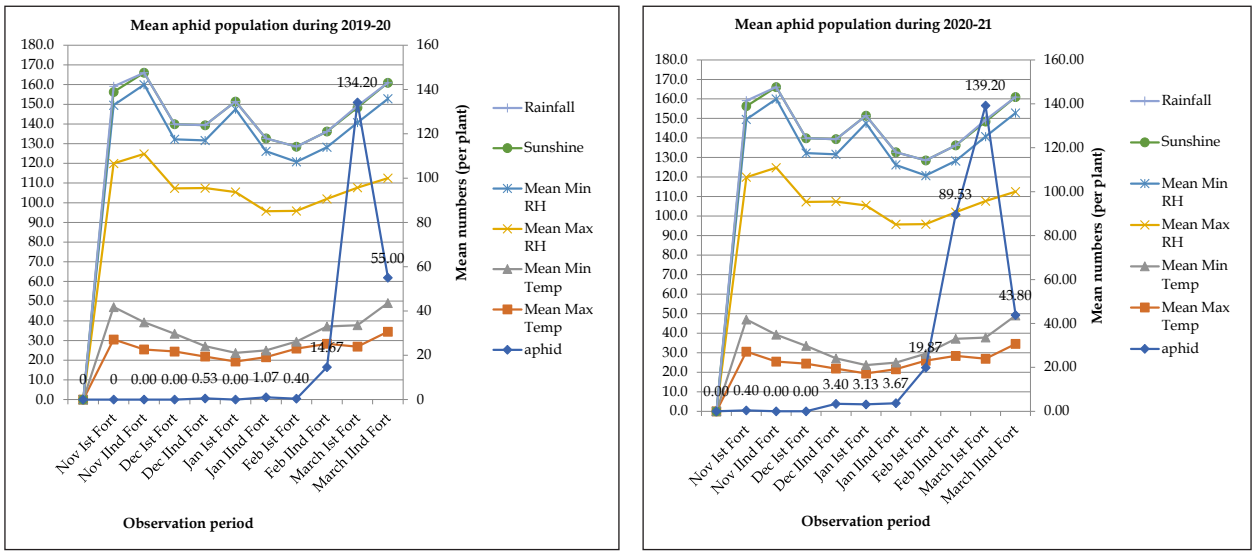

Fig. 1. Impact of weather parameters on mustard aphid during 2019-20 and 2020-21.

mean maximum temperature and positive correlation with mean minimum temperature, mean sunshine hours and mean rainfall. Aphid damage is likely to be more in canal command areas than in rainfed or tube well irrigated areas. This information can be utilized in developing sound pest management strategies.

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