International Journal of Environment and Climate Change

Volume 14, Issue 11, Page 595-604, 2024; Article no.IJECC.125438
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Insects Associated with Moringa and their Correlation with Abiotic Parameters

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijecc/2024/v14i114571

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/125438

Original Research Article

Received: 27/08/2024
Accepted: 29/10/2024
Published: 08/11/2024

ABSTRACT

The association of different insect pests and natural enemies was observed on moringa and their correlation with abiotic parameters also recorded at College of Agriculture, Jodhpur during 2023-24. Among the sixteen insect species leaf eating caterpillar, *Noorda blitealis* Walker was found prominent pest and cause great damage of moringa. The infestation of leaf eating caterpillar started from the first week of July with 3.60 larvae per branch and reached to peak at first week of August with 9.10 larvae per branch. July and August month was more compatible for damage of leaf eating caterpillar. Maximum population of whitefly, leaf-footed bug and ash weevil was observed at last week of October with 59.13 whitefly per 3 branches, first week of November with 3.87 bug per 3 branches and at first week of September with 0.12 weevil per 5 branches, respectively. Among the natural enemies, lady bird beetles were observed as a major predator against aphid and preying mantid preys upon leaf eating caterpillar.

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Cite as: *Yadav, Anita, M.M. Kumawat, D. Ram, Piyush Pradhan, and Tara Yadav. 2024. "Insects Associated With Moringa and Their Correlation With Abiotic Parameters". International Journal of Environment and Climate Change 14 (11):595-604. https://doi.org/10.9734/ijecc/2024/v14i114571.*

Keywords: Insects; moringa; natural enemies; abiotic factors.

1. INTRODUCTION

Moringa (*Moringa oleifera* Lam.) is a tropical plant that belongs to the Moringaceae family and is distributed throughout tropical areas. The moringa genus contains 13 species, with *Moringa oleifera* and *Moringa stenopetala* being the most extensively utilized. Moringa is a small deciduous tree of 2.5 to 10 m in height. It is a fast-growing, drought-tolerant plant well adapted to drier areas of the tropics and tolerates annual precipitation ranging from 250 to 3000 mm, annual temperature of 1 to 48 °C and pH of 5.5 to 7.5. It thrives in subtropical and tropical climates and grows best on dry sandy loam soil. Moringa is an important food commodity which has had enormous attention as the 'natural nutrition of the tropics. Moringa leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants. India is recognized as a prominent producer of moringa, with an output ranging from 2.20 to 2.40 million tonnes of tender pods cultivated over 38,000 hectares, yielding an average productivity of around 63.00 tonnes per hectare. The state of Andhra Pradesh leads in moringa cultivation, occupying 15,665 hectares, trailed by Tamil Nadu with 13,250 hectares and Karnataka with 10,280 hectares. Furthermore, other states contribute approximately 4,613 hectares to the overall moringa production (Sekhar et al., 2018).

Like any other crop, drumstick is also susceptible to the attack of number of insect pests. As many as 28 different insect species have been reported so far from India on various parts of drumstick trees. The major destructive pests are pod fly (*Gitona distigma* Meigan), leaf eating caterpillar (*Noorda blitealis* Walker), bud worm (*Noorda moringae* Tams), hairy caterpillar (*Eupterote mollifera* Walker) are observed as major insect pests whereas, trunk borer (*Indarbela tetraonis* Moore), leaf eating weevils (*Myllocerus maculosus* Desb.), whitefly (*Trialeurodes rara* Singh), scale insects and mites are considered as minor pests (Butani and Verma, 1981). *Noorda blitealis* Walker, 1859 is a caterpillar belongs to family crambidae of the order lepidoptera and it considered as a remarkable pest of annual moringa plant. It attacks the plant persistently and inflicts significant damage, it is regarded as the major serious defoliator of moringa leaves (Kumari et al., 2015). There is a diversity of natural enemies of insects in drumstick plantations. Natural enemies of insects are comprised of insects, pair of birds and spiders which are found in drumstick ecosystem (Mahesh et al*.,* 2013). Studies of insect pests and natural enemies of any crop are very important as these provide information about their status and also help in identifying the damaging stages of the crop. In view of above context, the present study was aimed to know the actual situation of insect pests of moringa in western Rajasthan.

2. MATERIALS AND METHODS

For the study of insects associated with moringa, already established orchard of moringa was selected for the study at the instructional farm of the College of Agriculture, Jodhpur during 2023-2024. Five plants of cultivar PKM-1 from orchard were selected randomly from entire field. The number of defoliators per branch were recorded at weekly interval. The branch length for recording the observation was 60 cm from the terminal end. For recording the population of sucking insect pests, two branches were selected randomly from four directions and the central portion of the plants or the total number of pests counted. Furthermore, population of natural enemies was also recorded and expressed as numbers per five branches. Insect pests and population of natural enemies was analysed for simple correlation or multiple linear forms of the regression.

2.1 Statistical Analysis

In order to study the effect of key abiotic factors on the population of major insects associated, simple correlations worked out between the population of insects and abiotic factors following the method given by Karl Pearson (1973).

3. RESULTS AND DISCUSSION

Observations on the activity of insect pests and predators were recorded on already established orchard of moringa. Insect pests associated during whole study period were leaf eating caterpillar, *Noorda blitealis* Walker; ash weevil, *Myllocerus viridanus* (Fab.); leaf footed bug, *Leptoglossus phyllopus* (L.) and whitefly, *Bemisia tabaci* (Gennadius). Among insect predators coccinellids, *Coccinella septempunctata* (L.), *Cheilomenes sexmaculata* (Fab.) and praying

mantid, *Hierodula* spp. were also recorded at weekly intervals from first week of July to last week of December. The effect of weather parameters *viz*., minimum and maximum temperature, morning and evening relative humidity and rainfall were correlated with the population of associated insect pests. Insect recorded as visitors during study were green bug, *Nezara viridula* (L.); red pumpkin bug, *Coridius janus* (Fab.); brown marmorated sting bug, *Halyomorpha halys* (Stal.); red cotton bug, *Dysdercus cingulatus* (Fab.); dusky cotton bug, *Oxycarenus hyalinipennis* (Costa); blister beetle, *Mylabris pustulata* (Thunb.); cotton Jassid, *Amarasca biguttula* (Ishida); cotton aphid, *Aphis gossypii* (Glover) and American grasshopper, *Schistocerca americana* (Dru.) on moringa plants (Table 1). Incidence of major insect pests and effect of weather parameters are mentioned as below (Tables 2&3).

3.1 Leaf Eating Caterpillar, *Noorda blitealis* Walker

Incidence of leaf eating caterpillar was observed during the throughout study period of which July and August month found more prominent for attack. This pest caused great damage by eating green foliage of plants. The infestation of leaf eating caterpillar started from the first week of July in 27th Standard Meteorological Week (SMW) with 3.60 larvae per branch and reached to peak in second week of August (32nd SMW) with 9.10 larvae per branch. The infestation of leaf eating caterpillars was observed to be lowest 3.06 larvae per branch in the first week of November (45th SMW). The infestation of leaf eating caterpillar showed positive non-significant correlation with minimum temperature (r = 0.331), maximum temperature (r = 0.044) and rainfall (r = 0.169) whereas, it showed positive significant correlation with morning relative humidity (r = 0.430) and evening relative humidity (r = 0.446). Munj et al. (2001) reported *Noorda blitealis* Walker infestation on drumstick occurred in three peak periods, first from July to August, second on October and third on January. Mahesh and Kotikal (2014) observed severe infestation of *N. blitealis* on drumstick and it caused 100 per cent foliage damage. The activity of *N. blitealis* was noticed throughout the year. A maximum (11.2 larvae per branch) larval population was noticed during second fortnight of April and 7.8 larvae per branch were noticed during second fortnight of October. Patel (2008) reported six peaks of *N. blitealis* during February, March, April, June, October and January which is contradictory to the present findings.

Table 1. Insects associated with moringa

S.N.	Common name	Scientific name	Order	Family
1.	Leaf eating caterpillar	*Noorda blitealis* Walker	Lepidoptera	Crambidae
2.	Green bug	*Nezara viridula* (L.)	Hemiptera	Pentatomidae
3.	Red pumpkin bug	*Coridius janus* (Fab.)	Hemiptera	Dinidoridae
4.	Brown marmorated sting bug	*Halyomorpha halys* (Stal)	Hemiptera	Pentatomidae
5.	Red cotton bug	*Dysdercus cingulatus* (Fab.)	Hemiptera	Pyrrhocoridae
6.	Leaf footed bug	*Leptoglossus phyllopus* (L.)	Hemiptera	Coreidae
7.	Cotton aphid	*Aphis gossypii* Glover	Homoptera	Aphididae
8.	White fly	*Bemisia tabaci* (Gennadius)	Hemiptera	Aleyrodidae
9.	Cotton Jassid	*Amarasca biguttula biguttula* (Ishida)	Hemiptera	Cicadellidae
10.	Dusky cotton bug	*Oxycarenus hyalinipennis* (Costa)	Hemiptera	Lygaeidae
11.	Ash weevil	*Myllocerus viridanus* Fabricius	Coleoptera	Curculionidae
12.	Blister beetle	*Mylabris pustulata* Thunberg	Coleoptera	Meloidae
13.	Grasshoppers	*Schistocerca americana* (Drury)	Orthoptera	Acrididae
14.	Praying mantid	*Hierodula* spp.	Dictyoptera	Mantidae
15.	Ladybird beetle, (Coccinellids)	*Coccinella septempunctata* (L.)	Coleoptera	Coccinellidae
16.	Ladybird beetle, (Coccinellids)	*Cheilomenes sexmaculata* (Fabricius)	Coleoptera	Coccinellidae

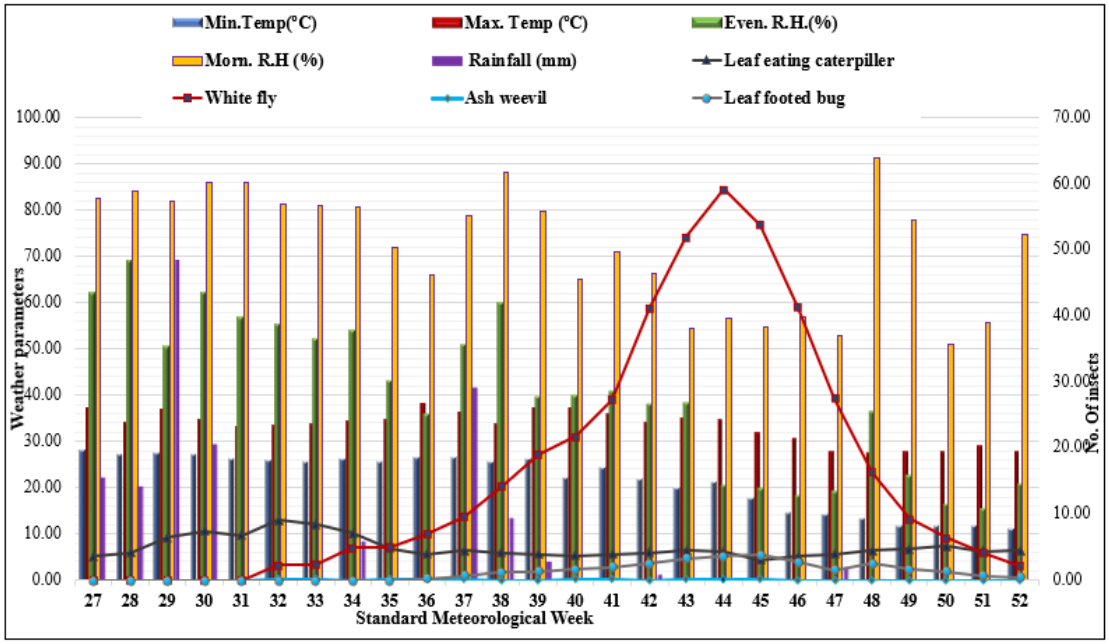


Fig. 1. Seasonal incidence of insect pests of moringa

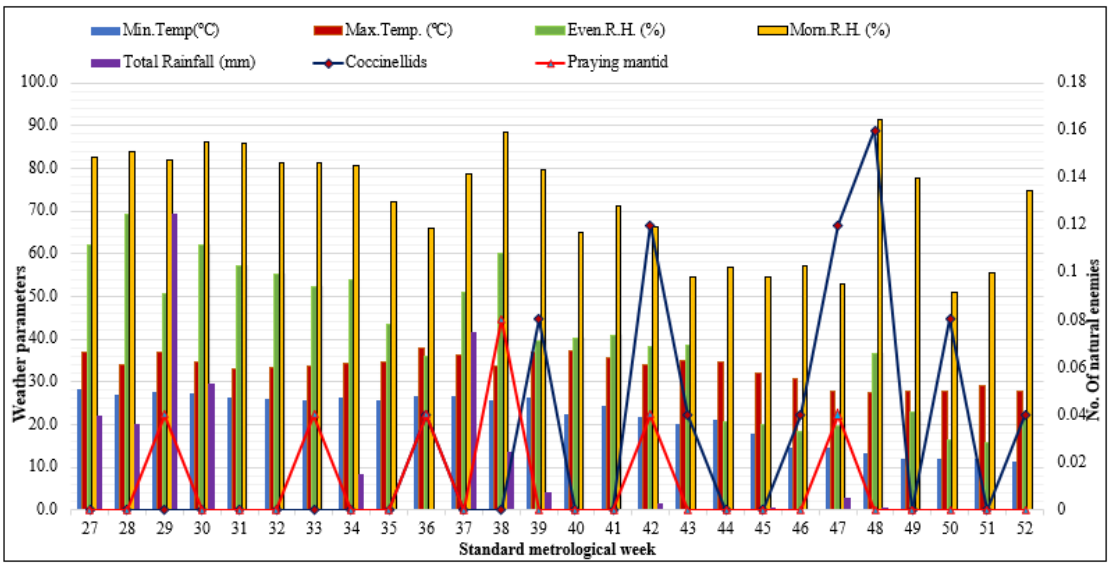


Fig. 2. Seasonal incidence of natural enemies of moringa

3.2 Ash Weevil, *Myllocerus viridanus* Fab.

The population of ash weevil fluctuated from 0.04 to 0.12 weevil per 5 branches from first week of August to first week of November. The correlation with weather parameters revealed that the ash weevil showed positive significant correlation (r = 0.463) with maximum temperature and positive non-significant correlation (r = 0.289) with minimum temperature. A positive non- significant correlation was observed with evening relative humidity (r = 0.030) and negative non- significant correlation was observed with morning relative humidity (r = -0.206) and rainfall (r = -0.111) with ash weevil infestation. The present findings are in accordance with Kumari et al. (2015) who recorded four species of ash weevils of which *Myllocerus viridanus* Fab. was observed throughout the year.

Table 2. Insect pests and natural enemies associated with moringa in relation to weather parameters.

SMW*	Duration	Temp. (ºC)		RH (%)		Rainfall (mm)	Leaf eating caterpillar / branch	Ash Weevil / 5 branches	Leaf footed bug / 3 branches	White fly / 3 branches	Coccinellids / 5 branches	Praying mantid / 5 branches
		Max.	Min.	Morning	Evening		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
27	2 July – 08 July	37.00	28.20	82.70	62.10	22.00	3.60 ± 0.29	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
28	9 July – 15 July	34.10	27.10	84.00	69.10	20.10	4.12 ± 0.32	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
29	16 Jul – 22 Jul	36.80	27.60	81.90	50.70	69.10	6.40 ± 0.35	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.04 ± 0.09
30	23 Jul – 29 Jul	34.60	27.30	86.10	62.10	29.30	7.44 ± 0.46	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
31	30 Jul – 05 Aug	33.00	26.40	85.90	57.00	0.00	6.72 ± 0.33	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
32	06 Aug – 12 Aug	33.30	25.90	81.30	55.30	0.00	9.10 ± 0.60	0.04 ± 0.09	0.00 ± 0.00	2.24 ± 0.35	0.00 ± 0.00	0.00 ± 0.00
33	13 Aug – 19 Aug	33.70	25.70	81.10	52.30	0.00	8.40 ± 0.35	0.08 ± 0.11	0.00 ± 0.00	2.37 ± 0.24	0.00 ± 0.00	0.04 ± 0.09
34	20 Aug – 26 Aug	34.30	26.20	80.60	54.00	8.30	7.20 ± 0.50	0.00 ± 0.00	0.00 ± 0.00	4.86 ± 0.15	0.00 ± 0.00	0.00 ± 0.00
35	27 Aug – 02 Sep	34.50	25.60	72.00	43.30	0.00	4.80 ± 0.44	0.04 ± 0.09	0.00 ± 0.00	4.94 ± 0.79	0.00 ± 0.00	0.00 ± 0.00
36	03 Sep – 09 Sep	38.00	26.50	65.90	35.90	0.00	3.90 ± 0.49	0.12 ± 0.09	0.20 ± 0.03	6.99 ± 0.55	0.04 ± 0.09	0.04 ± 0.09
37	10 Sep – 16 Sep	36.20	26.60	78.70	51.00	41.50	4.56 ± 0.52	0.08 ± 0.18	0.64 ± 0.06	9.59 ± 0.74	0.00 ± 0.00	0.00 ± 0.00
38	17 Sep – 23 Sep	33.50	25.80	88.30	60.10	13.40	4.10 ± 0.39	0.00 ± 0.00	1.20 ± 0.04	14.09 ± 0.70	0.00 ± 0.00	0.08 ± 0.11
39	24 Sep – 30 Sep	37.00	26.20	79.60	39.60	4.00	3.88 ± 0.30	0.00 ± 0.00	1.33 ± 0.04	19.06 ± 0.74	0.08 ± 0.11	0.00 ± 0.00
40	01 Oct – 07 Oct	37.10	22.40	65.00	40.10	0.00	3.72 ± 0.55	0.04 ± 0.09	1.69 ± 0.02	21.71 ± 0.83	0.00 ± 0.00	0.00 ± 0.00
41	08 Oct – 14 Oct	35.70	24.40	71.00	40.90	0.00	3.98 ± 0.24	0.04 ± 0.09	2.00 ± 0.08	27.34 ± 0.56	0.00 ± 0.00	0.00 ± 0.00
42	15 Oct – 21 Oct	33.90	21.90	66.30	38.30	1.30	4.10 ± 0.40	0.00 ± 0.00	2.57 ± 0.07	41.18 ±0.81	0.12 ± 0.18	0.04 ± 0.09
43	22 Oct – 28 Oct	35.00	20.20	54.40	38.40	0.00	4.56 ± 0.46	0.08 ± 0.11	3.24 ± 0.09	51.92 ± 0.83	0.04 ± 0.09	0.00 ± 0.00
44	29 Oct – 4 Nov	34.69	21.20	56.76	20.76	0.00	4.22 ± 0.55	0.04 ± 0.09	3.63 ± 0.19	59.13 ± 0.73	0.00 ± 0.00	0.00 ± 0.00
45	5 Nov – 11 Nov	31.92	17.90	54.65	19.95	0.02	3.06 ± 0.42	0.04 ± 0.09	3.87 ± 0.10	53.77 ± 0.52	0.00 ± 0.00	0.00 ± 0.00
46	12Nov – 18 Nov	30.58	14.60	57.08	18.42	0.00	3.56 ± 0.37	0.00 ± 0.00	2.79 ± 0.13	41.32 ± 0.60	0.04 ± 0.09	0.00 ± 0.00
47	18 Nov – 25 Nov	27.87	14.50	52.99	19.59	2.62	3.92 ± 0.67	0.00 ± 0.00	1.53 ± 0.25	27.54 ± 0.69	0.12 ± 0.11	0.04 ± 0.09
48	26 Nov – 2 Dec	27.46	13.40	91.22	36.54	0.02	4.42 ± 0.58	0.00 ± 0.00	2.56 ± 0.11	16.37 ± 0.77	0.16 ± 0.17	0.00 ± 0.00
49	3 Dec – 9 Dec	27.86	12.00	77.76	22.76	0.00	4.70 ± 0.34	0.00 ± 0.00	1.73 ± 0.21	9.28 ± 0.55	0.00 ± 0.00	0.00 ± 0.00
50	10 Dec – 16 Dec	27.83	11.98	50.96	16.47	0.00	5.26 ± 0.57	0.00 ± 0.00	1.31 ±0.22	6.40 ± 0.28	0.08 ± 0.18	0.00 ± 0.00
51	17 Dec – 23 Dec	29.09	11.94	55.65	15.80	0.00	4.40 ± 0.37	0.00 ± 0.00	0.57 ± 0.10	4.16 ± 0.33	0.00 ± 0.00	0.00 ± 0.00
52	24 Dec – 30 Dec.	27.69	11.19	74.82	21.09	0.00	4.48 ± 0.69	0.00 ± 0.00	0.47 ± 0.06	2.13 ± 0.36	0.04 ± 0.09	0.00 ± 0.00

Table 3. Correlation coefficient between insect pests and their natural enemies with weather parameters

Insects	Weather Parameters				
	Temperature		Relative Humidity (%)		Rainfall
	Max.	Min.	Morn.	Even.	(mm)
Leaf eating caterpillars	0.044^{NS}	0.331^{NS}	0.430*	0.446*	0.169^{NS}
Ash Weevils	0.463*	0.289 ^{NS}	-0.206 ^{NS}	0.030^{NS}	-0.111^{NS}
Leaf footed bugs	-0.215 ^{NS}	-0.470*	-0.568**	-0.595**	-.383^{NS}
Whitefly	-0.004 ^{NS}	-0.267 ^{NS}	-0.632**	-0.498 **	-0.344^{NS}
Coccinellids	-0.423*	-0.448*	-0.172 ^{NS}	-0.366^{NS}	-0.265^{NS}
Praying mantids	0.112 ^{NS}	0.203 ^{NS}	0.115 ^{NS}	0.166^{NS}	0.195^{NS}

** Significant at 5% level, ** Significant at 1% level; NS = non-significant*

Table 4. Multiple linear regression between abiotic factors and insect pests of moringa

Insects	Regression equations	R^2 value
Leaf eating caterpillar	Y =3.23+ 0.04 X_3	0.199
Whiteflies	Y =83.21+ (-0.926) X_4	0.399
Ash weevil	Y =-0.134 + 0.005 X_2	0.215
Leaf footed bug	Y =3.028 + (-.046) X_3	0.354
Coccinellids	Y =0.102 +(-0.003) X_1	0.200
Praying mantid	No regression	---

Y = Dependent variable X1 = Max. Temp. (ºC), X2= Min. Temp. (ºC), X3= Morning RH (%), X4 = Evening RH(%), X5= Rainfall (mm)

Table 5. Multiple linear regression equations of insect pests with weather parameter

Insects	Multiple Linear Regression Equations
Leaf eating caterpillar	(Y = 15.106 + (-0.539) X_1+ 0.36 X_2 + (-0.000) X_3 + 0.007 X_4 +0.000 X_5 + 0.383R^2 + 0.288 Adjusted R)
whiteflies	(Y = −0.146 + 0.006 X_1 +0.001 X_2 + 0.000 X_3 +0.000 X_4 + (− 0.001) X_5 + 0.367R^2 + 0.209 Adjusted R)
Ash weevil	(Y = −1.812 + 0.245 X_1 + (− 0.170) X_2 + (− 0.007) X_3 + (− 0.014) X_4 + (− 0.012) X_5 + 0.445R^2 + 0.307 Adjusted R)
Leaf footed bug	(Y = 0.494 + 2.523 X_1 + (− 0.683) X_2 + (− 0.199) X_3 + (− 0.601) X_4 + (− 0.194) X_5 + 0.464R^2 + 0.330 Adjusted R)
coccinellids	(Y = 0.090 + (−0.001) X_1+ (− 0.002) X_2+ (− 0.00) X_3 +0.00 X_4+ (− 0.00) X_5+ 0.215R^2 + 0.019 Adjusted R)
Praying mantid	(Y = 0.085 + (−0.003) X_1 + 0.003 X_2 + (− 0.00) X_3 + (− 0.00) X_4 + 0.00 X_5 + 0.101R^2 + (−0.123) Adjusted R

Y = Dependent variable X1 = Max. Temp. (ºC), X2= Min. Temp. (ºC), X3= Morning RH (%), X4= Evening RH (%), X5= Rainfall (mm)

3.3 Leaf-footed Bug, *Leptoglossus phyllopus* (L.)

Initial population of leaf footed bug was recorded as meagre during first week of September with 0.20 bugs per 3 branches and it further reached to it's peak at last week of December with 3.87 bugs per 3 branches. The leaf footed bug damage showed negative non-significant correlation (r = -0.215) with maximum temperature and negative significant correlation (r = -0.470) with minimum temperature. A negative significant correlation was observed with evening relative humidity (r = -0.595) and morning relative humidity (r = -0.568). Rainfall showed negative non-significant correlation (r = -0.383) with leaf-footed bug infestation. The present finding is in relevance with Reddy et al. (2017) who reported that the highest incidence of leaf footed bug *Riptortus pedestris* (Fab.) population on field bean, *Lablab purpureus* L. was observed with two peaks *i.e.*, first at 3rd week of November and second one at 1st week of December with 3.5 and 3.8 bugs per plant, respectively.

a. *Noorda blitealis* on leaves

b. *Noorda blitealis* in Pod

Fig. 3. Nature of damage of leaf eating caterpillar, *N. blitealis*

a. Green bug, *Nezara viridula* (L.)

b. Red pumpkin bug, *Coridius janus* (Fab.)

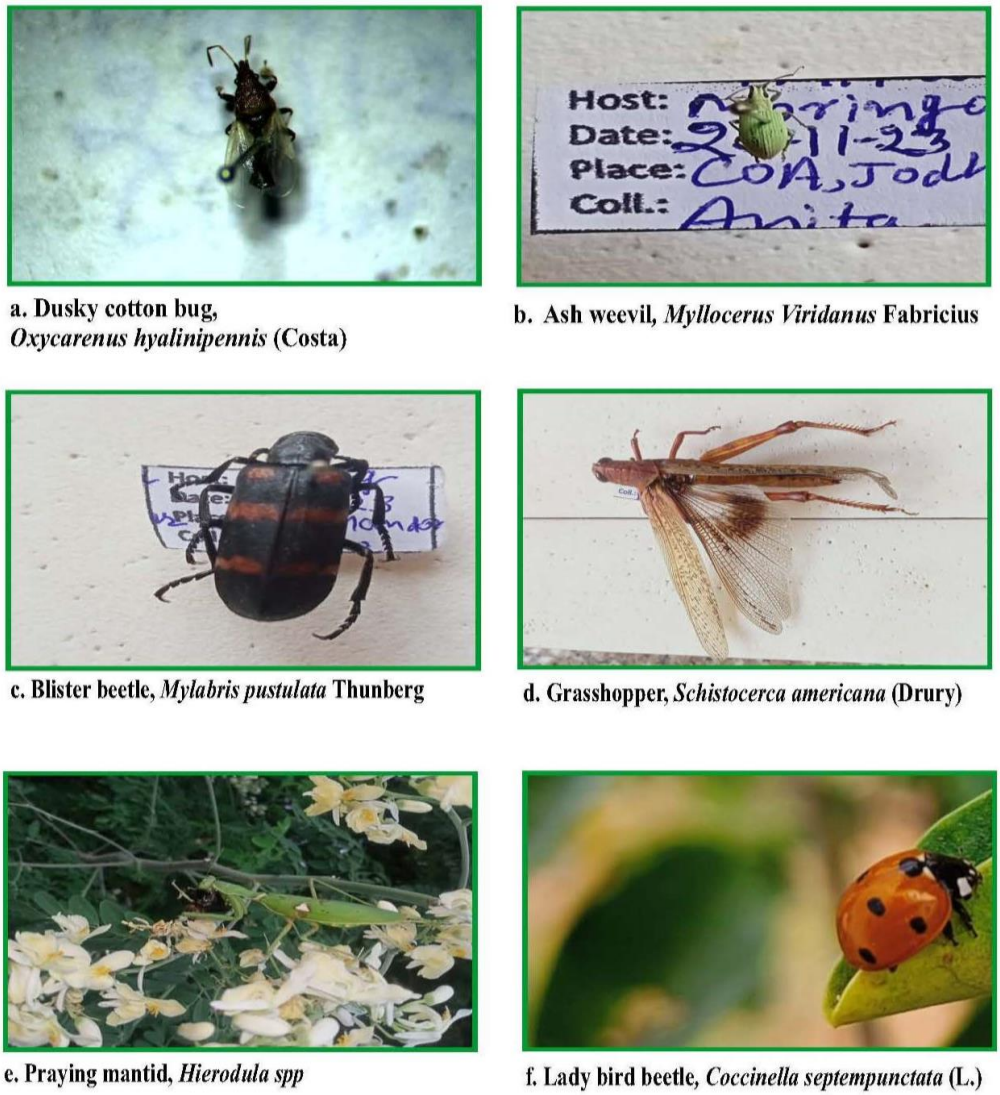
c. Brown marmorated sting bug, *Halyomorpha halys* (Stal)

d. Red cotton bug, *Dysdercus cingulatus* (Fab.)

e. Leaf Footed bug, *Leptoglossus phyllopus* (L.)

f. Cotton aphid, *Aphis gossypii* (Glover)

Fig 4. Insects associated with moringa



a. Dusky cotton bug, *Oxycarenus hyalinipennis* (Costa)

b. Ash weevil, *Myllocerus Viridanus* Fabricius

c. Blister beetle, *Mylabris pustulata* Thunberg

d. Grasshopper, *Schistocerca americana* (Drury)

e. Praying mantid, *Hierodula spp*

f. Lady bird beetle, *Coccinella septempunctata* (L.)

Fig. 5. a-f. Insects associated with moringa

3.4 Whitefly, *Bemisia tabaci* (Gennadius)

First appearance of whitefly, *B. tabaci* was observed during the first week of August and increased gradually and reached its peak with 59.13 flies per 3 branches at last week of October and after it decreased. The whitefly incidence had negatively high significant correlation with evening relative humidity (r = -0.498) and morning relative humidity (r = -0.632). It showed negative non-significant correlation with maximum temperature (r = -0.004), minimum temperature (r = -0.267) and rainfall (r = -0.344). The present findings are in accordance with Palada and Chang (2003) and Okonkwo et al. (2014) reported occurrence of whiteflies (*Bemisia* spp.) among other insect pests of moringa in India.

4. CORRELATION STUDIES OF COCCINELLIDS AND PRAYING MANTID WITH WEATHER PARA-METERS

Among the natural enemies, lady bird beetles and praying mantids were observed as major predators against aphid and leaf eating caterpillar, respectively. The activity of coccinellids was observed during first week of September with 0.04 beetles per 5 branches whereas maximum population of coccinellids (0.16 beetles/ 5 branches) recorded during last week of November. Coccinellids showed negative significant correlation with maximum temperature (r = -0.423) and with minimum temperature (r = -0.448) while, negative non-significant correlation was observed with evening

relative humidity (r = -0.366), morning relative humidity (r = -0.172) and rainfall (r = -0.265). The population of praying mantid was ranged from 0.04 to 0.08 per 5 branches where peak population was recorded during third Week of September. Praying mantid showed positive non-significant correlation with all weather parameters *viz.,* maximum temperature (r = 0.112), minimum temperature (r = 0.203), evening relative humidity (r = 0.166), morning relative humidity (r = 0.115) and rainfall (r = 0.195). Mahesh et al. (2013), Brunda (2014) and Chandrakar, and Gupta (2020) reported that praying mantis was observed in drumstick ecosystem and found to pray on lepidopteran caterpillars. The present findings also in accordance with Mahesh et al. (2013) who reported that both grubs and adults of *Cheilomenes sexmaculata* Fabricius were predating upon aphids on drumstick and its activity was noticed during August and December. Preying mantids were predating upon lepidopteran caterpillars throughout the year. Kumari et al. (2015) reported green lace wing (*Chrysoperla zastrowii simili* Stephens), lady bird beetle (*Menochilus sexmaculatus* Fabricius), praying mantid (*Anaxarcha limbata* Goglio Toss), pentatomid bug (*Eocanthecona furcellata* Wolf) and 13 species of spiders as natural enemies in drumstick ecosystem.

5. CONCLUSION

A total of sixteen species of insects were associated with the moringa plantations in the western Rajasthan. Leaf eating caterpillars, ash weevils, leaf footed bugs and whitefly were found damaging the plants while, green bugs, red pumpkin bugs, brown marmorated sting bugs, red cotton bugs, dusky cotton bugs, blister beetles, cotton Jassids, cotton aphids, and American grasshoppers, were only visitors present in very few numbers. The visitor insects may be migrated for some time from the nearby fields. Among the natural enemies, lady bird beetles were observed as a major predator against aphids whereas, preying mantids were found to prey upon leaf eating caterpillars.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Brunda, K. M. S. (2014). Studies on the insect defoliators of drumstick with special reference to *Noorda blitealis* Walker (Lepidoptera: Crambidae) (M.Sc. thesis). Department of Entomology, College of Horticulture, University of Horticultural Sciences, Bagalkot.

Butani, D. K., & Verma, S. (1981). Insect pests of vegetables and their control: Drumsticks. *Pesticides*.

Chandrakar, T., & Gupta, A. K. (2020). Seasonal incidence of insect pests on drumstick (*Moringa oleifera* Lamk). *Journal of Entomology and Zoology Studies, 8*(4), 1384-1387.

Kumari, M. B., Kotikal, Y. K., Narabenchi, G. B., & Nadaf, A. M. (2015). Bio-efficacy of insecticides, botanicals and biopesticide against the leaf eating caterpillar, *Noorda blitealis* Walker on drumstick. *Karnataka Journal of Agricultural Sciences, 28*(2), 193-196.

Mahesh, M., & Kotikal, Y. K. (2014). Studies on insect pests of drumstick, *Moringa oleifera* Lamk. *Indian Journal of Plant Protection, 42*(4), 461-464.

Mahesh, M., Kotikal, Y. K., & Madalageri, M. B. (2013). Studies on natural enemies of insect pests of drumstick. *Journal of Biological Control, 27*(4), 336-339.

Munj, A. Y., Patil, P. D., Desai, S. D., & Naik, K. V. (2001). Seasonal incidence of major pests of drumstick *Moringa oleifera* L. *Pestology, 25*(2), 32-34.

Okonkwo, N. J., Nwankwo, E. N., Ozumba, N. A., Egbuche, C. M., & Ezugbo-Nwobi, I. K. (2014). Studies on the invertebrate fauna associated with *Moringa oleifera* (Lam) (Moringaceae) during the rainy season in Awka, Anambra State, Nigeria. *International Journal of Agriculture and Biosciences, 3*(1), 22-25.

Palada, M. C., & Chang, L. C. (2003). Suggested cultural practices for *Moringa*. *International Cooperators' Guide AVRDC*, (3), 1-5. AVRDC publication.

Patel, B. P. (2008). Biology and population dynamics of leaf eating caterpillar, *Noorda blitealis* Walker of drumstick, *Moringa oleifera*, and field bioefficacy of

insecticides against leaf eating caterpillar (M.Sc. thesis). Department of Entomology, N. M. College of Agriculture, Navsari.

Reddy, S. S., Reddy, C. A., Srinivas, C., Rao, A. M., & Reddy, S. N. (2017). Studies on the seasonal incidence of leaf footed bug, *Riptortus pedestris* (Fabricius) in field bean, *Lablab purpureus* L. and its relation with weather parameters.

Sekhar, C., Venkatesan, N., Vidhyavathi, A., & Murugananthi, M. (2018). Factors influencing Moringa cultivation in Tamil Nadu: An economic analysis. *Horticulture International Journal, 2*(5), 223-230.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/125438