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Incidence of mango hoppers *Idioscopus nitidulus* Walker in high-density mango plantation under south Gujarat conditions

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Abstract
Studies on population dynamics of mango hoppers and their correlation and regression with abiotic factors in the high-density plantation of Kesar mango orchard under drip irrigation were conducted during 2017 to 2019 at mango orchard of Soil & Water Management Research Unit, Navsari Agricultural University, Navsari, Gujarat. Maximum (9.20, 6.00 and 10.20 hoppers/twig) population of the hopper was recorded at 4th, 13th and 19th SMW in 2017, 2018 and 2019 respectively. Correlation analysis with various weather parameters indicated that sunshine showed a significant positive correlation with hoppers whereas minimum temperature, evening relative humidity and evaporation rate had a significant negative correlation with the incidence of hoppers. Among those abiotic factors, evening relative humidity and evaporation rate were founded the highest impactable factors so far by simple and stepwise regression analysis.

Keywords: Mango, hopper, population dynamics, regression, correlation, Navsari, Gujarat

Introduction
Mango is one of the major fruit crops of south Asia from ancient times and at present, it is a prominent horticulture crop of India. It is grown in India to large extent and is considered as a king of all the fruits. Adoption of the High Density Planting (HDP) system with proper canopy management practices coupled with a drip-fertigation system is highly essential to increase productivity (Kumar 2013) [4]. Among the mango pests, mango hoppers are the most serious and widespread pests throughout the country. *Idioscopus nitidulus* Walker is the most common and destructive species of hoppers, which cause heavy damage to mango crop. A large number of nymphs and adults of the hoppers puncture and suck the sap from tender shoots, inflorescence and leaves of mango crop, which cause non-setting of flowers and dropping of immature fruits, thereby reducing the yield. Hoppers also excrete a secretion, called honeydew.

Methods and Materials
An experiment was carried out at Mango orchard of Soil & Water Management Research Unit, Navsari Agricultural University, Navsari (AES-III heavy rainfall zone), Gujarat from 2017 to 2019. Mango (var. *Kesar*) orchard having the age of 10 years and planted at 5m X 5m (High density) was selected for the experiment. The total area of an orchard is 1.0 hector with 400 mango trees having a drip irrigation system. Total 25 trees were selected randomly for taking observations. Weekly observations of mango hoppers were taken from 5 twigs per tree. Observations of hoppers were further correlated with meteorological data to workout correlation and regression analysis. Correlation between the pest population and weather parameters *viz*., maximum temperature, minimum temperature, morning relative humidity, afternoon relative humidity, evaporation, rainfall, wind speed and sunshine hours, was assessed using Carl Pearson's correlation analysis. Statistical analysis of the data was carried out by using the SPSS software. Whole experiment area was kept free from any insecticidal spray.

Results
The incidence of mango hopper (Table-1) on mango was started from 1st to 21st standard

meteorological week (SMW) during the year 2017. The number of mango hoppers recorded from 0.40 to 9.20 during the year. The presence of mango hopper was not recorded due to rainfall from 22nd to 44th standard meteorological week. Mango hopper infestation again started from 0.80 to 5.80 hoppers/twig from 45th to 52nd SMW. The highest mango hopper population (9.20 hoppers/twig) was recorded during the 4th SMW. Among different weather parameters, bright sunshine (hrs) showed a highly significant positive correlation with the mango hopper population, whereas minimum temperature and evening relative humidity showed a highly significant negative correlation with the hopper population for the years 2017. (Table-2).

The incidence of the hopper (Table-1) on high density mango plantation was started from 1st to 21st Standard Meteorological Week (SMW) during the year 2018. The number of hoppers per twig ranged from 0.2 to 6.2 during this period. Due to rainfall from 22nd to 38th SMW hopper population was not found on mango trees. The infestation of mango hoppers again started from 0.8 to 4.0 per twig during 42nd to 52nd SMW. The highest mango hopper population (6.2 hopper/twig) was recorded during the 13th SMW during the year 2018. From various weather parameters (Table-2) minimum temperature showed a highly significant negative correlation and bright sunshine showed a significant positive correlation with mango hoppers, while Evening relative humidity had a significant negative correlation with mango hopper incidence during the year 2018.

The incidence of the hopper (Table-1) was started on mango trees from 1st to 22nd and 50th to 52nd Standard Meteorological Week (SMW) during 2019. The total number of hoppers per twig ranged from 0.80 to 10.20 during these periods. During 22nd to 49th SMW, there was no hopper infestation found on mango trees. The highest (10.20 hopper/twig) mango hopper population was recorded during 16th SMW during the year 2019. Among various weather parameters (Table-2) Evaporation rate was found highly significant negative correlated with hoppers on mango trees while Evening relative humidity was found highly significant negative correlated with mango hoppers. Bright sunshine was found significant positive correlated and remaining factors found positive or negative but non-significant correlated with the incidence of mango hoppers during the year 2019.

Population dynamics of hoppers were studied during 2017, 2018 and 2019 and also pooled analysis of all three years together. In the pooled analysis (Table-1), it is observed that the highest activity of hoppers on mango was found during the 3rd SMW. This means the weather parameters at 3rd SMW (3rd week of January) are highly favourable for a higher incidence of the hopper on mango. 2nd peak activity was observed from 13th to 15th SMW (April month) which is also a favourable condition which increases the hopper infestation on mango. Talpur and Khuhro (2003) [5] also reported the highest hopper population from 12th to 13th SMW. The present findings also match with the report of Jha *et al.*, (2017) [3] had observed a higher hopper population during 13th to 15th SMW. Among different weather parameters, evening relative humidity and evaporation rate had a negative highly significant correlation with hopper. It indicates that a slight change in these weather parameters highly affects the hopper population (Table-2). Girish *et. al.* (2019) [1] and Gundappa *et. al.* (2016) [2] also found evening relative humidity correlated negatively with the hopper population on mango trees.

Data after full and stepwise regression analysis presented in Table 3 shows correlation and regression model of mango hoppers with different weather parameters which indicates that evening relative humidity and evaporation rate were highly significant negative correlated with hopper activity especially during 1st to 3rd SMW while during 1st to 3rd SMW peak activity of hopper was observed. These two climatic factors are responsible for the outbreak of this pest.

Table 1: Incidence of hoppers on mango tree (No. of hoppers/tree)

Standard Meteorological week	No. of hoppers/ twig			
	2017	2018	2019	Pooled
1	8.40	1.60	2.40	4.27
2	8.80	3.20	2.60	4.20
3	6.80	3.00	4.40	5.53
4	9.20	1.80	3.80	4.20
5	7.00	2.00	5.20	4.67
6	6.80	2.80	5.80	5.00
7	6.40	2.80	4.40	3.87
8	4.40	3.40	4.80	3.80
9	3.20	3.20	5.40	4.20
10	4.00	3.40	6.20	4.47
11	3.80	3.80	6.00	3.93
12	2.00	4.80	6.80	4.60
13	2.20	6.20	7.60	5.20
14	1.80	5.60	7.20	4.80
15	1.60	4.80	8.80	5.20
16	2.00	3.20	10.20	4.87
17	1.20	2.60	9.20	4.20
18	0.80	2.00	7.00	3.47
19	1.40	1.40	6.00	2.67
20	0.60	0.60	5.20	2.07
21	0.40	0.20	3.80	1.33
22	0.00	0.00	1.20	0.40
23	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00
37	0.00	0.00	0.00	0.00
38	0.00	0.00	0.00	0.00
39	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00
41	0.00	0.00	0.00	0.00
42	0.00	0.80	0.00	0.27
43	0.00	0.40	0.00	0.13
44	0.00	1.60	0.00	0.73
45	0.60	1.40	0.00	0.73
46	0.80	2.00	0.00	0.80
47	0.40	3.20	0.00	1.47
48	1.20	2.20	0.00	1.93
49	3.60	2.40	0.00	2.27
50	4.40	4.00	0.80	4.13
51	7.60	2.20	1.40	3.13
52	5.80	1.20	1.80	3.80
AV.	2.06	1.61	2.46	3.22*

* zero data excluded from the analysis

Table 2: Correlation of mango hopper with weather parameters

Abiotic factors	Correlation Matrix			
	2017	2018	2019	Pooled
Maximum temperature (°C)	-0.252	0.313	0.459	0.093
Minimum temperature (°C)	-0.774**	-0.784**	-0.346	-0.217
Morning relative humidity (%)	-0.505*	-0.392	-0.495	0.176
Evening relative humidity (%)	-0.637**	-0.582*	-0.738**	-0.555**
Wind speed (km/hr)	-0.358	-0.337	-0.114	0.153
Bright sunshine (hrs/day)	0.705**	0.504*	0.631*	0.306
Evaporation (mm)	-0.269	-0.441*	-0.742**	-0.590**

Table 3: Correlation and regression studies between mango hoppers and weather parameters

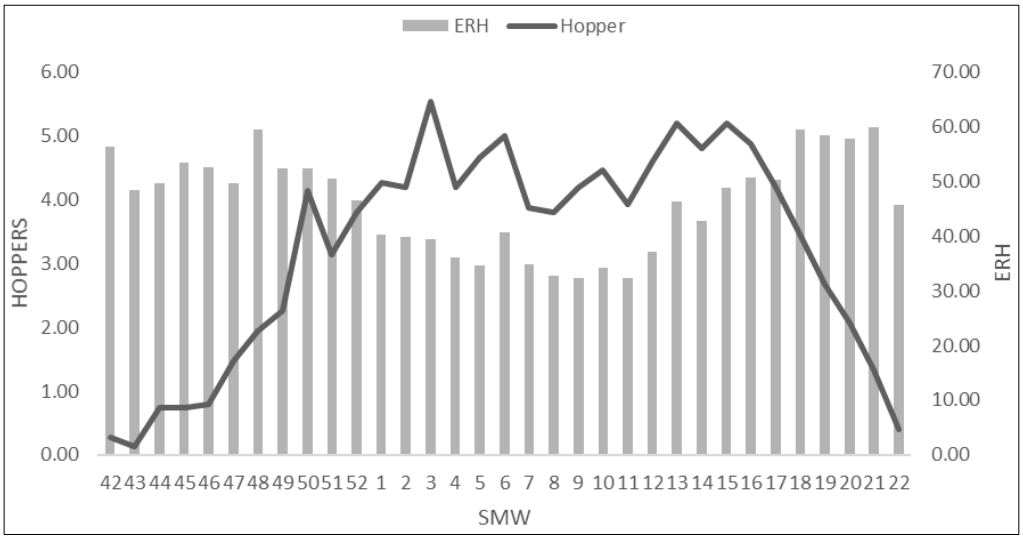
Insect	X_1 = Tmax	X_2 = Tmin	X_3 = MRH	X_4 = ERH	X_5 = WS	X_6 = BSSH	X_7 = Evapo	Regression equation	R^2
Hopper	0.093	-0.217	0.176	-0.555**	0.153	0.306	-0.590**	Y= -5.980 + (0.398) x X_1+ (-0.890) x X_2 + (0.025) x X_3 + (0.093) x X_4 + (0.630) x X_5 + (-0.577) x X_6 + (1.918) x X_7	0.721

Stepwise regression analysis

Insect	Regression equation	R2
Hopper	Y= 7.726 - 0.125 (ERH) - 0.355 (Evapo)	0.419

Peak activity of insects on mango and their Correlation & Regression

Insect	Peak SMW	Correlation (r)	Regression Equation	R^2
Hopper	1st – 3rd	ERH (-0.555**) Evapo (-0.590**)	Y= 7.726 - 0.125 (ERH) - 0.355 (Evapo)	0.419



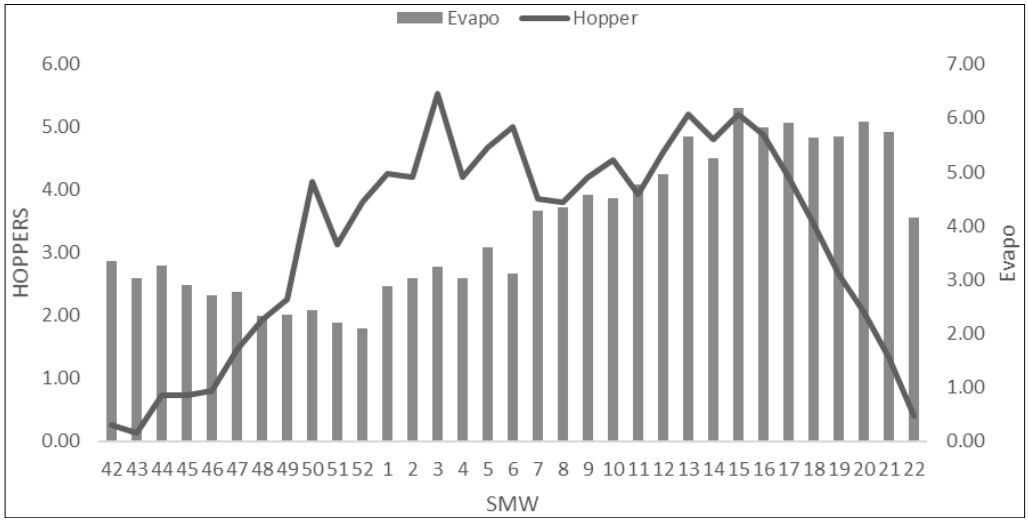


Fig 1: Correlation of mango hopper population with ERH and Evapo

Conclusion

Mango growers of south Gujarat having Kesar variety in high density plantation (5 x 5m) needs to observe mango hopper population during 1st to 3rd standard meteorological week, and take proper management measure for managing mango hopper.

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