Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 591-595
Received: 04-03-2019
Accepted: 06-04-2019

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Influence of abiotic factors on population dynamics of sucking insect pests in oats

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Abstract
A field experiment was conducted to investigate the impact of abiotic factors on population dynamics of sucking insect pests in oats variety Sabzar *viz.*,Wheat aphid (*Schizaphis graminum*), Green Stink bug (*Carpocoris* spp), Aster Leafhoppers (*Macrosteles quadrillineatus*), Broad-headed bug (*Camptopus lateralis* Germar) under unprotected condition. *S. graminum*, *M. quadrillineatus* and *Carpocoris* spp were observed from the experimental site. Among these, aphid population appeared from 9th meteorological week (2.29/plant) and reached their peak (17.95/plant) in the 22nd meteorological week. Hoppers appeared from 10th meteorological week (2.68/plant) and reached their peak in the 24th meteorological week (17.23/plant). However, bug's appeared from 9th meteorological week (2.37/plant) and reached their peak (12.56/plant) in the 21st meteorological week. All hemipteran insect pests after reaching the peak showed declining trend as crop progressed to the maturity. Correlation analysis with the weather parameter *viz.*, temperature, relative humidity, wind velocity, sunshine hours and rainfall revealed that correlation of hemipteran insect pests (aphids, hopper and bug's) these pests exhibited a highly significant positive correlation with maximum temperature ($r = 0.75$), minimum temperature ($r = 0.76$), sunshine ($r = 0.55$). While, these pests exhibited highly significant negative correlation with relative humidity of morning and non-significant correlation with relative humidity of evening, aphids hoppers and bugs showed non-significant correlation with rainfall.

Keywords: Population dynamics, abiotic factors, correlation, sucking insect pests

1. Introduction
Oats rank sixth in the world cereal production statistics following wheat; maize, rice, barley and sorghum (Pandey and Roy, 2011) [15]. It is mainly cultivated as fodder for animals and also for grain because of its high nutritional and medicinal value. It is cultivated in Punjab, Haryana, West Bengal, Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan and Maharashtra (Pandey and Roy, 2011) [15]. Various arthropods and nematodes cause damage to oats (*Avena sativa* L. and *A. byzantino* K.) plants throughout their life and no stage of the crop is free from damage. Crops can be affected from the seedling stage until the grain is harvested (Southwood and Norton, 1973) [18]. Pests of oats are either polyphagous (damaging a wide range of plants) or oligophagous (feeding on only a few plant species) and it is very rare, any insect found to be monophagous to oats crop. Hundreds of arthropod species feed on oats cultivated in the USA and other countries. Low infestations of certain pests in cereals may stimulate growth and tillers, and actually increase yields (Southwood and Norton, 1973) [18]. Oats crop is invaded by different pests among which with specific agronomic importance. There are six species of aphids that damage oats crop. These species include *Rhopalosiphum padi, Schizaphis graminurn, R. maidis, Metopoliphiurn dirhodum, Sitobion avenae* and *Diuraphis noxia*. Two of the species commonly known as russian wheat aphid (*D. noxia*) and bird cherry-oat aphid (*Rhopalosiphum padi*) are considered notorious for their direct and indirect losses. In favorable climate conditions they are reproducing in great number and cause significant damages to the crop by decreasing the yield (Vasilina *et al*., 2009) [20]. In addition to this some aphid species inject toxins during their feeding as well as transmit viral diseases (Maneva *et al*., 2008) [13]. *Schizaphis graminum* Rondani or green bug is a warm season perennial pest, causing substantial losses to cereal crops and wheat in particular. Green bug was first reported on oats during early 20th century and also has colonized successfully in sorghum during 1960 (Harvey and Hackerott, 1969) [6]. Large populations of green bug shift onto sorghum during summer when wheat is harvested and colonize in masses. In absence of sorghum, they can shift to wild grasses which can rarely accommodate larger populations. Aster leafhopper is native to North America, where it is nearly everywhere. It is most common, however, in the central region of the continent. Also, it overwinters poorly in cold areas. Most areas with aster leafhopper problems are invaded annually by leafhoppers originating in the southern Great Plains.

In the mild-climate northwest, however, leafhoppers are able to overwinter successfully, and long-distance dispersal is not an important factor. Oman (1949) [14] Observed leafhoppers are not normally considered of major importance in small grains, believed that they sometimes cause appreciable grain and forage losses. They also transmit blue dwarf virus disease of oats. Many species of leafhoppers can cause damage to oats crops. Several of them are attracted to oats fields in the late fall or early spring, when small grains are the principal green plants. Hari Prasad *et al.* (2008) [5] reported that peak incidence of jassids (*Empoasca kerri*) was negatively significant with minimum temperature and the incidence of aphids (*Aphis craccivora*) had positive highly significant association with coccinellids and spiders whereas all the other abiotic factors had no significant association. Chakraborty (2011) [2] studied effect of abiotic conditions on incidence of Aphids (*Aphis gossypii* Glover) results showed that maximum temperature, minimum temperature, temperature gradient, rainfall, minimum relative humidity and sunshine hours had significant negative influence on it, but in case of maximum relative humidity and relative humidity gradient positive influence were observed. Keeping in view the above facts it becomes imperative to study the Impact of abiotic factors on population dynamics of sucking insect pests in oats

2. Materials and Methods

Oats variety "Sabzar" was raised during the Rabi season in 2015-16 under the recommended package of practices of SKUAST-Kashmir at Faculty of Agriculture, Wadura. Observations were recorded at weekly intervals to know the Impact of abiotic factors on population dynamics of sucking insect pests in oats. After sowing of oats in the last week of November, white snow carpet remains over the crop during December-February. Oats variety "Sabzar" was planted at 22.5 cm spacing in 3 x 4 m plot size. The experimental plot was maintained without application of any insecticides. Crop was raised in natural conditions (*i.e.* without any application of insecticides) to allow population buildup of insect pests. Aphids, jassids, thrips, hoppers and bugs were counted on plant basis. Weekly observations were carried out from 20 tagged plants replicated thrice in the experimental plot.

2.1 Meteorological data

Data on temperature (Max. / Min. in ^{0}C), sunshine (hrs.) relative humidity (%) and rainfall (mm) was collected from automatic weather station, Wadura. Multiple correlations were worked out to determine the cumulative and individual effects of weather factors (temperature, sunshine, rainfall and relative humidity) on population buildup of the insect pests.

2.2 Statistical analysis

Data collected from the experimental site was subjected to standard statistical procedure using standard statistical procedures (Gomez and Gomez, 1984) [4].

3. Results and Discussion

3.1 Aphid

The result showed in Table-1 indicated that the incidence of aphid population appeared from 9th meteorological week (2.29/plant) and reached their peak (17.95/plant) in the 22nd meteorological week. Aphids are small soft bodied insects on wheat and oats based ecosystem that depend heavily on environmental factors as well as their host plant. The seasonal fluctuation in their dynamic is determined by population growth rate and length of the period for which the population can grow. Aphid abundances grow quickly and may attain more than 100 individuals per tiller in late June or early July (Honek and Martinkova, 1999) [7]. The peak is followed by an abrupt decline caused by host plant senescence and spreading of mycoses (Honek and Martinkova, 2004) [8]. High temperatures of ≥30°C have fatal behavioral consequences (Ma and Ma, 2012) [12] increase physiological developmental time and decrease fecundity and survival (Asín and Pons, 2001) [1], even when acting for short periods (Jeffs and Leather, 2014) [9].

3.2 Correlation studies between aphid population with weather parameters

Correlation between meteorological factors and aphid adult population revealed that the population exhibited a highly significant positive correlation with maximum, minimum temperature and sunshine with their respective values of (r =0.75), (r =0.76) and (r =0.55). However, these adults were highly significant negatively correlated with relative humidity of morning (r = -0.76). Similarly, the populations exhibited non-significant negative correlation with rainfall (r = -0.13) and relative humidity with evening(r = -0.24) (Table -2). Our results showed that out of the four factors *e.g.*, temperature, humidity, sunshine(hr) and rainfall, correlation of aphids population dynamics was positive and significant (minimum, maximum and sunshine) compared with other two factors *i.e.*, humidity and rainfall. These results are in agreement to above statement (Chakravarty and Gautam, 2004) [3] that temperature is the most important abiotic factor affecting aphid population dynamics. Relative humidity (%) exerted negative and non- significant effect on population of aphids however rainfall (mm) which remained mild in the agro climatic conditions of this region and it exerted a negative and non- significant effect on aphid population (Table-2).

3.3 Hoppers

The result showed in (Table-1) indicated that the incidence of Hoppers population appeared from 10th meteorological week (2.68/plant) and reached their peak in the 24th meteorological week (17.23/plant).

3.4 Correlation studies between aphid population with weather parameters

Correlation between meteorological factors and hoppers population revealed that the population exhibited a highly significant positive correlation with maximum, minimum temperature and sunshine with their respective values of (r =0.82), (r =0.83) and (r =0.62). However, these adults were highly significant negatively correlated with relative humidity of morning (r = -0.83). Similarly, the populations exhibited non-significant negative correlation with rainfall (r = -0.03) and relative humidity with evening(r = -0.28) (Table -2). According to Singh *et al*. (1990) [17] leafhopper population had significant positive association with maximum daily temperature and positive correlation with minimum temperature. Jena and Kuila (1996) [10] reported that leafhopper infestation had positive correlation with maximum temperature whereas it was negatively correlated with sunshine. The variable effect of different weather parameters on the pest population might be due to the difference in phenology of the crop and time of appearance of the pest at different localities, where crops have been grown.

3.5 Bugs

The result showed in (Table-1) indicated that the incidence of bug's appeared from 9th meteorological week (2.37/plant) and reached their peak (12.56/plant) in the 21st meteorological week. All hemipteran insect pests after reaching the peak showed declining trend as crop progressed to the maturity. Webster and Amosson (1995) [21] reported 41% dry land and 93% irrigated area under wheat cultivation in Western US was infested with green bug. A notorious periodic outbreak during 1976 in Oklahoma caused estimated losses exceeding $80 million (Starks and Burton, 1977) [19]. Large populations of green bug shift onto sorghum during summer when wheat is harvested and colonize in masses. In absence of sorghum, they can shift to wild grasses which can rarely accommodate larger populations.

3.6 Correlation studies between bugs population with weather parameters

Correlation between meteorological factors and hoppers population revealed that the population exhibited a highly significant positive correlation with maximum, minimum temperature and sunshine with their respective values of (r =0.789), (r =0.780) and (r =0.62). However, these adults were highly significant negatively correlated with relative humidity of morning (r = -0.78). Similarly, the populations exhibited non-significant negative correlation with rainfall (r = -0.03) and relative humidity with evening(r = -0.30) (Table-2).The predominant pest species of phytophagous stink bugs in the south eastern coastal plain are the green stink bug, *Chinavia hilaris* (Say),the southern green stink bugs, *Nezara viridula* (L.) and the brown stink bug, *Euschistus servus* (Say).Stink bugs are highly polyphagous and move between adjacent agricultural and wild hosts in the farmer scapes; this movement is linked to crop phenology and the availability of suitable food sources (Jones and Sullivan, 1982) [11]. Southeastern farmer scapes are typically characterized by a mosaic of relatively small field (<16ha) of cotton soybean, corn, wheat and peanut, providing stink bugs with a sequence of suitable hosts throughout the season (Reeves *et al.*, 2010) [16].

Table 1: Population fluctuation of sucking insect pests in oats in relation to abiotic factors

Standard week	Number of insects per plant			Temperature (°C)		Rainfall/week (mm)	Relative Humidity (%)		Sun shine (hr.)
	Aphids	Hoppers	Bugs	Max.	Min.		Morning	Evening	
47th	0.00	0.00	0.00	15.21	0.21	0.00	90.43	72.57	3.64
48th	0.00	0.00	0.00	12.07	0.14	0.14	89.14	66.71	1.71
49th	0.00	0.00	0.00	12.85	-1.94	0.00	87.29	62.57	2.87
50th	0.00	0.00	0.00	7.71	0.41	3.11	87.29	76.57	0.00
51ist	0.00	0.00	0.00	8.50	-4.01	0.00	90.29	66.71	4.10
52nd	0.00	0.00	0.00	6.75	-3.28	0.17	89.86	65.86	1.83
1st	0.00	0.00	0.00	8.14	-1.07	2.54	91.71	74.00	1.50
2nd	0.00	0.00	0.00	8.71	-3.01	0.60	92.29	72.14	2.53
3rd	0.00	0.00	0.00	11.71	-4.41	0.00	92.86	50.71	5.79
4th	0.00	0.00	0.00	11.57	-3.28	0.17	92.14	46.29	4.80
5th	0.00	0.00	0.00	13.31	-1.78	0.00	90.14	42.14	6.46
6th	0.00	0.00	0.00	9.64	-0.65	3.40	91.43	60.00	2.19
7th	0.00	0.00	0.00	13.21	-0.58	4.37	88.29	52.71	5.80
8th	0.00	0.00	0.00	21.07	-0.97	0.00	99.14	34.57	9.66
9th	2.29	0.00	2.37	18.05	1.21	0.57	85.71	42.14	4.47
10th	3.76	2.68	4.58	14.35	3.62	6.01	86.29	63.86	2.96
11th	4.54	3.57	1.70	10.14	1.84	16.62	92.00	75.43	2.26
12th	6.67	5.54	3.94	15.28	3.14	4.54	84.43	64.29	3.97
13th	9.87	5.91	4.51	14.18	7.11	4.75	91.57	81.71	0.37
14th	8.94	7.43	5.67	18.21	5.77	4.80	90.29	68.57	5.33
15th	7.83	8.87	7.68	19.42	7.48	5.02	88.29	70.00	3.60
16th	10.25	7.91	6.94	20.28	4.42	2.10	85.43	64.29	7.17
17th	11.35	9.61	8.61	23.57	8.21	1.62	80.86	58.29	5.79
18th	13.57	11.10	9.67	25.21	9.64	1.64	81.29	54.71	5.53
19th	14.94	10.21	10.51	29.14	10.21	1.71	76.29	43.14	8.56
20th	11.65	12.25	8.97	27.14	11.35	3.82	80.00	54.43	7.63
21st	15.69	15.84	12.56	30.21	12.54	0.00	70.43	39.86	9.83
22nd	17.95	12.25	11.57	28.92	13.05	0.48	74.86	44.00	9.07
23rd	15.28	14.10	10.91	30.21	15.48	0.08	78.29	49.57	7.61
24th	14.87	17.23	7.86	31.42	14.84	0.00	69.14	54.86	8.80
25th	6.68	11.15	5.94	32.00	16.18	0.80	76.86	41.57	10.10
26th	5.84	7.71	4.56	31.00	16.91	0.85	75.86	47.43	6.41
27th	0.87	1.35	1.27	29.35	16.71	4.94	81.71	50.29	6.33

Table 2: Correlation of different sucking insect pest population along with weather parameters

Factors	Aphid		Hoppers		Bugs	
	Correlation coefficient (r)	Regression Equation	Correlation Coefficient (r)	Regression Equation	Correlation Coefficient (r)	Regression Equation
Temperature (°C)						
Max.	0.75**	Y= -4.62+0.550 X	0.82**	Y= -5.22+0.553X	0.789**	Y= -3.48+0.402X
Min.	0.76**	Y=2.38+0.670X	0.83**	Y= 1.80+0.677X	0.780**	Y= 1.67+ 0.481X
Relative humidity (%)						
Morning	-0.76**	Y=61.4+ (-0.653) X	-0.83**	Y=61.1+(-0.656)X	-0.78**	Y=44.0+ (-0.468) X
Evening	-0.24 NS	Y= 12.3+ (-0.117) X	-0.28 NS	Y=12.3+(-0.126)X	-0.30 NS	Y= 9.96+ (-0.140) X
Sun shine (hr.)	0.55**	Y= -0.61+ 1.20X	0.62**	Y= -1.40+1.25 X	0.59**	Y= -0.63+ 0.892 X
Rainfall/week (mm)	0.001 NS	Y= 5.53+ 0.003X	-0.03 NS	Y=5.13+(-0.062)X	-0.03 NS	Y=4.03+(-0.042) X

NS= Non-significant (P>0.05); *, Significant (P<0.05); **, highly significant (P<0.01)

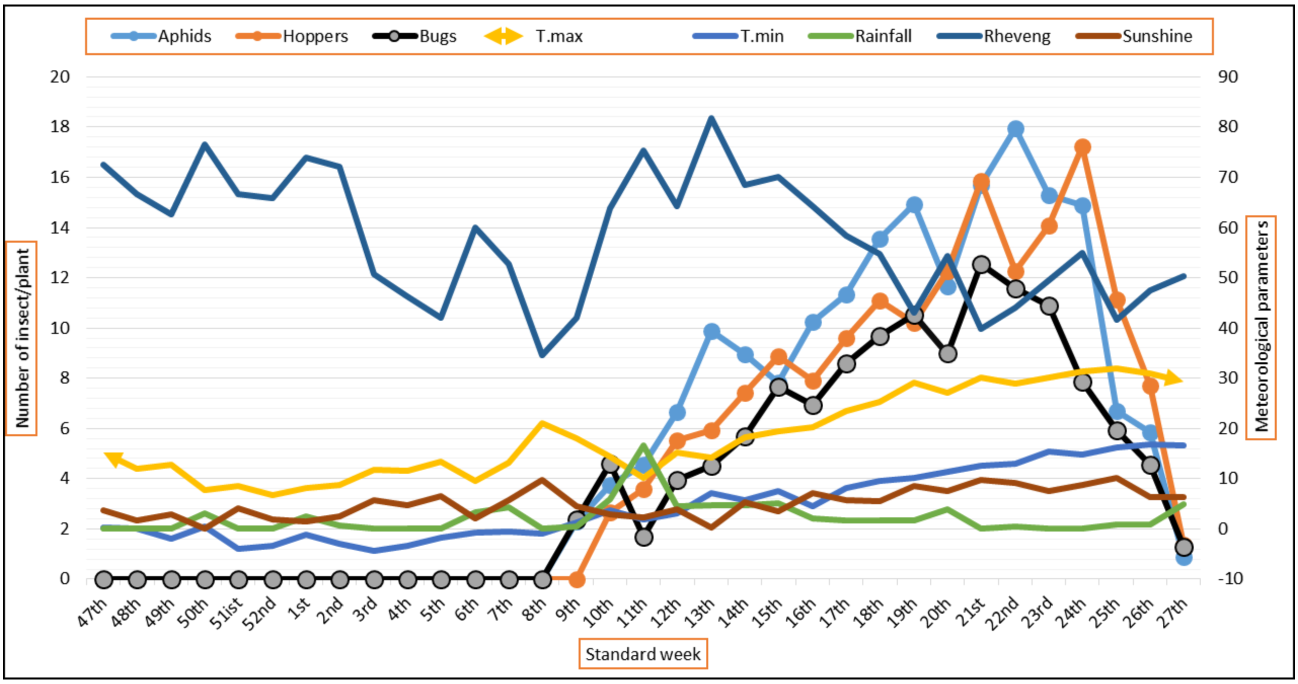

Fig 1: Population of sucking insect pest along with weather parameter

4. Conclusion

From all abiotic factors maximum and minimum temperature and relative humidity having much greater impact on the population dynamics of sucking insect pest in oats; aphid population while remaining all factors also having non-significant impact. For biotic factors, Lady beetles; syrphid flies, dragon flies, damsel flies and chrysopa also having much greater impact on population dynamics of sucking insect pest in oats, if there population increases in the field timely by using different trap, intercrop or artificial releasing then we can manage the sucking pest population without insecticide application or with reduced number of insecticide application.

5. Acknowledgement

Authors are thankful to Dean (Agriculture), Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadura, Sopore, for providing the necessary facilities and support for carrying out the study successfully.

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