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Seasonal incidence of foliage insect-pests infesting rabi oats (*Avena sativa* L.) in north Kashmir

Ritesh Kumar, Ishtiyaq Ahad, Kawsar Rasool, Shaheen Gul and Sheikh Aafreen Rahman

Abstract
Experiment was carried out in the field at the Faculty of Agriculture, Wadura, Kashmir, India during 2015-16 under free choice conditions to Seasonal incidence of different foliage insect-pests infesting Rabi Oats (*Avena sativa* L.) in North Kashmir. The results of investigation on Per cent damage of caterpillars of armyworm (*M. separata*) appeared from 10th meteorological week (7.57%) and reached its peak (29.97%) in the 22nd meteorological week whereas, caterpillars of gram pod borer (*H. armigera*) appeared from 12th meteorological week (2.75%) and reached its peak (22.67%) in the 18th meteorological week. Similarly, damage of cereal leaf beetle (*O. melanopa* L.) appeared from 8th meteorological week (5.94%) and reached its peak (34.58%) in the 23rd meteorological week while, damage of surface grasshoppers appeared from 10th meteorological week (1.26%) and reached its peak (3.21%) in the 22nd meteorological week. Later on, the pest population declined gradually towards the maturity of crop. Correlation between abiotic factors and per cent damage through caterpillars of *M. separata*, *Helicoverpa armigera*, and *O. melanopa* and grasshopper exhibited highly significant positive correlation with maximum, minimum temperature and sunshine (hrs.), while as highly significant negative correlation with relative humidity of morning as well as non-significant negative correlation with relative humidity of evening. However, this pest exhibited non-significant positive correlation with rainfall.

Keywords: *Helicoverpa armigera*, percentage damage, oats, weather parameters and correlation

1. Introduction

Oats rank sixth in the world cereal production statistics following wheat; maize, rice, barley and sorghum (Pandey and Roy, 2011) [21]. It is mainly cultivated as fodder for animals and also for grain because of its high nutritional and medicinal value. The use of grain is now more focused on mining its benefits as a health food. The importance of oats in the biochemical and cosmetic industry is also on the rise (Tiwari and Cummins, 2009) [26]. Out of cereals, the highest amounts of β-glycan are found in barley and oats grains (Ahmad and Zaffar, 2014) [1]. It is cultivated in Punjab, Haryana, West Bengal, Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan and Maharashtra (Pandey and Roy, 2011) [21]. 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) [25]. The armyworm is one of the most destructive insects infesting oats. It destroys oats in some areas almost every year. Outbreaks are frequently local and sporadic, but occasionally high populations have infested large sections of the eastern USA and Canada (Walkden, 1950) [29]. Damage to oats in 1954 was estimated to be over $5 million (USA); an estimated $12 million (USA) loss was prevented with insecticides. In Jammu and Kashmir Lone *et al.* [20] reported armyworm *Mythimna separata* major pest in the state which caused heavy losses in the oats which is grown only for fodder purpose. *Helicoverpa armigera* (Hubner) (Lepidoptera:

Noctuidae), is well known as cotton bollworm, gram caterpillar, pod borer or American bollworm. It is highly polyphagous pest with broad spectrum of host families including important agriculture crop such as cotton, chickpea, pigeon pea, sorghum, sunflower, cotton, soybean, groundnut, even wheat etc. (Fitt, 1989) [12]. These characteristics make *H. armigera* particularly well adapted to exploit transient habitats, such as man-made ecosystems. Worldwide, *H. armigera* has been reported on over 180 cultivated hosts and wild species in at least 45 plant families (Venette *et al*., 2003) [28]. The larvae feed mainly on the flowers and fruit of high value crops, and thus high economic damage can the flowers and fruit of high value crops, and thus high economic damage can be caused at low population densities (Anonymous, 2007) [4]. It is considered as the most damaging insect pests in Australian agriculture, costing approximately $225.2 million per year to control (Clearly *et al*., 2006) [9]. This pest is considered as a major insect pest of both field and horticultural crops in many parts of the world (Fitt, 1989) [12]. Surface grasshoppers (*Chrotogonus trachypterus* and *C. oxypterus*) are widely distributed in the Orient and Africa. These grasshoppers are polyphagous and feed on a number of cultivated crops. The occurrence and abundance of the surface grasshopper, *C. trachypterus* on paddy was monitored by (Lanjar *et al*., 2002) [19] in Dokri, Pakistan. In India, *C. trachypterus* is more common in the north, whereas, *C. oxypterus* occurs in the southern regions. The surface grasshopper is a pest of pastures throughout the year. The common desert representative of the genus collected from western Rajasthan appeared to belong to *C. trachypterus*, being widely distributed on the ground (their habitat is the surface of the soil) and more frequently collected from nurseries, gardens and wheat and oats fields. It is distributed throughout the plains in India including Orissa, South Arcot, Madura, Coimbatore, Bellary, Madhya Pradesh and Rajasthan (Kevan, 1959) [18]. Akhtar (1971) [2] examined nymphs and adults feeding on leaves by cutting germinating plants of cotton, wheat, paddy, oats, barley and others particularly in areas adjoining wastelands. However, Cereal leaf beetle, *O.melanopus*; is considered a major pest of small grains in Europe, Asia, and the United States. Since its introduction into Michigan, it has rapidly spread and is now found in most states south and east of North Dakota, as well as in Montana, Idaho, Utah, Wyoming, Nevada, Oregon, and Washington (Herbert *et al*., 2007) [16]. It feeds on numerous species of wild and cultivated grasses although preferences are shown for including oats, barley, and wheat, possibly because of increases in survival and development time (Wilson and Shade, 1966) [30]. Although adults feed on young small grain plants, their feeding typically does not affect yield. Larvae however, eat long strips of parenchyma tissue skeletonizing the leaf decreasing the plant's ability to photosynthesize (Buntin *et al*., 2004) [8]. Significant feeding injury in wheat gives the field a frosted appearance. This loss of photosynthetic ability can cause significant losses in yield or grain quality (Grant and Patrick, 1993) [14]. Losses are highly variable, and depend on infestation levels as well as the crop and the region with maximum losses of 40 per cent (Buntin *et al*., 2004) [8]. In Virginia commercial wheat fields average 15 per cent yield loss if cereal leaf beetle is left untreated. One possible reason for these large populations is poor establishment of introduced biological control agents leading to limited or no control (Herbert *et al*., 2007) [16]. Poor establishment of these parasitoids may be attributed to several factors including management practices, with a key reason being the unnecessary and poorly timed use of pesticides. Upadhyay *et al.* (1989) [27] conducted Experiment to study the impact of weather parameters on larval populations of *H. armigera* on groundnut revealed that *H. armigera* population showed a positive association with maximum temperature and minimum temperature as well as relative humidity. James *et al.* (1986) [17] showed that 32.2ºC is upper limit to shoot bugs in summer count was lower as compare to winter; to bearing the temperature shoot bug are preferring moist place on maize plant *viz.* whorls, leaf sheath, downside of leaf etc. Keeping in view the above facts it becomes imperative to study the Seasonal Incidence of Foliage Insect-Pests Infesting Rabi Oats (*Avena sativa* L.) in North Kashmir.

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 Seasonal incidence of different foliage insect-pests infesting Rabi Oats (*Avena sativa* L.) in North Kashmir. 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.

2.1 Foliage feeders

Caterpillars of *M. separata* and *H. armigera*, grubs and adult of Cereal leaf beetle and adult of surface grasshoppers, feed on foliage of the crop, these insects was observed by square meter method and the damage was worked out as under

$$\text{Damage percentage} = \frac{\text{No. of damaged plants}}{\text{Total number of plants}} \times 100$$

Larval activity was determined by counting the total number of larvae at weekly interval. To assess the larval populations at experimental sites, square meter/quadrant method was done within the experimental plots. Larvae registered in the experiment were correlated with the abiotic factors (temperature, relative humidity, sunshine and rainfall).

2.2 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.

2.3 Statistical analysis

Data collected from the experimental site was subjected to standard statistical procedure using standard statistical procedures (Gomez and Gomez, 1984) [13].

3. Results and Discussion

3.1 Per cent damage of different foliage feeders (caterpillars, beetles, and grasshoppers) infesting oats

During the course of study, caterpillars, beetles and grasshoppers were found to be infesting oats starting from its germinating stage to physiological maturity and their percentage damage were recorded at weekly intervals. Table-1 predicted that foliage insect pests of Per cent damage of caterpillars of armyworm (*M. separata*) appeared from 10th meteorological week (7.57%) and reached its peak (29.97%) in the 22nd meteorological week. Whereas, caterpillars of gram pod borer (*H. armigera*) appeared from 12th meteorological week (2.75%) and reached its peak (22.67%) in the 18th meteorological week. Similarly, damage of cereal leaf beetle (*O. melanopa* L) appeared from 8th meteorological week (5.94%) and reached its peak (34.58%) in the 23rd meteorological week while, damage of surface grasshoppers appeared from 10th meteorological week (1.26%) and reached its peak (3.21%) in the 22nd meteorological week. Our results are in close conformity with Lone *et al.* (2009) [20] who reported the peak period of *M. separata* and grasshopper *H. banian* in 1st and 2nd week of June. Anderson (1961) [3] reported 25.9 % to 62.1 % loss of forage due to grasshopper in Montana range lands of U.S.A. Asad *et al*. (2001) [5] reported that when adults of *C. trachypterus* were provided leaves of 41 plant species belonging to 25 families as food, 36 were accepted and 5 rejected. It was found that the grasshopper preferred, the seedlings of wheat, Oats, millet (*Pennisetum glaucum*) and cotton (*Gossypium hirsutum*). The most preferred food plants were berseem (Egyptian clover, *Trifolium alexandrianum*), cotton, mustard (*Brassica campestris*), lucerne, potato, and tomato. An estimated 6 to 12 percent of the available forage is consumed by them in U.S.A. (Cowan, 1958) [10]. Akhtar (1971) [2] reported nymphs and adults feeding on leaves by cutting germinating plants of cotton, wheat, and others, particularly in areas adjoining wastelands. Such damaged fields often had to be resown. Surface grasshoppers are polyphagous and feed on a number of cultivated crops. Cereal leaf beetles feed on many members of the grass family. Small grains (oats, barley, wheat, spelt, and rye) are among the most favorable foods for cereal leaf beetles (Wilson and Shade 1966) [30]. Some forage grasses are also favorable, but larval development on them is usually slower than on small grains. The adults and larvae feed mainly on the upper surfaces of leaves and chew lengthwise between the leaf veins. Larvae feed only on parenchyma tissue between the veins in the leaves (Shade and Wilson 1967) [23]. Adults may chew completely through leaf tissue, causing leaves to split lengthwise and giving them a tattered appearance. Larvae have a slug-like appearance and are usually covered in a layer of moist fecal material. Cereal leaf beetles are univoltine in North America and overwinter as adults in a wide variety of protected places, including under bark, forest litter, grass crowns, and grain stubble (Denton 1973) [11]. Armyworms feed on a variety of plants, although small grain crops are a common food source for larvae. Larvae skeletonize the surface of the leaves or the inner surface of sheaths as early instars and later feed from the margins of the leaves. The inflorescence is seldom damaged unless leaf foliage is scarce, but in some grasses, notably timothy (*Phleum pratense* L.), green heads are often readily consumed by older larvae even when foliage is abundant (Guppy 1961) [15]. Larvae typically pass through six instars and feed mainly at night. Early-instar larvae loop as they move and may drop from threads when disturbed (Breeland 1958; Guppy 1961) [7, 15]. The wheat head armyworm is native to North America. It overwinters as a pupa (Beirne 1971). Adults emerge in the spring and lay eggs on many grass species. Adults fly at night and are attracted to light. Host plants include wheat, rye, oats, barley, and wild oats (Beirne 1971) [6]. *H. armigera* has been reported on over 180 cultivated hosts and wild species in at least 45 plant families (Venette *et al*., 2003) [28]. The larvae feed mainly on the flowers and fruit of high value crops, and thus high economic damage can the flowers and fruit of high value crops, and thus high economic damage can be caused at low population densities (Anonymous, 2007) [4]. It is considered as the most damaging insect pests in Australian agriculture, costing approximately $225.2 million per year to control (Clearly *et al*., 2006) [9]. This pest is considered as a major insect pest of both field and horticultural crops in many parts of the world (Fitt, 1989) [12]. The pest status is due to its broader host range of its larvae, its feeding preference for reproductive stages of plants; its high fecundity; its high mobility; and its ability to enter facultative diapauses and thus adapt to different climates (Cleary *et al*., 2006) [9].

Table 1: Per cent damage of foliage feeders (caterpillars, beetles, and grasshoppers) infesting oats

Standard week	Percentage(%) damage				Temperature (°C)		Rainfall/week (mm)	Relative Humidity (%)		Sun shine (hr.)
	M. separata	*H. armigera*	*O. melanopa*	*C. trachypterus*	Max.	Min.		Morning	Evening	
47th	0.00	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	0.00	12.07	0.14	0.14	89.14	66.71	1.71
49th	0.00	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	0.00	7.71	0.41	3.11	87.29	76.57	0.00
51ist	0.00	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	0.00	6.75	-3.28	0.17	89.86	65.86	1.83
1st	0.00	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	0.00	8.71	-3.01	0.60	92.29	72.14	2.53
3rd	0.00	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	0.00	11.57	-3.28	0.17	92.14	46.29	4.80
5th	0.00	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	0.00	9.64	-0.65	3.40	91.43	60.00	2.19
7th	0.00	0.00	0.00	0.00	13.21	-0.58	4.37	88.29	52.71	5.80
8th	0.00	0.00	5.94	0.00	21.07	-0.97	0.00	99.14	34.57	9.66
9th	0.00	0.00	7.85	0.00	18.05	1.21	0.57	85.71	42.14	4.47
10th	7.57	0.00	10.21	1.26	14.35	3.62	6.01	86.29	63.86	2.96
11th	10.86	0.00	13.35	1.57	10.14	1.84	16.62	92.00	75.43	2.26
12th	11.24	2.75	12.29	2.21	15.28	3.14	4.54	84.43	64.29	3.97
13th	13.57	5.67	14.58	1.58	14.18	7.11	4.75	91.57	81.71	0.37
14th	17.46	6.68	16.54	1.97	18.21	5.77	4.80	90.29	68.57	5.33

15th	18.52	9.95	12.57	2.21	19.42	7.48	5.02	88.29	70.00	3.60
16th	19.37	16.65	19.57	2.64	20.28	4.42	2.10	85.43	64.29	7.17
17th	21.08	18.85	18.57	1.85	23.57	8.21	1.62	80.86	58.29	5.79
18th	21.97	22.67	21.89	2.35	25.21	9.64	1.64	81.29	54.71	5.53
19th	25.30	22.54	26.58	1.64	29.14	10.21	1.71	76.29	43.14	8.56
20th	27.94	20.97	29.95	2.34	27.14	11.35	3.82	80.00	54.43	7.63
21st	29.94	21.89	25.57	0.29	30.21	12.54	0.00	70.43	39.86	9.83
22nd	29.97	21.95	29.64	3.21	28.92	13.05	0.48	74.86	44.00	9.07
23rd	27.85	21.29	34.58	1.84	30.21	15.48	0.08	78.29	49.57	7.61
24th	22.80	18.35	19.95	2.52	31.42	14.84	0.00	69.14	54.86	8.80
25th	15.65	14.54	15.56	1.59	32.00	16.18	0.80	76.86	41.57	10.10
26th	7.50	10.67	9.61	1.87	31.00	16.91	0.85	75.86	47.43	6.41
27th	2.95	4.00	3.84	1.13	29.35	16.71	4.94	81.71	50.29	6.33

3.2 Correlation of per cent damage of foliage feeders with abiotic factors

Table-2&3 Observed that correlation between abiotic factors and per cent damage through caterpillars of *M. separata*, *Helicoverpa armigera*, and *O. melanopa* and grasshopper exhibited highly significant positive correlation with maximum, minimum temperature(r= 0.75**,0.76**)(r=0.797***,0.793***)(r=0.769**,0.761**)(r=0.06**,0.73**) and,sunshine(hrs.)(r=0.57**)(0.59**)(0.59**)(r=0.40*, while as highly significant negative correlation with relative humidity of morning as well as non-significant negative correlation with relative humidity of evening. However, this pest exhibited non-significant positive correlation with rainfall. Our results are in close agreement with Sharma *et al.* (2012) [24] who reported that abiotic factors like maximum temperature and minimum temperature had positive correlation with male moth catches and larval population of *H. armigera* while, relative humidity had negative correlation with male moth catches and larval population of *H. armigera*. Reddy *et al*. (2009) [22] recorded larval abundance of *H. armigera* and reported non-significant correlations with temperature (ºC), R.H. (%) and rainfall, sunshine, wind speed at Allahabad. Upadhyay *et al.* (1989) [27] conducted Experiment to study the impact of weather parameters on larval populations of *H. armigera* on groundnut revealed that *H. armigera* population showed a positive association with maximum temperature and minimum temperature as well as relative humidity. James *et al.* (1986) [17] showed that 32.2ºC is upper limit to shoot bugs in summer count was lower as compare to winter; to bearing the temperature shoot bug are preferring moist place on maize plant *viz*. whorls, leaf sheath, downside of leaf etc.

Table 2: Correlation of weather parameters with per cent damage of *H. armigera* and *M. separate*

Factors	***M. separata***		***H. armigera***	
	Correlation coefficient (r)	**Regression equation**	**Correlation coefficient (r)**	**Regression equation**
Temperature (°C)				
Max.	0.75**	Y= -8.28+0.992 X	0.797**	Y= -6.64+ 0.834 X
Min.	0.76**	Y= 4.30+ 1.22 X	0.793**	Y= 4.03+ 1.01 X
Relative humidity (%)				
Morning	-0.73**	Y= 108 +(-1.14) X	-0.75**	Y= 87.7 +(-0.923) X
Evening	-0.22 NS	Y= 21.5+ (0.197) X	-0.27 NS	Y= 19.9+ (-0.192) X
Sun shine (hr.)	0.57**	Y= -1.45+ 2.25 X	0.59**	Y= -0.60+ 1.83X
Rainfall/week (mm)	0.06 NS	Y= 9.52+ 0.232 X	0.07 NS	Y= 8.32+0.199 X

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

Table 3: Correlation of weather parameters and per cent damage of *O. melanopa* and *C. trachypterus*

Factors	***O. melanopa***		***C. trachypterus***	
	Correlation coefficient (r)	**Regression Equation**	**Correlation coefficient (r)**	**Regression Equation**
Temperature (°C)				
Max.	0.769**	Y= -7.83+ 0.996 X	0.06**	Y= -0.500+0.0830X
Min.	0.761**	Y= 4.93+ 1.19 X	0.73**	Y= 0.499+0.113 X
Relative humidity (%)				
Morning	-0.70**	Y=102+ (-1.07) X	-0.58**	Y=8.50+ (-0.0873) X
Evening	-0.29 NS	Y= 25.1+ (-0.251) X	-0.03 NS	Y= 1.22+ (-0.0032) X
Sun shine (hr.)	0.59**	Y= -1.09+ 2.28 X	0.40*	Y= 0.259+ 0.151 X
Rainfall/week (mm)	0.07 NS	Y= 9.97+0.264 X	0.26 NS	Y=0.837 +0.860 X

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

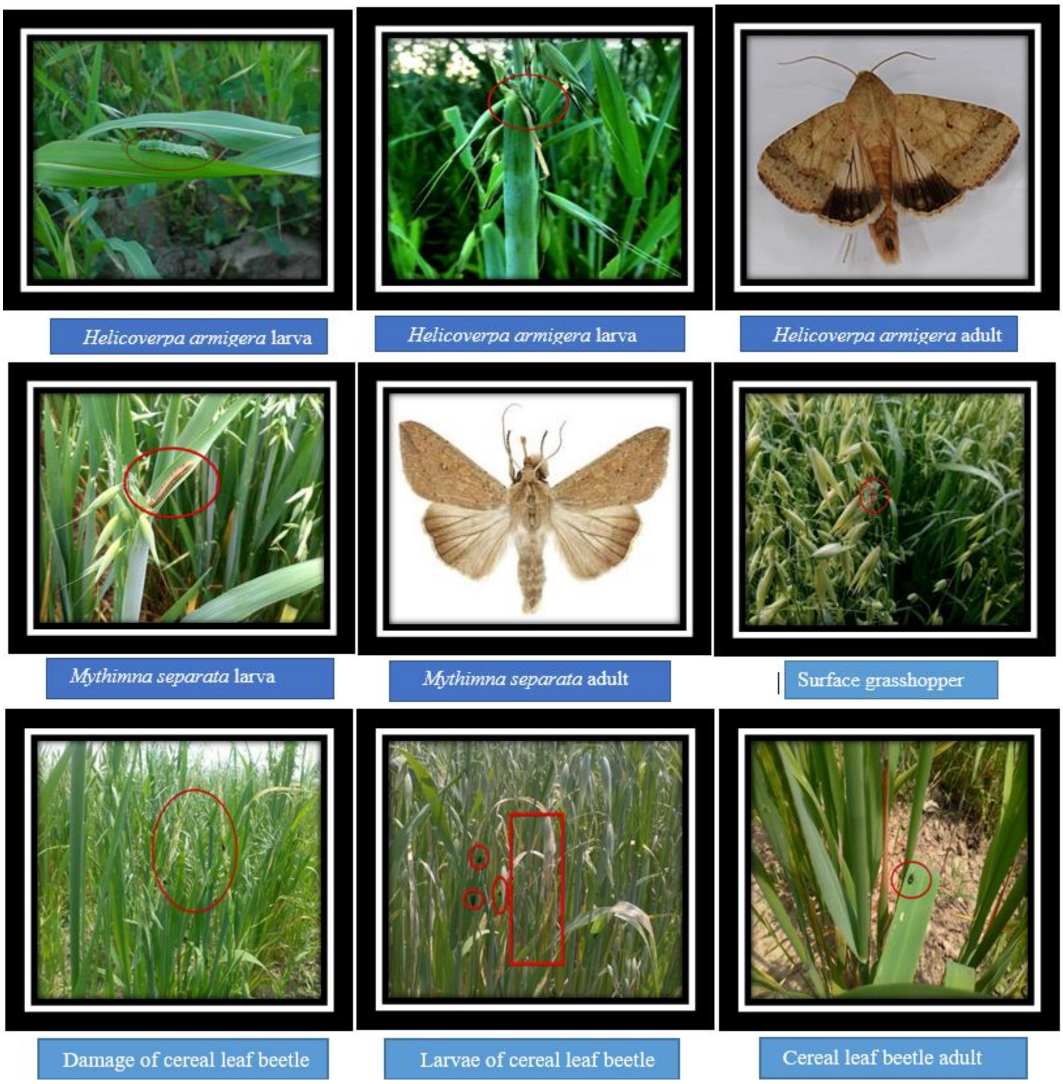

Plate 1: Foliage Insect Pests of Oats

4. Conclusions

It was concluded that insect pests of oats is changing year after year and most of the insect pests are changing their host range due to climate change all over the world. Per cent damage of caterpillars of armyworm (*M. separata*) appeared from 10th meteorological week (7.57%) and reached its peak (29.97%) in the 22nd meteorological week whereas, caterpillars of gram pod borer (*H. armigera*) appeared from 12th meteorological week (2.75%) and reached its peak (22.67%) in the 18th meteorological week. Similarly, damage of cereal leaf beetle (*O. melanopa* L) appeared from 8th meteorological week (5.94%) and reached its peak (34.58%) in the 23rd meteorological week while, damage of surface grasshoppers appeared from 10th meteorological week (1.26%) and reached its peak (3.21%) in the 22nd meteorological week. Later on, the pest population declined gradually towards the maturity of crop. Correlation between abiotic factors and per cent damage through caterpillars of *M. separata*, *Helicoverpa armigera*, and *O. melanopa* and grasshopper exhibited highly significant positive correlation with maximum, minimum temperature and sunshine (hrs.), while as highly significant negative correlation with relative humidity of morning as well as non-significant negative correlation with relative humidity of evening. However, this pest exhibited non-significant positive correlation with rainfall.

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