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Impact of weather parameters on population dynamics of soil borne insect pests infesting oats (*Avena sativa* L.) in North Kashmir

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Abstract
The present experiment was carried out in the field at the Faculty of Agriculture, Wadura, North Kashmir during 2015-16. Various adult and larval populations' *viz.* white grubs (*Holotrichia longipennis*, *Brahmina* spp, *Melolntha furcicauda* and *Oryctes* spp), wireworm (*Agriotes* spp) and cutworm (*Agrotis* spp) were observed at the experimental site. Among these pests *H. longipennis* populations were found to be the dominating one. Correlation studies depicted that, white grub larvae and adult showed highly significant positive correlation with temperature(r =0.89, 0.93), (r =0.86, 0.91) and sunshine (r =0.65, 0.64). Wire worm larvae and adult were positively correlated with temperature(r =0.47, 0.61), (r =0.87, 0.87) and sunshine (hrs.); however larvae and adult showed highly significant negative correlation with relative humidity. Larvae showed highly significant positive correlation with rainfall and adult resulted non-significant negative correlation with rainfall. On the other hand cut worm larvae and adults showed highly significant positive correlation with temperature(r =0.67, 0.62), (r =0.78, 0.86) and sunshine (hrs.).

Keywords: Beetles, population, infestation and correlation

1. Introduction
Oats rank sixth in the world cereal production statistics following wheat; maize, rice, barley and sorghum [13]. 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 [21]. Out of cereals, the highest amounts of β-glycan are found in barley and oats grains [2]. It is cultivated in Punjab, Haryana, West Bengal, Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan and Maharashtra [13].The total area covered under oats cultivation in the country is about 5 lakh ha. The crop occupies maximum area in Uttar Pradesh (34 per cent), followed by Punjab (20 per cent), Bihar (16 per cent), Haryana (9 per cent) and Madhya Pradesh (6 per cent) [13].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 [20]. 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 [20]. 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 [24]. 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.* [10] reported armyworm *Mythimna separata* major pest in the state which caused heavy losses in the oats which is grown only for fodder purpose. White grubs are polyphagous pests and are cosmopolitan in distribution. It is the immature stage of scarab beetle popularly known as Cock chafer, Chafer beetle, May beetle or June beetles [12]. The grubs are subterranean and actively feed on living roots and underground stem of living plants. In the state of Jammu and Kashmir, white grub has gained a tremendous importance in recent past, due to its attack on many agricultural and horticultural crops, golf courses, lawns

and park and they wear a bald and ugly look [16]. A number of species of white grub have been reported in Jammu and Kashmir State and they include *Protecta neglecta* (Hope.), *Melolontha furcicauda*, *Hilyotrogus holoscericus* (Redt.), *Articaphia battalina* (Bates), *Adoretus ladakhansis*, *Adoretus* sp., *Brahmina* sp., *Hetronychus subhoeosis* [16]. In Kashmir valley, *Agrotis ipsilon* is a destructive pest on maize, potato, vegetable crops, flowers and fruit seedlings. Thus, reducing the plant stand and biological yields [16]. In this valley, five species of cutworms that have been recorded are *Agrotis melafida*, *Agrotis exclamationsis*, *Peeridorma saucia* and *Noctus pronubo* [16].The nocturnal larvae of this pest cut the haulms and stalk of young plants at the collar region and defoliate the plants in their early growth stage [14]. They rarely consume the entire plant, but more commonly move to the next plant and damage in the row or to another row. Larvae spoil more than consume and a severely infested fields looks like as if it has been grazed [9]. The cutworm is most serious in weedy, late planted fields with poor drainage especially during cool and wet springs. Eggs are laid singly or a few together on leaves or stem of weeds, crop residue or bordering fields before the crop is planted. The young larvae feed on these plants until seedling emerge. Keeping in view the above facts it becomes imperative to study the Impact of weather parameters on population dynamics of soil borne insect pests infesting 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 the status and succession of the pests at the experimental site. 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. The observation of various beetles and caterpillar of cutworm infesting oats was taken at weekly intervals throughout the growing season. Quantification of soil arthropods grubs hiding in the soil debris (soil arthropods *viz.* white grubs and wireworms) were quantified by taking three samples of larvae excavating in 8400 cm^2 area *i.e.* (20cm x 20cm) of 21cm deep in soil in the field. Mean number of larvae present per three samples was recorded [22]. Three samples of cutworm larvae was taken by excavating 6250 cm^2 area (25cm x 25cm) of 10 cm deep soil in the field. Mean number of larvae present per three samples was recorded [4]. To estimate the population of different soil borne insect pests in oats agro ecosystem, light trap was installed in the field to monitor the adult beetles and cutworm adult (mostly of nocturnal habit). The number of adult beetles per plot was statistically analyzed and correlated with meteorological parameters *viz*., maximum and minimum temperature (°C), morning and evening RH (%), sun shine (hr.) and rainfall (mm). The observations of the insect pests were recorded in morning as well as in the dusk period to take the advantage of sedentary nature of the insects. Mean of three plots was calculated to make further statistical analysis.

2.1 Statistical analysis

Data collected from the experimental site was subjected to standard statistical procedure using standard statistical procedures [7].

3. Results and Discussion

3.1 Population dynamics of soil borne insect pest

During the course of study, White grub, Wireworm and cutworm were found to be infesting oats starting from its germinating stage to physiological maturity and their populations were recorded at weekly intervals. Table-1 predicted that soil borne insect pests, white grub larvae appeared from 47th meteorological week (0.33/8400cm^3) after sowing of crop which increased and reached its peak in the 22nd meteorological week (4.33/8400cm^3) while, adults appeared from 10th meteorological week (1.00/trap/week) and reached its peak in the 24th meteorological week (8.00/trap/week). However, wire worm larvae/grubs population appeared from 48th meteorological week (0.33/8400cm^3) which increased and reached the maximum values in the 15th meteorological week (1.66/8400cm^3) while, adults appeared from 15th meteorological week (3.00/trap/week) and reached its peak in the 22nd meteorological week (5.00/trap/week). Other soil borne insect pest, cutworm larvae population appeared from 11th meteorological week (0.33/6250cm^3) which increased and reached its peak in the 21th meteorological week (4.33/6250cm^3) while, adult appeared from 9th meteorological week (3.00/trap/week) and reached its peak in 23rd meteorological week (5.00/light trap/week). Soil borne insects *viz.* white grub, cutworm and wire worm observed in the experimental site appeared as minor pests (Table-1, Fig-1). These results are in agreement with Day *et al.* [6] who made various collections of wire worm on monthly basis in light trap and found maximum number between June to September. Similarly, Ahad *et al.* [1] reported the abundance of soil borne insects white grubs, wire worms and cutworm higher reaches at Udhampur, Jammu and Kashmir. Bohm and Krause [3] reported the occurrence of click beetles in early to mid-May. Moreover, less population of larva might be due to the saturation of moisture in the soil during winter season as soils remain fully submerged is reported by Dalthorp *et al.* [5] who reported that localized populations of white grubs annually shrink and correlation with relative humidity, except grub showing non-significant results with evening relative humidity. Similarly, swell because of variations in rainfall and soil moisture. Mishra *et al.* [12] reported that beetles of *Anomala lineatopennis* emerged between 19.30 and 19.45 h from soil with peak emergence in first week of June. The mass beetle emergence of *Holotrichia longipennis* occurred during fourth week of June at dusk and mated on preferred host *Rubus ellipticus*. The longevity of females was greater and there was only one generation per year. Moreover, *Holotrichia longipennis* was the predominant species of white grub beetle on 51 host plant in Garhwal hills Singh *et al.* [19] In Kashmir valley, *Agrotis ipsilon* is a destructive pest in maize, potato, vegetable crops, flowers and fruit seedlings. Thus, reducing the plant stand and biological yields [16]. The extent of damage due to black cutworm in maize is 30-40 percent and 90 percent under moderately and heavily infested conditions respectively in Kashmir. The damage inflicted to maize seedling is mainly from April to third week of June when sampling are two to six leaf stages and May sown crop is most severely damaged [11]. This period coincides with sowing and transplanting of most of the crops. Williamson and Porter [25] hypothesized that black cutworm densities could build up in areas of tall fescue or perennial rye grass surrounding golf course putting greens and tees.

3.2 Correlation coefficient between soil borne insect pest population and some abiotic factors

The data (Table-2, 3, 4) reveled that white grub larval population highly significant positive correlation with maximum & minimum temperature (r = 0.89, 0.93) and also adult population highly significant positive correlation with maximum & minimum temperature (r =0.86, 0.91). Whereas, sunshine (hrs.) Also positive correlation was observed with larvae as well as adult (0.65, 0.64). These populations showed significant negative correlation with relative humidity of morning and evening with larvae as well as adult (r =-0.87, -0.41), (r = -0.81, -0.34). However, it was non-significant with rainfall. Wire worm larvae and adult were positively correlated with temperature and sunshine; however larvae and adult showed highly significant negative correlation with relative humidity, except grub showing non-significant results with evening relative humidity. Larvae showed highly significant positive correlation with rainfall and adult resulted non-significant negative correlation with rainfall. On the other hand cut worm larvae and adults showed highly significant positive correlation with temperature and sunshine however, these populations were negatively correlated with relative humidity. Moreover, both the stages showed non-significant results with rainfall. Vishwadhar *et al.* [23] also reported that a sudden rise in the minimum temperature above 7.5 ^{0}C around 7-8 standard weeks shown a major rise in pest population. When exceeded maximum temperature as 35.46 ^{0}C, the lowest relative humidity in evening as 19.43%, highest rainfall as 11.70 mm/week, drastically declined the multiplication of the pest to its lowest level as - 0.56 larvae/day. Reddy *et al*. [15] similarly found that the population has significantly positive correlation with both minimum and maximum temperature and the correlation coefficient being 0.71 and 0.82, respectively. Though, the relative humidity in morning (r = -0.49), relative humidity evening (r = -0.37), rainfall (r = - 0.27) and parasitization (r = -0.37) played a negative role on larval population. Yadav and Jat [26], Shinde *et al.* [17] and Jagdish and Agnihotri [8] have also confirmed that maximum and minimum temperatures had a significant positive correlation with larval population whereas relative humidity and rainfall had no effect on population fluctuation.

Table 1: Population dynamics of adults and larvae of soil borne insect pests on oats

Standard week	White grub		Wire worm		Cut worm	
	No. of adults/ trap/week	No. of larvae/ 8400cm^3	No. of adults/ trap/week	No. of larvae/ 8400cm^3	No. of adults/ trap/week	No. of larvae/ 6250cm^3
47th	0.00	0.33	0.00	0.00	0.00	0.00
48th	0.00	0.33	0.00	0.33	0.00	0.00
49th	0.00	0.33	0.00	0.33	0.00	0.00
50th	0.00	0.33	0.00	0.33	0.00	0.00
51^{ist}	0.00	0.33	0.00	0.00	0.00	0.00
52nd	0.00	0.00	0.00	0.00	0.00	0.00
1st	0.00	0.00	0.00	0.00	0.00	0.00
2nd	0.00	0.00	0.00	0.00	0.00	0.00
3rd	0.00	0.00	0.00	0.00	0.00	0.00
4th	0.00	0.00	0.00	0.00	0.00	0.00
5th	0.00	0.00	0.00	0.00	0.00	0.00
6th	0.00	0.00	0.00	0.00	0.00	0.00
7th	0.00	0.00	0.00	0.00	0.00	0.00
8th	0.00	0.00	0.00	0.00	0.00	0.00
9th	0.00	0.00	0.00	0.33	3.00	0.00
10th	1.00	0.33	0.00	0.33	2.00	0.00
11th	1.00	0.66	0.00	1.33	3.00	0.33
12th	2.00	0.66	0.00	0.66	3.00	0.66
13th	1.00	1.33	0.00	1.00	3.00	0.66
14th	3.00	0.33	0.00	0.66	1.00	1.00
15th	3.00	0.66	3.00	1.66	2.00	1.66
16th	4.00	1.33	3.00	0.33	2.00	2.66
17th	4.00	1.33	3.00	0.33	4.00	2.33
18th	2.00	2.66	4.00	0.33	3.00	3.00
19th	2.00	2.33	4.00	0.66	2.00	3.33
20th	3.00	3.00	3.00	0.66	4.00	3.66
21st	5.00	3.33	3.00	0.66	4.00	4.33
22nd	6.00	4.33	5.00	0.66	3.00	3.66
23rd	7.00	3.66	4.00	0.66	5.00	2.66
24th	8.00	3.33	3.00	1.00	4.00	1.00
25th	6.00	3.33	3.00	1.00	3.00	0.33
26th	5.00	3.00	4.00	0.66	4.00	0.33
27th	7.00	3.33	5.00	0.33	3.00	0.66

Table 2: Correlation of larval and adult population of white grub with weather parameters

Factors	Larvae		Adult	
	Correlation coefficient (r)	Regression equation	Correlation coefficient (r)	Regression equation
Temperature (°C)				
Max.	0.89**	Y= -1.58 + 0.152X	0.86**	Y= -2.76+ 0.264X
Min.	0.93**	Y= 0.329+0.191X	0.91**	Y= 0.523+ 0.339X
Relative humidity (%)				
Morning	-0.87**	Y= 1.61+ (-0.174)X	-0.81**	Y= 27.1+ (-0.293) X
Evening	-0.41**	Y=3.97+ (-0.0473)X	-0.34*	Y= 6.18+ (-0.700) X
Sun shine (hr.)	0.65**	Y= -0.449+ 0.328X	0.64**	Y= -0.859+ 0.583X
Rainfall/week (mm)	-0.10 NS	Y= 1.33+ (-0.0447)X	-0.04 NS	Y= 2.21+ (-0.038) X

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

Table 3: Correlation of larval and adult population of wire worm with weather parameters

Factors	Larvae		Adult	
	Correlation coefficient (r)	Regression equation	Correlation coefficient (r)	Regression equation
Temperature (°C)				
Max.	0.47**	Y= -0.011+ 0.0240X	0.87**	Y= -2.17+ 0.194 X
Min.	0.61**	Y= 0.253+ 0.0378X	0.87**	Y= 0.313+ 0.235 X
Relative humidity (%)				
Morning	-0.43**	Y= 2.67+ (-0.0262) X	-0.79**	Y= 19.1+(-0.207) X
Evening	0.11 NS	Y= 0.213+ (-0.00378) X	-0.43**	Y= 5.12+ (0.0639) X
Sun shine (hr.)	0.16 NS	Y=0.308+ 0.0241X	0.64**	Y= -0.726+ 0.421 X
Rainfall/week (mm)	0.47**	Y=0.289+ 0.0630X	-0.11 NS	Y= 1.57+(-0.066) X

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

Table 4: Correlation of larval and adult population of Cutworm with weather parameters

Factors	Larvae		Adult	
	Correlation Coefficient (r)	Regression equation	Correlation Coefficient (r)	Regression equation
Temperature (°C)				
Max.	0.67**	Y= -1.05+0.110 X	0.78**	Y= -1.19+ 0.159 X
Min.	0.62**	Y= 0.379+0.123 X	0.86**	Y= 0.763+ 0.211X
Relative humidity (%)				
Morning	-0.66**	Y= 11.9+ (-0.128) X	-0.76**	Y= 17.3+ (-0.181) X
Evening	-0.30 NS	Y= 2.89+ (-0.0330) X	-0.26 NS	Y= 3.82+ (-0.0356) X
Sun shine (hr.)	0.56**	Y= -0.417+ 0.273 X	0.46**	Y= 0.330+ 0.279 X
Rainfall/week (mm)	-0.06 NS	Y= 1.04 +(-0.0258) X	0.18 NS	Y= 1.54+ 0.0943X

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

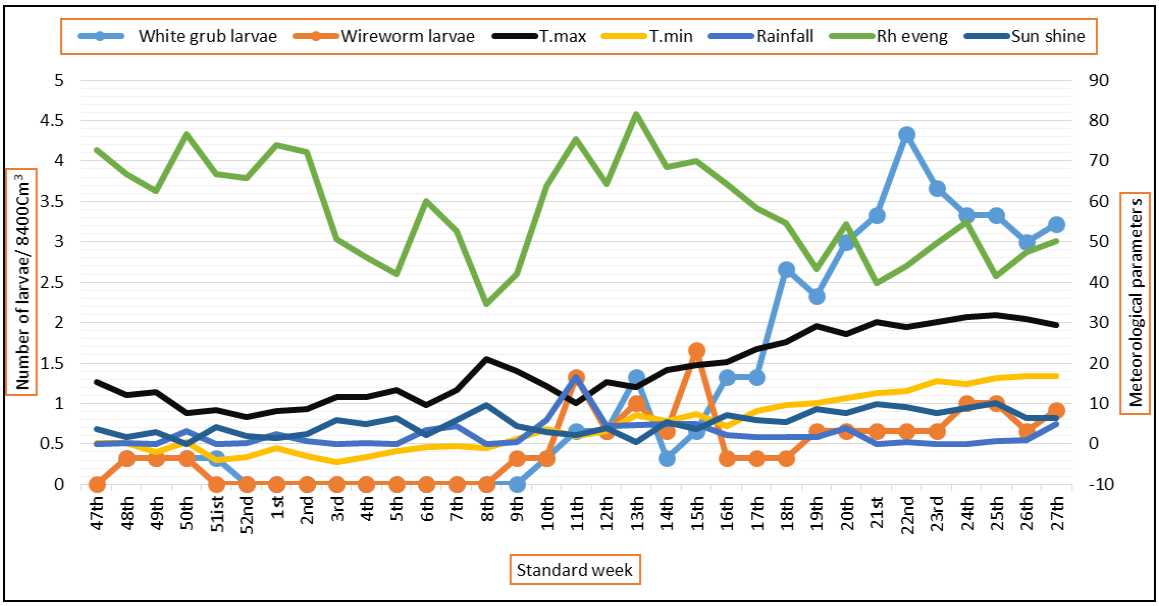

Fig 1: Population of soil borne insect pests (larval activity) along with weather parameters

4. Conclusions

It was concluded that during June month, due to increase in maximum temperature 24th meteorological week White grub adult populations reached its peak (8.00/trap/week) and larval population reached its peak in the 22nd meteorological week (4.33/8400cm^3), thereafter, during 22nd meteorological week Wireworm adult population reached its peak in the (5.00/trap/week) and larval population reached its peak 15th meteorological week (1.66/8400cm^3) in the month of April. However, Cutworm adult reached its peak in the 23rd

meteorological week (5.00/light trap/week) and larval population reached its peak 21th meteorological week (4.33/6250cm^3). Simple correlation coefficient (r) of abiotic factors revealed that minimum temperature (r = 0.93, 0.91) and maximum temperature (r = 0.89, 0.86), sunshine (hrs.)(r = 0.65, 0.64) showed highly significant positive correlation with White grub larvae as well as adult. Wire worm larvae and adult were positively correlated with temperature and sunshine; however larvae and adult showed highly significant negative correlation with relative humidity, except grub showing non-significant results with evening relative humidity. Larvae showed highly significant positive correlation with rainfall and adult resulted non-significant negative correlation with rainfall. On the other hand cut worm larvae and adults showed highly significant positive correlation with temperature and sunshine however, these populations were negatively correlated with relative humidity. Moreover, both the stages showed non-significant results with rainfall.

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