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Seasonal abundance of rice caseworm and whorl maggot under mid hill conditions of Himachal Pradesh, India

Neeru Dumra and Ajai Srivastava

Abstract
Studies were conducted to record the abundance of arthropod insect pests in rice fields as influenced by rice growth stages and neighboring crops at the experimental farm of paddy in Rice and Wheat Research Centre, Malan during *kharif* 2017. Rice caseworm and whorl maggot larvae started appearing during 2nd week of July and rice caseworm reached the peak population during 1th week of August with 29 larvae/ 100 leaves. Adult population of rice caseworm initiated first in 2nd week of July (28 SW) as recorded through light trap and were intercepted through sweep net in the third week of July (29 SW). The pest remained active till 38 SW (4th week of September, 2017) and the adult catches of rice caseworm was at its peak during 32 SW (2nd week of August) and adult population of rice whorl maggot observed first in 3rd week of July (29 SW) as recorded through light trap and were intercepted through sweep net in the third week of July (29 SW). Adult catches of rice whorl maggot was at its peak during 34 SW (4th week of August).

Keywords: Abundance, rice, caseworm, whorl maggot, population

Introduction
One of the oldest cereal grains, rice (*Oryza sativa*) is believed to have been grown for at least 5000 years. Rice is the seed of the grass species *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice). It is a staple food for more than half of the world's population, particularly those living in southern and eastern Asia. Rice is the most important grain with regard to human nutrition and caloric intake, providing more than one-fifth of the calories consumed worldwide by humans. Damage by insect pests is a serious challenge to rice production in India. So far, 175 species of insects have been identified on rice from seed sowing to crop harvest (Kamal, 1998) [3]. The rice plant is an ideal host for a large number of insect pests-root feeders, stems borers, leaf feeders and grain feeders. Apart from these, rice caseworm and whorl maggot are also reported from different parts of country specially Himachal Pradesh. Visualization of real pest problem of an area is the pre-requisite for formulating a sustainable IPM strategy. The dynamics of pests in the area is influenced by the crop management. Considering the above facts, the present study was undertaken to assess the abundance of rice caseworm and whorl maggot in rice fields as influenced by rice growth stage and neighboring crops.

Materials and Methods
The present study entitled "Population buildup of rice caseworm and whorl maggot under mid hill conditions of Himachal Pradesh" was conducted at CSK Himachal Pradesh Krishi Vishvidyalaya, Rice and Wheat Research Centre, Malan, District Kangra during *kharif*, 2017.

Material utilized
The experiment material comprised Kasturi variety of paddy.

Crop raising
The nursery was raised on June 25, 2017 and the transplanting of seedling was carried on July 15, 2017. Various intercultural operations, such as nutrient application, irrigation and weeding were carried out in accordance with the recommended package of practices to ensure a healthy crop.

Population buildup of rice caseworm and whorl maggot

Kasturi Basmati was sown over an area of 500 m² for recording the population of caseworm and whorl maggot (adults and larvae) and their natural enemies, by larval population count, sweep net and light trap. These studies on population build up were also taken on nearby farmer's field (Jia), where in these pests had been reported to occur very Frequently from last couple of years, was selected, besides the experimental field trail at RWRC, Malan. The starting from nursery stage up to harvest, the crop was surveyed regularly. Observations on its build up during the crop season were made at weekly intervals.

Influence of abiotic factors on population buildup of rice caseworm and whorl maggot

The pattern of numerical changes in rice caseworm and whorl maggot population and its relationship with various environmental factors like maximum and minimum temperature (ºC), morning and evening relative humidity (%) and rainfall (mm) was worked out. For this study, the daily meteorological data were taken from the meteorological observatory of Rice and Wheat Research Centre, Malan. The correlation coefficient of population of rice caseworm and whorl maggot (both adults and larvae) and per cent leaf infestation with various environmental factors was worked out.

Results and Discussions

Population buildup of rice caseworm and whorl maggot

Studies on the population buildup of rice caseworm and whorl maggot were carried out by employing different methods viz., larval population count, sweep net method and light trap catches during kharif 2017.

i) Larval population count

Rice caseworm: The study on the population build up of rice caseworm larvae (Table 1) at Malan revealed that the larval infestation due to caseworm was noted in 2nd week of July with 2 larvae/ 100 leaves. Larval population increased by the 3rd week of July with 6 larvae/ 100 leaves and reached to its peak during the 1st week of August with 29 larvae/100 leaves. Thereafter, the population declined till harvest.

While at Farmer's field (Jia), larval infestation due to rice caseworm was observed in 3rd week of July with 2 larvae/ 100 leaves. The peak population of larvae of rice caseworm was observed during the 1st week of August with 18 larvae/ 100 leaves. The present findings are in agreement with results of Yumnam *et al*. (2016) [6], who observed that rice plant was damaged only by the caterpillar of *Nymphula depunctalis* that was most predominant during early vegetative stage of rice crop in flooded rice field.

Whorl maggot: The study on the population buildup of whorl maggot larvae (Table 1) at Malan revealed that the larval infestation due to whorl maggot was observed in 2nd week of July with 1 larvae/ 100 leaves and reached to its peak during the 2nd week of August with 84 larvae/ 100 leaves. Thereafter, the population declined till harvest.

At Farmer's field (Jia), larval infestation due to whorl maggot was observed in 2nd week of July with 1 larva/ 100 leaves. The larval population of whorl maggot reached to its peak during 3rd week of August with 53 larvae/ 100 leaves. Population of insect pests was low at Jia in comparison to field at Malan.

Table 1: Population buildup of rice caseworm and whorl maggot larvae in Kasturi Basmati during kharif 2017

Month	SW	Number of larvae per 100 leaves			
		Malan		Farmer's field (Jia)	
		CW	WM	CW	WM
July	28	2	1	0	1
	29	6	2	2	2
	30	16	10	12	8
August	31	29	47	18	32
	32	20	84	7	41
	33	18	68	12	53
	34	16	63	8	35
September	35	9	42	4	29
	36	4	22	0	21
	37	6	14	1	9
	38	3	7	0	2
	39	2	0	0	0

SW = Standard Week, CW = Caseworm, WM = Whorl maggot

ii) Leaf infestation

Rice caseworm: The data in terms of per cent leaf infestation by rice caseworm at Malan was recorded at weekly interval (Table 2). It was observed that rice caseworm leaf infestation was first observed in the 3rd week of July (1.56%) and it kept on increasing throughout the season and reached its peak during 2nd week of August (16.44%). Almost similar results were recorded by Bhuyan *et al*. (2008) [1] and reported that mean per cent leaf infestation by caseworm larvae based on the damaged leaves at 20 DAT ranged from 2.92 to 3.25 and was found to be non-significant with each other.

At Farmer's field (Jia), rice caseworm leaf infestation was observed in the 4th week of July (2.22%) and it kept increased throughout the season and reached the peak during 2nd week of August (8.67%). The data showed that maximum infestation due to caseworm was in vegetative stage followed by maturity and reproductive stage.

Whorl maggot: Data contained in Table 2 revealed per cent leaf infestation by whorl maggot at weekly interval. Leaf infestation due to whorl maggot was also first observed in the 3rd week of July (3.11%) and it kept on increasing throughout the season and reached peak during 3rd week of August (29.65%) at Malan. Present studies substantiate the findings of Singh and Singh (1988) [6] and they reported the occurrence of rice whorl maggot in Gurdaspur and Kapurthala (Punjab), which resulted in leaf damage varying from 12 to 71 per cent.

At Farmer's field (Jia), whorl maggot leaf infestation was first evident in the 3rd week of July (1.52%) and it kept on increasing throughout the season and reached peak during 1st week of September (20.78%). As shown in data, maximum infestation due to whorl maggot was in maturity stage followed by vegetative and reproductive stage.

Table 2: Per cent leaf Infestation due to caseworm and whorl maggot during kharif 2017

Month	SW	Leaf Infestation (%)			
		Malan		Farmer's field (Jia)	
		CW	WM	CW	WM
July	28	0.00	0.00	0.00	0.00
	29	1.56	3.11	0.00	1.52
	30	3.22	5.66	2.22	3.82
August	31	11.34	15.24	6.54	8.22
	32	16.44	23.53	8.67	12.98
	33	14.46	29.65	7.21	16.56
	34	12.76	28.17	6.82	18.34
September	35	10.45	31.21	4.30	20.78
	36	8.34	19.21	3.21	16.56
	37	6.12	18.51	0.29	11.81
	38	3.19	17.81	0.00	4.76
	39	0.43	0.00	0.00	0.00

SW = Standard Week, CW = Caseworm, WM= Whorl maggot

iii) Sweep net collections

Rice caseworm: A perusal of data (Table 3) showed that adults of caseworm started appearing in 3rd week of July (29 SW). The highest peak of caseworm was noted during 2nd week of August (32 SW) with 23.5 adults per five sweeps. Thereafter, the population of pest decreased and the activity ceased during 4th week of September (38 SW).

At Farmer's field (Jia), adults of caseworm started appearing in 4th week of July (30 SW) with population level of 7.4 adults per five sweeps. The highest peak of caseworm was obtained during 2nd week of August (32 SW) with 18.4 adults per five sweeps. Thereafter, the population of pest decreased and the activity ceased during 3rd week of September (37 SW).

Whorl maggot: As shown in Table 3, adults of whorl maggot started appearing in 3rd week of July (29 SW). The highest peak of whorl maggot adults by this method was observed during 4th week of August (34 SW) with 48.5 adults per five sweeps. Thereafter, the population of pests decreased and the activity ceased during 4th week of September (38 SW).

At Farmer's field (Jia), adults of whorl maggot started appearing in 4th week of July (30 SW). The highest peak of whorl maggot adults was observed during 3rd week of August (33 SW) with 32.5 adults per 5 sweeps. Thereafter, the population of pest decreased and the activity ceased during 3rd week of September (37 SW).

Similar studies were made by Sharma *et al*. (2004) [5] and they recorded the population level of 10 adults of whorl maggot through sweep net during first week of transplanting. The population of the pest was maximum during mid or late August. The adults of whorl maggot were not observed from first week of October onwards till the harvesting of crop.

Table 3: Monitoring of rice caseworm and whorl maggot adults by sweep net method during Kharif 2017

Month	SW	Mean adult catch per 5 sweeps	
		Malan	Farmer's field(Jia)
		CW WM	CW WM
July	28	0.0 0.0	0.0 0.0
	29	4.1 1.0	0.0 0.0
	30	8.5 2.0	7.4 1.2
August	31	16.3 6.3	12.2 5.9
	32	23.5 10.4	18.4 18.3
	33	11.4 21.2	12.1 32.5
	34	9.6 48.5	10.2 27.4
September	35	2.7 18.1	9.0 12.2
	36	1.7 13.2	2.1 9.8
	37	0.5 8.1	2.4 1.4
	38	0.2 2.4	0.0 0.0

SW = Standard Week, CW = Caseworm, WM= Whorl maggot

iv) Light trap catches

Rice caseworm: Data on light trap collections (Table 4) revealed that caseworm first appeared in 2nd week of July (28 SW) and remained active up to 4th week of September (38 SW). Caseworm adults trapped per week was low till 1st week of August. Trap catches of caseworm reached to its highest peak (26.40 adults trapped per week) during 2nd week of August which declined in subsequent weeks. The present findings are in similar with Haq *et al*. (2004) [2] and he reported that the light trap catches of caseworm was higher during the month from August to September. Caseworm preferred early stage of rice crop and the maximum damage occurred within 30 days of transplanting

Whorl maggot: Whorl maggot first appeared in 3rd week of July (29 SW). The number of adults of whorl maggot trapped per week was however quite low till 3rd week of August (33 SW). Then the trap catches of whorl maggot reached to its highest peak (46.10 adults trapped per week) during 4th week of August (34 SW). No adult activity was recorded in light trap beyond 1st week of October (40 SW).

Table 4: Weekly light trap catches of adult caseworm and whorl maggot during kharif 2017

Trap catches/ week			
Month	SW	CW	WM
July	27	0.00	0.00
	28	0.90	0.00
	29	2.10	2.40
	30	3.40	5.00
August	31	15.10	4.57
	32	26.40	11.85
	33	11.20	22.57
	34	6.80	46.10
September	35	2.50	12.85
	36	2.90	8.57
	37	1.20	5.42
	38	0.40	3.33
	39	0.00	0.00

SW = Standard Week, CW = Caseworm, WM= Whorl maggot

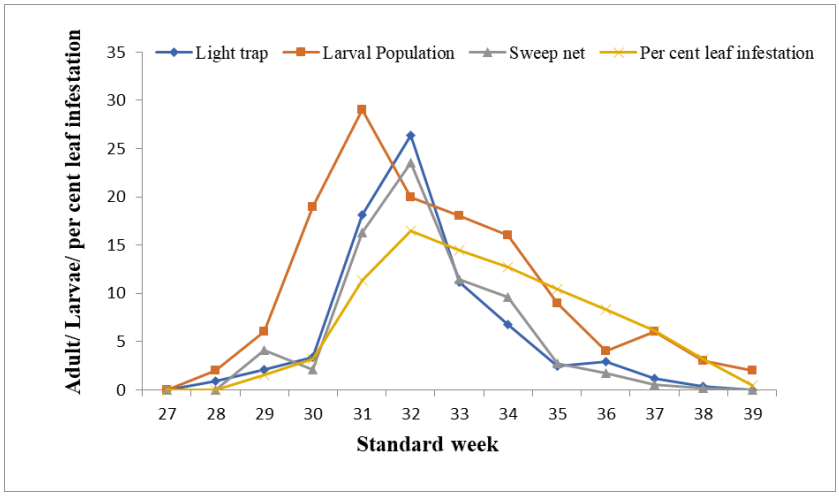

Fig 1: Comparative population buildup of rice caseworm as observed by different methods of population estimation during kharif 2017

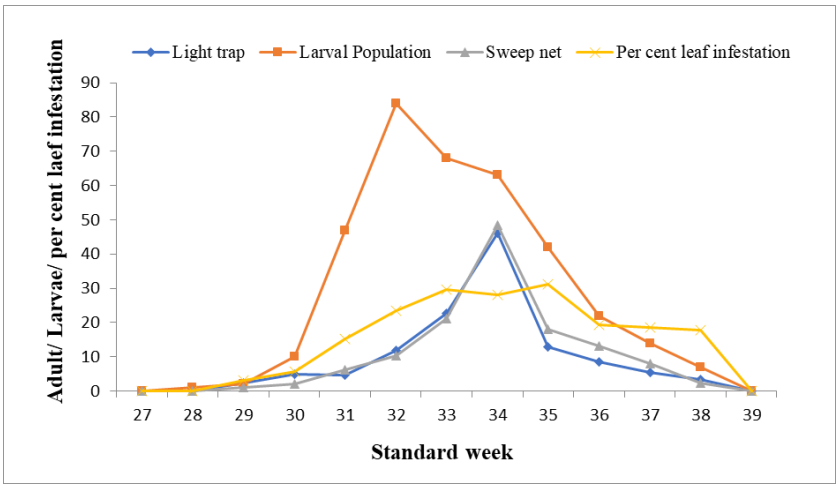

Fig 2: Comparative population buildup of rice whorl maggot as observed by different methods of population estimation during kharif 2017

Influences of weather factors on the seasonal abundance of caseworm and whorl maggot

The correlation between the seasonal abundance of both rice caseworm and whorl maggot with various environmental factors viz., relative humidity, maximum and minimum temperature and rainfall was worked out.

Maximum temperature showed non-significant positive correlation with adult population of rice caseworm, the value of which being 0.119 as shown in Table 5. However, minimum temperature, rainfall, relative humidity showed non-significant negative correlation. Larval population showed non-significant negative correlation with maximum temperature, minimum temperature, relative humidity and rainfall.

These are in strong conformity with Nirala *et al.* (2013) [4] who showed non-significant negative correlation of rice caseworm with minimum temperature, relative humidity and rainfall however positive relation with maximum temperature and sunshine hours at 1 and 5% Level of significance.

Table 5: Correlation coefficient (r) between various abiotic factors and population buildup of rice caseworm

Correlation (r)				
Factor	**Light trap catches**	**Adult catches per 5 sweeps**	**Larval Population**	**Per cent Leaf infestation**
Maximum temperatue (ºC)	0.119	0.142	-0.052	-0.265
Minimum temperature (ºC)	-0.214	-0.254	-0.099	0.421
Relative Humidity (%)	-0.016	-0.066	-0.070	-0.248
Rainfall (mm)	-0.248	-0.144	-0.078	-0.183

Values of r are based on mean values of different locations,* Significant at 5%

While Minimum temperature showed significant positive correlation with adult population, larval population and per cent leaf infestation of rice whorl maggot as shown in Table 6. However, maximum temperature and relative humidity showed non- significant negative correlation with adult population, larval population and percent leaf infestation of rice whorl maggot under mid hill conditions of Himachal Pradesh.

Table 6: Correlation coefficient (r) between various abiotic factors and population buildup of rice whorl maggot on paddy

Correlation (r)				
Factor	**Light trap catches**	**Adult catches per 5 sweeps**	**Larval Population**	**Per cent or (%) Leaf infestation**
Maximum temperature (ºC)	-0.182	-0.281	-0.116	-0.382
Minimum temperature (ºC)	0.596*	0.652*	0.315	0.716*
Relative Humidity (%)	-0.261	-0.335	-0.178	-0.411
Rainfall (mm)	-0.486	-0.523*	-0.495	-0.247

Values of r are based on mean values of different locations,* Significant at 5%

Simple linear regression equations were also worked out, keeping the pest population as dependent variable (y) and the weather parameters viz., maximum temperature (x1), minimum temperature (x2), relative humidity (x3) and rainfall (x4) as independent variables (Table 7).

Through these equations we can find out the population of whorl maggot after putting the values of independent variables in the equations.

Table 7: Simple linear regression equations between various abiotic factors and population of rice whorl maggot by various methods

Regression Equations				
Factor	**Light trap catches (Y)**	**Adult catches per 5 sweeps (Y)**	**Larval Population (Y)**	**% Leaf infestation (Y)**
Maximum temperature (X_1)	$Y= 67.35-1.95X_1$ $R^2 = 0.033$	$Y= 106.03-3.20X_1$ $R^2 = 0.079$	$Y=113.64-2.95X_1$ $R^2 = 0.013$	$Y=137.89-4.12X_1$ $R^2 = 0.155$
Minimum temperature (X_2)	$Y= -19.58+1.78X_2$ $R^2 = 0.356$	$Y= -23.54+2.08X_2$ $R^2 = 0.425$	$Y=-10.87+2.24X_2$ $R^2 = 0.099$	$Y= -20.04+2.11X_2$ $R^2 = 0.513$
Relative Humidity (X_3)	$Y= 44.18-0.47X_3$ $R^2 = 0.068$	$Y= 57.97-0.64X_3$ $R^2 = 0.112$	$Y= 82.48-0.76X_3$ $R^2 = 0.032$	$Y=69.44- 0.74X_3$ $R^2 = 0.178$
Rainfall (X_4)	$Y=10.78-0.11X_4$ $R^2 = 0.046$	$Y= 11.89-1.33X_4$ $R^2 = 0.059$	$Y=28.75-0.20X_4$ $R^2 = 0.028$	$Y=15.55-0.12X_4$ $R^2 = 0.059$

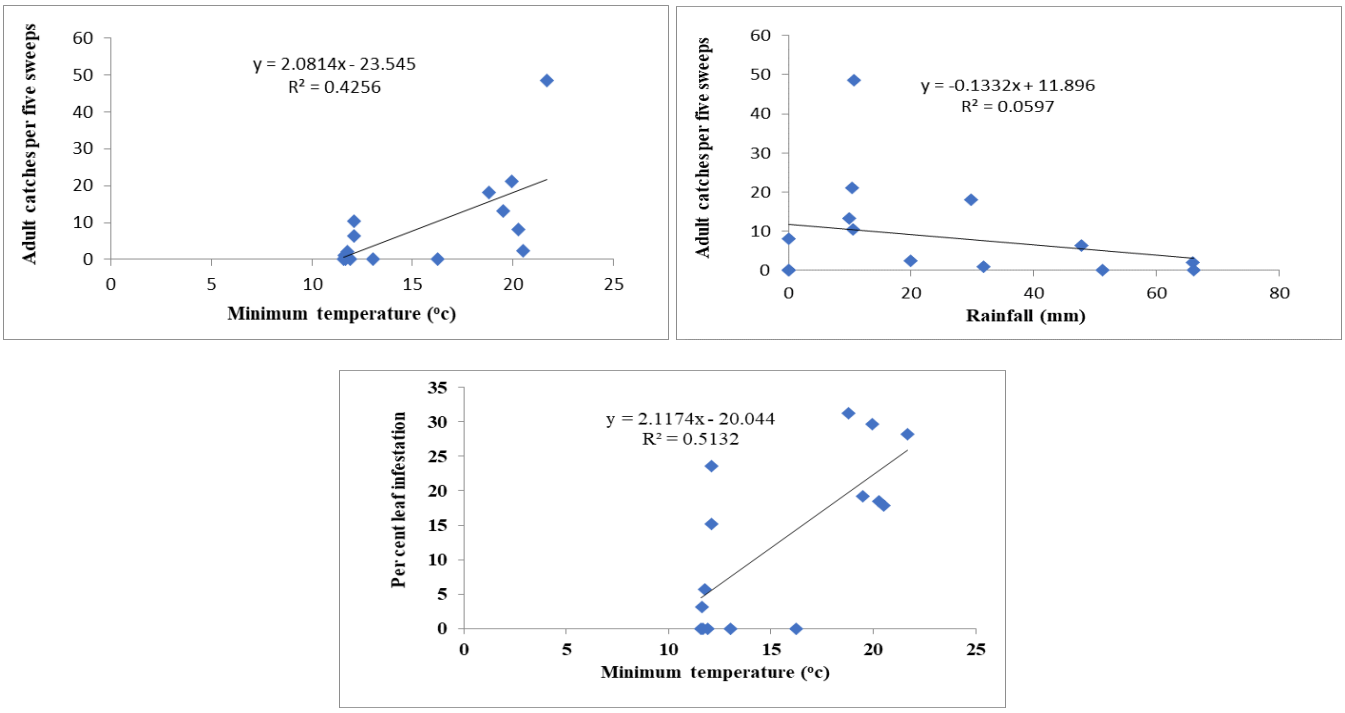

Fig 3: Linear regression analysis of various abiotic factors and population of rice whorl maggot by various methods

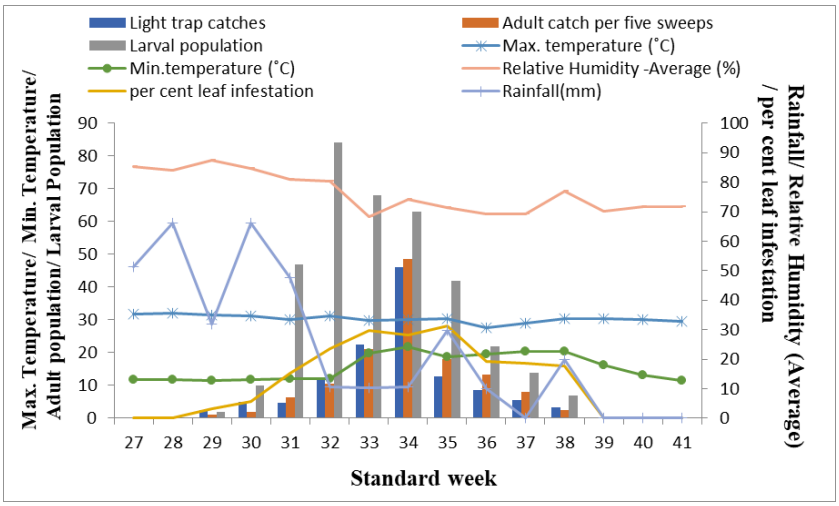

Fig 4: Seasonal Fluctuation of rice whorl maggot and weather Parameters

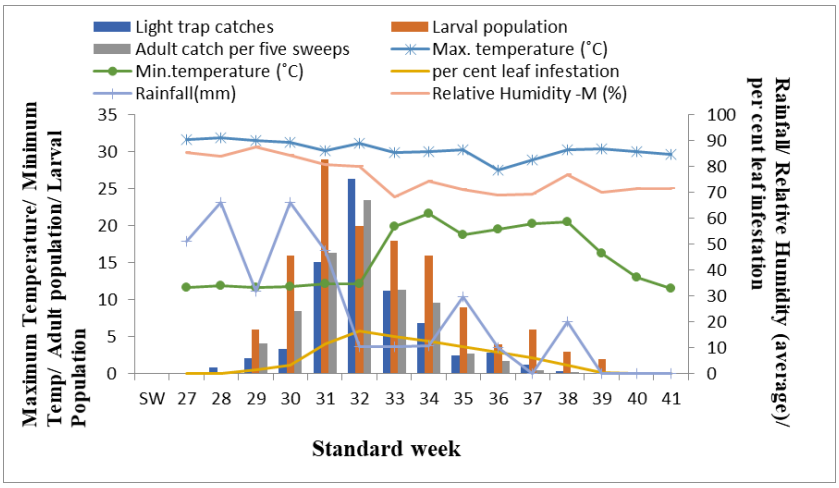

Fig 5: Seasonal fluctuation of rice caseworm and weather Parameters

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