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Impact of Abiotic and Biotic factors on population of sugarcane leaf hopper, *Pyrilla perpusilla* (Walk.) at Chhattisgarh

Bhupesh Joshi, VK Soni and DK Rana

Abstract
Impact of the various abiotic and biotic parameters on population of sugarcane leaf hopper, *Pyrilla perpusilla* (Walk.) was studied during 2016-17 and 2017-18 at Kawardha (Kabirdham) district of Chhattisgarh. On the basis of pooled mean various abiotic parameters *viz.* Maximum temperature, minimum temperature, relative humidity and sunshine hours and biotic parameters *viz.* egg parasitoid *Tetrastichus pyrillae* (Chrawford) and ento-pathogenic fungus, *Metarhizium anisopliae* (Metschn) were showed positive impact on the population of *Pyrilla* but in case of wind velocity and rainfall negative impact were shown. The *Pyrilla* population was reached maximum with 8.13 eggs, 28.16 nymphs and 5.17 adults leaf^{-1} at first fortnight of October. During this period, pooled two year mean maximum temperature, minimum temperature, relative humidity, rainfall, wind velocity and sunshine was 31.7^{0}C, 24.7^{0}C, 80.3%, 26mm, 2.0 Km hr^{-1} and 7.4 hr day^{-1} respectively. The maximum parasitization by *T. pyrillae* was noticed during second fortnight of December with 44.16 per cent and ento-pathogenic fungus *M. anisopliae* was high during the second fortnight of October with 11.37 per cent. In various abiotic weather parameters, the maximum temperature play significantly important role in the fluctuation the population of *P. perpusilla.*

Keywords: *Pyrilla perpusilla,* abiotic factors, biotic factors, *Tetrastichus pyrillae* and *Metarhizium anisopliae*

Introduction
Sugarcane is attacked by various insect pests, more than 200 species of insect and few species of non-insect pest have been recorded on the sugarcane in different part of country. Isaac (1937) [12] listed 79 species of insects infesting sugarcane and categorized 18 as major pests and 21 as minor pests which are important limiting factors for obtaining high yield of sugarcane. Sugarcane leaf hopper, *Pyrilla perpusilla* (Walk) (Hemiptera: Lophopidae) is one of the most serious pest widely distributed on wheat, barley, oats, maize, sorghum and numbers of grasses in many part of the country, often reaching epidemic levels in the subtropics (Gupta and Avasthi, 1957 [10]; Chaudhary and Sharma, 1990 [6]; Kumarasinghe, 1996 [13]; Rajak, 2007 [22]; Pandey *et al.,* 2008 [18], Patre *et al.,* 2017) [20]. Sugarcane is cultivated as one of the major cash crops in Kabirdham, Ambikapur and Balod district of Chhattisgarh where Kabirdham alone contributing area of 20,765 hectare with productivity of 82.3 tonnes ha^{-1} (Anonymous, 2017) [3]. Kabirdham is *Pyrilla* prone district of Chhattisgarh. In year 2014-15, the sugarcane crop was severely infested by *P. perpusilla* with an average 10-20 adult and 50-100 nymphs leaf $^{-1}$ in Kabirdham (Anonymous, 2015a) [2]. *P. perpusilla* causes indirect losses. The nymphs and adults cause heavy damage to the plant and excrete thick transparent liquid known as honey dew which is good medium for the growth of black mold. The mold reduces the photosynthetic activity of the leaves and reduces about 25% of the sugar yield. The cane juice becomes high in glucose and if it is used for making gur gives a soggy mass which does not solidify properly (Chaudhary and Ansari, 1988) [5]. An early infestation during the grand growth period of cane adversely affects the yield while the late-infestation from September onwards mostly affects the sucrose contents of cane (Puri and Siddharth, 2001) [21]. Different weather factors are quite important in regulating the insect populations. Gupta and Ahmed (1983) [9] found that temperature 29.4 °C and RH 75.84% are most suitable for proper growth and development of *Pyrilla*. Pest growth retards above 43 °C and below 9.4 °C. Rajak *et al.* (1987) [23] concluded that high humidity leads to low *Pyrilla* population but

Patil and Hapase (1992) [19] came to opposite conclusion. According to Ganehiarachchi and Fernando (2000) [8] *Pyrilla* abundance is negatively correlated with rainfall and humidity but positively with minimum temperature. They further concluded that egg parasitoid, predators and rainfall are the main factors responsible for fluctuating *P. perpusilla* population. For the adaptation of eco-friendly management practices in sugarcane, the first step is to know the pest population and their relationship with abiotic and biotic parameters. Hence, impact of abiotic and biotic factors on population of sugarcane leaf hopper, *Pyrilla perpusilla (*Walk.) was conducted during 2016-17 and 2017-18 at Kawardha (Kabirdham) district of Chhattisgarh.

Materials and Methods

Population of sugarcane leaf hopper, *Pyrilla perpusilla (*Walk.) and its natural enemies were recorded during the year 2016-17 and 2017-18 at Kabirdham districts of Chhattisgarh. The population of *P. perpusilla* (Walk.) was observed on three leaves *i.e*. top, middle and lower leaves on 10 randomly selected plants from each location. Number of egg mass, nymph and adult of *P. perpusilla* (Walk.) was recorded on each leaf of plant. At each location ten egg masses of sugarcane leaf hopper were collected at fifteen days interval than each egg mass was cut along with leaf 5 cm length. Each egg mass was kept inside the ½ kg transparent poly beg, afterwards emergence of parasitoid from the egg mass total number of eggs, parasitized egg and unparasitized eggs was counted with the help of binocular microscope. Percentage of egg parasitism of sugarcane leaf hopper was recorded by using the following formula as described by Mishkat and Khalid (2007) [15].

$$\text{Egg parasitism (\%)} = \frac{\text{Total no.of parasitized egg}}{\text{Total no.of eggs}} \times 100$$

For the study of parasitization by *M. anisopliae* on nymphs and adults of *P. perpusilla* (Walk.) thirty sugarcane leaves were randomly selected at fifteen days interval from each location. Percentage parasitism by *M. anisopliae* on sugarcane leaf hopper was carried out by using the following formula.

$$\text{Percent parasitization (\%)} = \frac{\text{No. of parasitized nymph and adult}}{\text{Total no.of nymph and adult}} \times 100$$

The data on various abiotic factors (weather parameters) were recorded daily from meteorological observatory of S.K. College of Agriculture and Research Station, Kabirdham from the occurrence to disappearance of leaf hopper. The population of leaf hopper was correlated with recorded temperature, rainfall, relative humidity, sunshine hours and wind velocity.

Results and Discussion

Various abiotic and biotic parameters were recorded along with *Pyrilla* population during 2016-17 and 2017-18 at Kawardha district Kabirdham Chhattisgarh. Population of sugarcane leaf hopper, *Pyrilla perpusilla* (Walk.) on sugarcane crop revealed that the occurrence of *P. perpusilla* commenced from second fortnight of July, increasing till second fortnight of October and then falls down from November to January. Results revealed that during the year 2016-17 and 2017-18, the population of sugarcane leaf hopper, *P. perpusilla* (Walk.) was first occurred second fortnight of July with 1.63 and 0.64 eggs, 0.07 and 0.04 nymphs and 0.04 and 0.05 adults leaf^{-1}, at this time maximum temperature, minimum temperature, relative humidity, rainfall, wind velocity and sunshine was 31.0 and 30.5 ^{0}C, 24.5 and 25.6 ^{0}C, 85.7 and 81.3%, 140.2 and 103.4mm, 2.4 and 4.7 Km hr^{-1} and 2.8 and 2.8 hr day^{-1} and gradually decreased first fortnight of January with 1.42 and 0.84 eggs, 0.80 and 0.47 nymphs and 0.32 and 0.24 adults leaf^{-1} at this time maximum temperature, minimum temperature, relative humidity, rainfall, wind velocity and sunshine was 26.9 and 25.3 ^{0}C, 12.6 and 11.3^{0}C, 62.1 and 65.7%, 0.0 and 0.0mm, 1.9 and 1.5 Km hr^{-1} and 6.1 and 6.2 hr day^{-1}, respectively. On the basis of pooled mean the *Pyrilla* population was first appeared in first fortnight of July with 1.14 eggs, 0.06 nymphs and 0.05 adults leaf^{-1} and gradually increasing and reached maximum with 8.13 eggs, 28.16 nymphs and 5.17 adults leaf^{-1} at first fortnight of October. The present findings are in agreement with Hugar *et al.* (2002) [11] who noticed the egg and nymphal incidence of the leaf hopper from June to December; while the adult activity was observed throughout the year. Rana *et al.* (2002) [24] observed *Pyrilla* first appeared in March, April and May. Peak population of *Pyrilla* was recorded during August.

The egg parasitoid, *T. pyrillae* was first appeared in first fortnight of August and gradually increasing trend of parasitization second fortnight of December. The population was disappeared at first fortnight of January. The maximum parasitization was noticed during second fortnight of December with 43.12 and 45.19 per cent during the year 2016-17 and 2017-18, respectively. Similar trend of result was obtained by Miah *et al.* (1986) [14] who studied the alternative food and natural enemies of the sugarcane pest *Pyrilla perpusilla.* These results indicated that *P. perpusilla* could survive in areas of sugarcane plantation. *Tetrastichus pyrillae* was identified as the egg parasite. Yadav and Choudhary (1987) [27] reported that the *Tetrastichus pyrillae* was egg parasitoid of sugarcane leaf hopper, *Pyrilla perpusilla*

Green muscardine fungus, *M. anisopliae* an ento-pathogenic fungus on nymphs and adults of sugarcane leaf hopper, *P. perpusilla* under field condition on sugarcane crop revealed that the parasitization was first appeared with 9.50 per cent parasitization in first fortnight of September and gradually increasing and reached maximum parasitization 11.63 per at first fortnight of October during the year 2016-17 but second year 2017-18 the *M. anisopliae* was first appeared with 4.16 per cent parasitization in first fortnight of October and gradually increasing and reached maximum parasitization 16.31 per cent at second fortnight of October (Table-2). Similar finding were found by Oblisami *et al.* (1969) [17] who isolated *M. anisopliae* from *P. perpusilla* proved pathogenic to another species of Pyrilla. Varma *et al.* (1977) [26] observed nymphal mortality caused by fungi in August-November. A comparative symptom of infection by *M. anisopliae* was seen on *Pyrilla*. Asre *et al.* (1983) [4] reported that the effectiveness of natural enemies for the control of *P. perpusilla* on sugarcane. The entomopathogenic fungi *M. anisopliae* was caused septicemia on *Pyrilla*. Varma and Singh (1987) [25] used *M. anisopliae* as microbial pesticide against leafhopper.

On the basis of pooled mean various abiotic parameters *viz.* Maximum temperature, minimum temperature, relative humidity and sunshine hours and biotic parameters *viz.* egg parasitoid *T. pyrillae* and ento-pathogenic fungus *M. anisopliae* were showed positive impact on the egg (0.69, 0.43, 0.27, 0.21 and 0.12), nymph (0.56, 0.29, 0.12, 0.33 and 0.75) and adult (0.56, 0.31, 0.16, 0.26 and 0.70) population of *Pyrilla* but in case of wind velocity (-0.32, -0.45 and -0.43)

and rainfall (-0.04 and -0.03) negative impact were shown. The *Pyrilla* population were reached maximum with 8.13 eggs, 28.16 nymphs and 5.17 adults leaf^{-1} at first fortnight of October. During this period, pooled two year mean maximum temperature, minimum temperature, relative humidity, rainfall, wind velocity and sunshine was 31.7 ^{0}C, 24.7 ^{0}C, 80.3%, 26mm, 2.0 Km hr^{-1} and 7.4 hr day^{-1}**,** respectively. It's evident that when the relative humidity was increased the population was also gradually increased *i.e.* relative humidity play significantly important role in the fluctuation of *P. perpusilla* population. Mishra (2005) [16] reported that *Pyrilla* is more active in the humid area and during summer bring down the population. More or less similar findings were obtained by Akhtar *et al.* (2014) [1] reported that maximum population of *P. perpusilla* during the second fortnight of September and more variation in *P. perpusilla* population by temperature rather than relative humidity. Choudhary *et al.* (2015) [7] reported the *Pyrilla* infestation initiated in last week of June. The peak activity (14-20 individuals/leaf) was observed from second last week of August to 1st week of September. The relative humidity of morning and evening, total rain fall were positive influence on *Pyrilla* field population.

Table 1: Meteorological parameters at the pest infestation period

SMW*	Date	Rain fall (mm)			Temperature^{0} C						Relative Humidity (%)			Wind Velocity (Km hr^{-1})			Sunshine (hr day^{-1})		
					Max.			Min.											
		2016-17	2017-18	Pooled (mean)	2016-17	2017-18	Pooled (mean)	2016-17	2017-18	Pooled (mean)	2016-17	2017-18	Pooled (mean)	2016-17	2017-18	Pooled (mean)	2016-17	2017-18	Pooled (mean)
30-31	July 30	140.2	103.4	121.8	**31.0**	**30.5**	**30.8**	24.5	25.6	25.1	85.7	81.3	83.5	2.4	4.7	3.6	2.8	2.8	2.8
32-33	August 15	63.4	29.3	46.4	29.5	31.5	30.5	24.1	25.6	24.9	84.8	78.3	81.6	4.6	3.7	4.2	1.6	2.5	2.1
34-35	August 30	52.3	104.9	78.6	31.9	32.1	32.0	24.5	25.5	25.0	81.4	83.4	82.4	2.7	3.1	2.9	2.2	4.1	3.2
36-37	September 15	28.8	68.9	48.9	30.9	33.5	32.2	23.1	24.9	24.0	78.3	84.6	81.5	3.2	1.6	2.4	1.9	4.5	3.2
38-39	September 30	182.6	71.5	127.1	31.3	32.8	32.1	25.8	24.9	25.4	87.4	80.9	84.2	2.7	2.1	2.4	3.8	4.2	4.0
40-41	October 15	14.0	38.0	26.0	30.9	32.5	31.7	25.3	24.1	24.7	78.3	82.3	80.3	2.1	1.9	2.0	6.5	8.3	7.4
42-43	October 30	0.0	0.0	0.0	31.8	33.6	32.7	19.8	22.1	20.9	64.1	68.4	66.3	1.8	1.8	1.8	9.2	8.5	8.9
44-45	November 15	0.0	27.0	13.5	29.4	28.8	29.1	17.3	14.5	15.9	40.4	69.7	55.1	1.9	1.9	1.9	8.6	7.3	8.0
46-47	November 30	0.0	0.0	0.0	29.8	28.2	29.0	16.1	14.3	15.2	36.7	64.6	50.7	1.8	2.0	1.9	9.1	8.3	8.7
48-49	December 15	0.0	0.0	0.0	28.4	26.4	27.4	15.7	12.3	14.0	45.9	54.2	50.1	1.6	2.2	1.9	8.2	7.6	7.9
50-51	December 30	0.0	0.0	0.0	27.8	24.3	26.0	11.5	10.1	10.8	50.9	45.8	48.4	2.0	1.6	1.8	9.1	9.2	9.2
52-01	January 15	0.0	0.0	0.0	26.9	25.3	26.1	12.6	11.3	12.0	62.1	65.7	63.9	1.9	1.5	1.7	6.1	6.2	6.2

*Source- Meteorological observatory, S. K. College of Agriculture & Research Station, Kawardha

Table 2: *Pyrilla perpusilla* population and its natural enemies at Kabirdham

Date	Eggs Leaf^{-1}			Nymphs leaf^{-1}			Adults leaf^{-1}			Percentage parasitization					
										Egg-parasitoid, *Tetrastichus pyrillae*			Ento-pathogenic fungus, *Metarhizium anisopliae*		
	2016-17	2017-18	Pooled (Mean)	2016-17	2017-18	Pooled (Mean)	2016-17	2017-18	Pooled (Mean)	2016-17	2017-18	Pooled (Mean)	2016-17	2017-18	Pooled (Mean)
30-Jul	1.63	0.64	1.14	0.07	0.04	0.06	0.04	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00
15-Aug	2.16	2.30	2.23	0.21	0.57	0.39	0.08	0.23	0.16	0.00	0.00	0.00	0.00	0.00	0.00
30-Aug	3.40	3.91	3.66	4.18	5.56	4.87	1.04	1.15	1.10	3.27	0.00	1.64	0.00	0.00	0.00
15-Sep	6.21	4.52	5.37	21.87	13.56	17.72	4.34	3.13	3.74	15.87	0.00	7.94	9.50	0.00	4.75
30-Sep	8.48	5.63	7.06	31.27	14.84	23.06	5.93	4.23	5.08	18.86	4.13	11.50	3.60	0.00	1.80
15-Oct	9.44	6.82	8.13	28.59	27.72	28.16	4.39	5.94	5.17	18.49	19.99	19.24	11.63	4.16	7.90
30-Oct	6.83	9.24	8.04	25.34	22.46	23.90	4.08	4.42	4.25	21.31	26.43	23.87	6.42	16.31	11.37
15-Nov	4.72	4.37	4.55	21.02	12.26	16.64	2.68	3.44	3.06	17.16	30.34	23.75	0.00	0.00	0.00
30-Nov	4.83	2.60	3.72	16.40	9.67	13.04	2.31	2.19	2.25	31.35	34.15	32.75	0.00	0.00	0.00
15-Dec	3.35	1.76	2.56	7.77	7.91	7.84	1.74	1.67	1.71	38.07	44.24	41.16	0.00	0.00	0.00
30-Dec	3.01	1.21	2.11	4.17	2.79	3.48	1.06	0.87	0.97	43.12	45.19	44.16	0.00	0.00	0.00
15-Jan	1.42	0.84	1.13	0.80	0.47	0.64	0.32	0.24	0.28	0.00	0.00	0.00	0.00	0.00	0.00

Table 3: Correlation of *Pyrilla perpusilla population* with weather parameters & natural enemies

Weather parameter	Eggs Leaf^{-1}			Nymphs leaf^{-1}			Adults leaf^{-1}		
	2016-17	2017-18	Polled Mean	2016-17	2017-18	Polled Mean	2016-17	2017-18	Polled Mean
Rain fall (mm)	0.10	0.01	0.04	0.06	-0.09	-0.04	0.16	-0.06	-0.03
Maximum Temperature (^{0}C)	0.55	0.72**	0.69*	0.50	0.56	0.56	0.50	0.54	0.56
Minimum Temperature (^{0}C)	0.43	0.43	0.43	0.32	0.26	0.29	0.35	0.25	0.31
Relative humidity (%)	0.16	0.36	0.27	0.01	0.25	0.12	0.12	0.27	0.16
Wind velocity (km/h)	-0.12	-0.34	-0.32	-0.21	-0.47	-0.45	-0.14	-0.50	-0.43
Sunshine hours (hours)	0.14	0.25	0.21	0.23	0.45	0.33	0.12	0.41	0.26
Tetrastichus pyrillae	0.28	0.02	0.12	-	-	-	-	-	-
Metarhizium anisopliae	-	-	-	0.61*	0.71*	0.75**	0.73**	0.49	0.70*

*: Significant (5%)

**: Highly significant (1%)

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