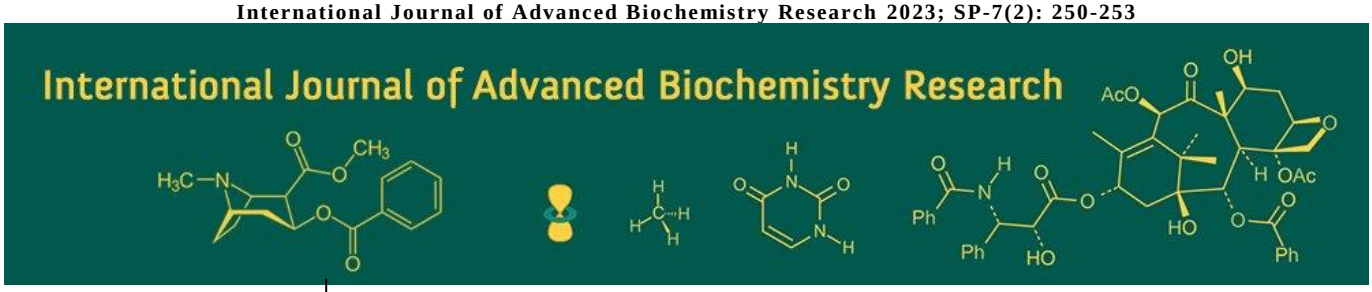

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Seasonal incidence and correlation studies between the rice whorl maggot (*Hydrellia philippina* F.) and weather parameters under Bastar Plateau conditions

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Abstract
For the assessment of the seasonal behavior of the whorl maggot of rice, an experiment was performed at research cum instructional farm of Shaheed Gundadhoor College of Agriculture and Research Station, Jagdalpur, Bastar (C.G.) during *Kharif* 2022. The whorl maggot (*Hydrellia philippina* F.) was active throughout the season in the rice habitat. The 34th SMW (month of August) had the highest levels of leaf damage (29.55%) caused by whorl maggots. According to research on the association between abiotic parameters and whorl maggot, a highly significant positive correlation with the minimum temperature (r = 0.756**) and a significant positive correlation with relative humidity-II (r = 0.576*) was observed.

Keywords: Seasonal incidence, correlation, weather parameters, whorl maggot, rice

Introduction
Rice (*Oryza sativa* L.) is an important staple food for nearly 50% of the global population (Heinrichs *et al*., 2017) [6]. India is the second largest producer and consumer of rice in the world, accounting for 20% of world rice production. During the years 2021-22, rice was grown in India over an area of 45.07 million hectares, with a production volume of 127.93 million tonnes and a productivity of approximately 2713 kg ha^{-1}. It was 11.49 million tonnes more than the 116.44 million tonnes average production over the previous five years. (Anonymous, 2022) [1].

Despite numerous pests attacking the rice crop in the field, only a few of them are capable of causing significant financial losses (Heinrichs *et al*., 2017) [6]. In tropical Asia, yield losses from rice pests are anticipated to range between 25 to 43% (Savary *et al*., 2012) [9]. In India, insect-pest infestations in rice result in roughly 25% of the crop's overall losses, being valued at Indian Rupees (INR) of 2, 40, 138 million (US$ 3290 million) (Dhaliwal *et al*., 2010) [3].

Insect pests, diseases, and other biotic stressors are the primary threats generating a yield loss of roughly 30% out of a variety of factors resulting in low production. Furthermore, the issue has already gotten worse due to the cultivation of high yielding rice cultivars with heavy nitrogen fertilizer use. An aggregate of 100 insect pests, 20 of which are important pests with varying degrees of yield loss depending on the agroclimatic conditions, have been recorded to attack the rice crop at various stages of crop growth under different seasons. (Cramer, 1967; Pathak and Dhaliwal, 1981; Kumar *et al*., 2015) [3]

Whorl maggot is one of the most prevalent insect-pest of rice in the Bastar region. Although modest damage can be evident in later growth phases, it typically damages rice plants during the vegetative phase, leading to necrosis of leaf edges, a distinctive damage symptom. Because it feeds on developing leaves that emerge from the shoot apical meristem at the base of each leaf sheath (whorl), this pest is also known as the "rice whorl maggot." Damage from rice whorl maggots lowers the photosynthetic surface and obstructs the flow of nutrients and water via the vascular tissue (Litsinger *et al*., 2013) [8].

In this article, correlation studies between the whorl maggot incidences and weather parameters were observed, by which the behavior of the pest throughout the season and its response against various weather parameters could be analyzed.

Materials and Method

The experiment was conducted in research cum instructional farm of Shaheed Gundadhoor College of Agriculture and Research Station, Jagdalpur, Bastar (C.G.) during *Kharif*, 2022 in the Swarna variety of rice. The crop was transplanted one month after the sowing in the spacing of 20 × 15 cm and all necessary agronomical operations were performed.

For the identification of the damage caused by the pest, following symptoms were observed:

- White patches along margin of one side of leaf towards the tip with holes and is referred as marginal blotching.
- Damaged leaves easily break and hang down near tip; Clear or yellow spots on inner margins of emerging leaves.
- Damage becomes visible when the leaves emerge from the whorl as pinholes and white and yellowish lesions on the leaf edge.

The incidence percentage of rice whorl maggot was observed by counting the total number of infested leaves and healthy leaves from 10 randomly selected hills. The per cent damage was calculated by using following formula:

$$\text{Per cent damage} = \frac{\text{Number of damaged leaves}}{\text{Total numbers of leaves}} \times 100$$

Correlation coefficient:

Statically the seasonal incidence of pest with weather parameters was correlated on the basis of the following formula by Draper and Smith (1998) [11].

$$r = \frac{Cov\,(X,Y)}{\sigma x \times \sigma y} = \frac{\sum_{i=1}^{n}(X-\bar{X}).(Y-\bar{Y})}{\sqrt{\sum_{i=1}^{n}(X-\bar{X})^2} * \sqrt{\sum_{i=1}^{n}(Y-\bar{Y})^2}}$$

Where

X = Mean of first factor

Y = Mean of second factors

n = Total number of observations

r = Correlation coefficient

Results and discussion

In the present investigation, whorl maggot damage symptoms appeared during the initiation of observation. The peak leaf damage (29.55%) was recorded during third week of August (34th SMW). After that, damage by whorl maggot gradually decreased and reached 0.30 per cent during 44th SMW (*i.e.*, 29th Oct. - 4th Nov.). The whorl maggot ranged from 0.30 to 29.55 per cent during crop growth stage. (Table 1, Fig 1).

Previous researchers, Dumra and Srivastava (2019) [5] reported that the whorl maggot reached peak during 3rd week of August (34th SMW) with 29.65 per cent. Similarly, Kalita *et al.* (2020) [7] found that the whorl maggot, being the pest of vegetative stage recorded as high as 9.87% damaged leaves/hill during 34th SMW.

For the correlation studies, seasonal population of rice whorl maggot was observed on weekly basis and the mean weekly population was evaluated with the weekly meteorological data of weather parameters at SGCARS, Jagdalpur, Bastar. The result of the correlation analysis (Table 2 and Fig. 1) made between whorl maggot damage per cent and weather parameters revealed that the whorl maggot showed highly significant positive correlation with minimum temperature (r = 0.756**), significant positive correlation with relative humidity - II (r = 0.576*), while positively nonsignificant correlation with maximum temperature (r = 0.333), relative humidity - I (r = 0.072) and rainfall (r = 0.387).

The present studies are in accordance with Singh *et al.* (2018) [10], who revealed that the rice whorl maggot was in positively non-significant correlation with the minimum temperature (0.275), maximum temperature (0.066), relative humidity (0.438) and rainfall (0.152).

Similarly, Kalita *et al.* (2020) [7] revealed that the whorl maggot population was found to be highly significant positively correlated with maximum temperature (0.631**) and minimum temperature (0.639**), while highly significant negatively correlated with relative humidity - I (-0.727**). Significant positively correlated with rainfall (0.429*). However, relative humidity - II (0.354) is non-significant positively correlated.

Table 1: The incidence of rice whorl maggot and it's relation with weather parameters during *Kharif* 2022

SMW	Date and months	Whorl Maggot Damaged leaf%	Max. Temp. (℃)	Min. Temp. (℃)	Relative Humidity - I (%)	Relative humidity - II (%)	Rainfall (mm)
33	13 Aug -19 Aug	23.54	28.14	21.70	94.57	82.71	216.40
34	20 Aug -26 Aug	29.55	30.13	21.92	90.50	67.00	35.60
35	27 Aug-2 Sep	28.09	32.41	22.09	88.14	58.14	47.10
36	3 Sep -9 Sep	20.14	31.27	22.33	93.14	72.29	35.30
37	10 Sep -16 Sep	11.78	28.67	21.96	93.00	74.00	219.20
38	17 Sep -23 Sep	16.33	28.29	21.17	91.86	77.71	69.50
39	24 Sep -30 Sep	15.54	30.61	21.36	92.86	66.14	117.80
40	1 Oct -7 Oct	8.82	29.16	21.23	93.43	74.14	4.10
41	8 Oct -14 Oct	6.13	29.89	20.76	93.71	71.00	64.50
42	15 Oct -21 Oct	3.52	30.63	20.19	94.86	60.14	20.20
43	22 Oct -28 Oct	1.39	29.30	15.27	87.57	44.43	0.00
44	29 Oct-4 Nov	0.30	28.66	15.60	87.14	46.14	0.00
45	5 Nov - 11 Nov	0.00	29.69	13.40	91.71	37.14	0.00
Seasonal mean		11.80	29.89	19.77	91.49	62.36	
Total							829.70

*SMW = Standard meteorological week, Aug. – August, Sept. – September, Oct. – October, Nov. - November

Table 2: Influence of abiotic factors on the activity of rice whorl maggot at Jagdalpur

Weather parameters (as independent factors)	Correlation 'r' value of Whorl Maggot Damage (Damaged leaf) as dependent factor
Maximum Temperature (°C)	0.333
Minimum Temperature (°C)	0.756**
Relative humidity - I	0.072
Relative humidity - II	0.576*
Rainfall	0.387

* Significant at 5% level of significance
** Significant at 1% level of significance

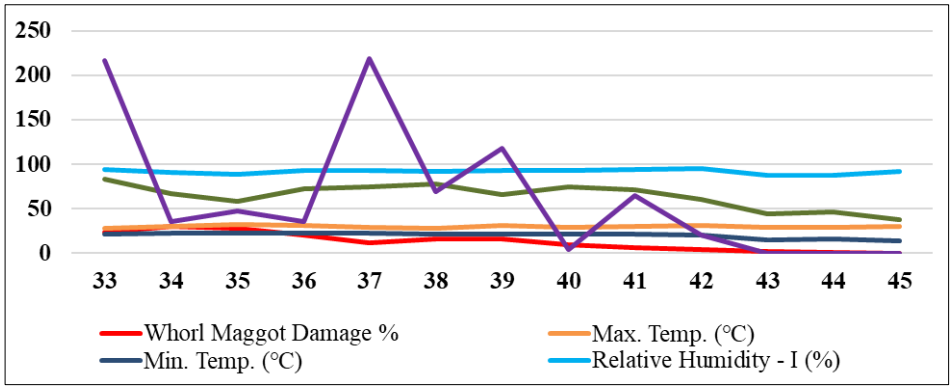

Fig 1: Graphical representation of whorl maggot population and various weather parameters at SGCARS Jagdalpur in *Kharif* 2022

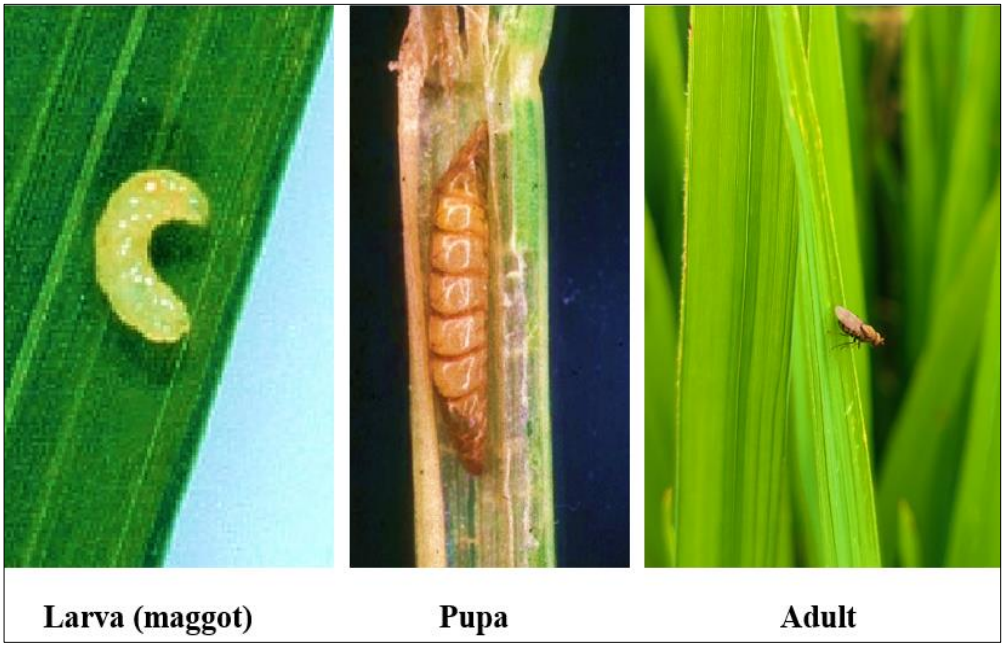

Fig 2: Various stages of whorl maggot life cycle

Fig 3: Damage symptoms caused by the whorl maggot in the rice crop

Conclusion

The rice whorl maggot was active throughout the season in rice ecosystem. The peak leaf damage per cent by whorl maggot was observed in 34th Standard meteorological week (month of August) with 29.55%. Studies on relationship between whorl maggot showed highly significant positive correlation with minimum temperature (r = 0.756**) and significant positive correlation with relative humidity - II (r = 0.576*).

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