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Studies on seasonal incidence of whorl maggot and other major insect pests of rice

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Abstract
Studies were conducted to record the seasonal incidence of whorl maggot and other major pests of rice at College farm, College of Agriculture, Rajendranagar, Hyderabad during late *rabi* 2020-21. The seasonal incidence of whorl maggot was noticed from7thstandard week (3rd week of February) and reached its peak activity during 10th SW (2nd week of March). The incidence of yellow stem borer was noticed during 7th SW and reached itspeak during 9th standard week and the highest per cent 27.59% of white ears were recorded during 14th SW (1st week of April). The initial 15 days of vegetative stage after transplantation the incidence of leaf folder was not observed. From 8th SW (21 DAT) the incidence of leaf folder larvae was observed. The incidence of leaf folder was highest during 11th SW (11.44%). The correlation studies revealed that per cent leaf damage by whorl maggot showed negative significant correlation with minimum temperature (r = -0.653*), RH-II (r = -0.849**). Whereas minimum temperature (r = 0.821**) showed significant positive correlation with the incidence of yellow stem borer. Furtherin case of leaf folder incidence, RH-II (r = -0.693*) showed significant negative correlation.

Keywords: seasonal incidence, rice, whorl maggot, yellow stem borer, leaf folder

Introduction
Rice is the most widely consumed food for a large part of the world's human population. It is the staple food crop of Asia and many developing countries feeding approximately more than two billion people (Food and Agricultural Organization, 1995) [4]. Rice occupies an area of about 162.06 million hectares with a total production of 495.78 million metric tonnes globally (Statista.com, 2019/20). India is the second largest producer occupying an area of 43.66 million hectares of total cropped area with an annual production of 118.87 million metric tonnes with a productivity of 2722 kg ha-1. Telangana state occupies an area of 1.631 million hectares with a production of 5.984 million tons with productivity of 3287 kg ha-1(Indiastat.com, 2019-20).
The rice whorl maggot (RWM) *Hydrellia philippina* Ferino, was first reported on rice in Khon Kaen, Thailand during 1961 by Somporn Patanakamjorn (Patanakamjorn, 1964) [10]. In India it was first reported on rice and seven other graminaceous weeds growing in rice fields as hosts of *H. philippina* (Ferino, 1968) [3]. It is distributed throughout South and Southeast Asia. Rice whorl maggot damages rice plants primarily during the vegetative phase, although minor damage can be seen in later growth stages. It is a pest of only irrigated rice because the flies do not oviposit on plants growing under dry land conditions.
Rice whorl maggot damage not only reduces photosynthetic area and also causes necrosis of leaf margins which is a unique damage symptom and reported upto a significant yield loss of 41 per cent from untreated plot (Ferino, 1968) [3]. In recent times, due to conducive environment whorl maggot is causing severe damage in all rice growing areas of Telangana. Available information on seasonal incidence of whorl maggot is very little scattered and scanty. Due to wide range of distribution, there is a need to figure out information on seasonal incidence and influence of weather factors on the whorl maggot in rice.
Considering the above facts, the present study was formulated to record the seasonal incidence and influence of weather factors on rice whorl maggot was done during *rabi* 2020-21.

Materials and Methods
Experimental site
The experiment was conducted at College farm, College of Agriculture, Rajendranagar, Hyderabad. This area comes under Southern Agro-Climatic Zone of Telangana.
The experimental site was situated at an altitude of 542.6 m above mean sea level with latitude

of 17˚ 19′ N and longitude of 78˚ 23′ E and it falls under semi-arid tropical climate.

Material used
A high yielding paddy variety, RNR 15048 (Telangana Sona) was used in the present investigation.

Raising of the nursery
Nursery was raised in College farm, College of Agriculture, Rajendranagar, Hyderabad during December 2020 and followed all package of practices like manures, fertilizer application and irrigation as per the schedule in the nursery stage.

Raising of bulk plot
A plot of 100 m^2 was transplanted by the seedlings at a spacing of 20 cm X 10 cm and recommended agronomic practices were followed. The bunds were carefully monitored for the presence of any type of grass or weed, which serves as alternate hosts.

Recording of data
Observations were recorded starting from the transplanting stage to till harvesting of the crop at weekly intervals for the seasonal incidence of whorl maggot and other major pests *viz.*, yellow stem borer and leaf folder.

Whorl maggot
To record the seasonal incidence, the entire 100 m^2field was divided into 10 equal quadrants and each quadrant was considered as a replication. In each replication, a quadrant of 1m X 1m was used for recording observation by counting the total number of plants with in quadrant and number of plants affected with whorl maggot and data obtained was analysed as per the statistical procedures of quadrant analysis. The observations were recorded as per the standard weeks and the incidence of whorl maggot was correlated with abiotic factors such as average max. tem, average min. tem, RH-I (7AM), RH-II (2PM) and rainfall.

$$\text{Per cent leaf damage} = \frac{\text{Number of leaves damaged}}{\text{Total number of leaves/hill}} \text{ X } 100$$

Yellow stem borer
The observations on yellow stem borer damage was recorded on ten randomly selected hills/ replication or quadrant. While recording, the per cent dead heart/white ear was recorded by counting number of dead hearts during vegetative stage and number of white ear heads in reproductive stage, at weekly intervals and continued upto harvesting of the crop. Per cent incidence was calculated by using the formula,

$$\text{Per cent dead heart} = \frac{\text{Number of dead hearts}}{\text{Total number of tillers}} \text{ X } 100$$

$$\text{Per cent white ear} = \frac{\text{Number of white ear heads}}{\text{Total number of productive ear heads}} \text{ X } 100$$

Leaf folder
In each quadrant or replication 10 hills were selected randomly to record data. While recording, the per cent leaf damage was recorded by counting the total number of leaves and infested leaves per hill at weekly intervals and this was continued upto harvesting of the crop. Per cent incidence was calculated by using the formula,

$$\text{Per cent damage} = \frac{\text{Number of infested leaves}}{\text{Total number of leaves}} \text{ X } 100$$

Results and Discussions
Seasonal incidence and correlation studies
1. whorl maggot
The first observation recorded in 7th SW (3rd week of February) was 4.79 per cent damage per quadrant. Then, the per cent damage was gradually increased and reached its peak during 10th SW (2nd week of March) 27.88 per cent damage per quadrant. Afterwards from the 11th SW to 16th SW the whorl maggot infestation was followed decreasing trend except at 14th SW (Table 1).
The correlation studies revealed that per cent leaf damage by whorl maggot showed negative significant correlation with minimum temperature (r = -0.653*) and RH-II (r = -0.849**). Whereas maximum temperature showed non-significant positive correlation and RH-I, rainfall showed non-significant negative correlation (Table 2). Regression studies indicates that minimum temperature & RH-II contribute the incidence of whorl maggot and showed that all the weather parameters together contribute for 89 per cent **(**R^2=0.89**)** of variation in whorl maggot population (Table 3).

Table 1: Seasonal incidence of whorl maggot, yellow stem borer and leaf folder

Month	SW	Per cent damage per quadrant	Per cent damage per 10 hills	
		Whorl Maggot	Yellow Stem Borer	Leaf Folder
February	7	4.79	5.00	0.00
	8	11.05	8.98	2.96
March	9	20.58	11.38	3.42
	10	27.88	8.53	6.76
	11	17.86	10.73	11.44
	12	7.94	12.54	2.90
	13	7.65	10.58	1.56
April	14	9.16	27.59	2.96
	15	3.11	21.05	2.15
	16	2.50	14.67	0.85

SW= Standard Week,

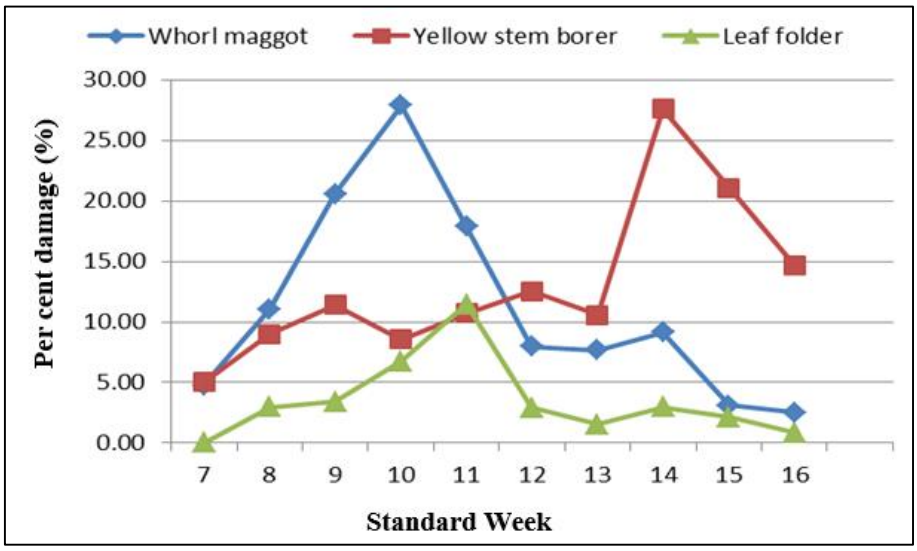

Fig 1: Seasonal incidence of whorl maggot, yellow stem borer and leaf folder

Table 2: Correlation coefficient (r) between abiotic factors and per cent incidence of whorl maggot, yellow stem borer and leaf folder.

Factor	Correlation (r)		
	Whorl Maggot	Yellow Stem Borer	Leaf Folder
Maximum temperature (°C)	0.027	0.546	0.142
Minimum temperature (°C)	-0.653*	0.821**	-0.301
RH-I	-0.058	0.169	-0.080
RH-II	-0.849**	0.425	-0.693*
Rainfall (mm)	-0.355	0.408	-0.156

* = significant at 5% level ** = significant at 1% level

Table 3: Regression equation between abiotic factors and per cent incidence of whorl maggot, yellow stem borer and leaf folder.

Factor	Regression equations	R^2
WM	$Y = -43.28 + 1.68X_1 - 1.77X_2 + 0.55X_3 - 0.44X_4 + 0.14X_5$	0.89
YSB	$Y = -74.69 + 1.08X_1 + 1.30X_2 + 0.30X_3 + 0.01X_4 + 0.92X_5$	0.75
LF	$Y = 5.69 - 0.16X_1 + 0.31X_2 + 0.11X_3 - 0.29X_4 + 1.24X_5$	0.58

Where,
X_1 = Maximum temperature X_2 = Minimum temperature
X_3 = Morning relative humidity X_4 = Afternoon relative humidity
X_5 = Rainfall

2. Yellow stem borer

The per cent dead heart formation was gradually increased from 7th SW (5.00 per cent) to 9thSW (11.38 per cent) and then followed declining trend. The dead heart damage was highest during 9th SW (at 28 DAT) with 11.38 per cent damage per 10 hills at vegetative phase. The lowest per cent (10.58%) of white ears was recorded during 13th SW and the highest per cent (27.59%) of white ears was recorded during 14th SW (Table 1).

The correlation studies revealed that the minimum temperature showed significant positive correlation with the incidence of yellow stem borer (r = 0.821**). While the other weather parameters like maximum temperature (r = 0.546), RH-I (r = 0.169), RH-II (r = 0.425) and rainfall (r = 0.408) showed non-significant positive correlation with incidence of yellow stem borer (Table 2). Regression analysis indicated that minimum temperature will definitely influence the YSB incidence. All weather parameters contributes 75% variation in YSB population (Table 3).

3. Leaf folder

The per cent damage was almost constant throughout the crop period. However highest leaf damage was noticed 11.44 per cent recorded during 11th SW. Later, the damage was suddenly decreased to 2.90 per cent during 12th SW (4th week of March) (Table 1). Thereafter, the level of leaf damage was slightly decreased and recorded only 0.85 per cent damage level at the time of maturity stage of the crop.

The correlation studies revealed that leaf folder incidence showed negative correlation with all the weather parameters except maximum temperature. RH-II (r = -0.693*) showed significant negative correlation with incidence of leaf folder, While minimum temperature, RH-I and rainfall showed non-significant negative correlation (Table 2). Regression analysis indicates that RH-II will greatly influence the incidence of leaf folder and indicated that all the weather parameters combinedly contribute for 58 per cent **(**R^2=0.58**)** of variation in leaf folder population (Table 3).

The present study on seasonal incidence indicates that whorl maggot showed peak activity during 2nd week of March (10th SW), stem borer reached peak during 9th SW(dead heart) and 14th SW(white ear) and leaf folder recorded its maximum activity during 11th SW. Correlation studies indicated that whorl maggot incidence having significant negative correlation with minimum temperature and afternoon relative humidity, similarly YSB incidence having highly significant positive correlation with minimum temperature and leaf folder showed significant negative correlation with afternoon

RH (r = -0.693*) for the incidence. Weather parameters will contribute and influence the incidence of the pests.

The present results were in accordance with the earlier reports of Saroja and Raju (1983) [12], who reported that October, December and January transplanted rice showed highest incidence (>20%) of whorl maggot. Chattopadhyay *et al.* (2003), they reported that the incidence of yellow stem borer was highest during the 14th SW (2-8 April) indicating high temperature favours the pest incidence. Ali *et al.* (2019) reported that due to increased temperature in the month of March and April leads to increase in the population of leaf folder. Dumra and Srivastava (2019) [2], who were reported afternoon relative humidity showed significant effect on incidence and the minimum temperature (r = 0.716*) showed significant positive correlation with whorl maggot incidence. Misra *et al.* (2005) [8] reported that relative humidity and rainfall were showed non-significant positive correlation with the seasonal incidence of yellow stem borer. Kumar *et al.* (2013) [7] where they reported that leaf folder population showed negative correlation with the rainfall and positive correlation with the maximum temperature. Similar results were reported by Netam and Gupta (2015) [9] they indicated that the infestation of leaf folder showed significant negative correlation with the afternoon relative humidity (r = -0.523*).

Conclusion

The present study concludes that whorl maggot showed peak activity during 2nd week of March (10th SW), dead heart and white ear per cent were reached peak during 9th SW and 14th SW and leaf folder recorded its maximum activity during 11th SW. Correlation studies of incidence of whorl maggot revealed that minimum temperature and afternoon relative humidity showed significant negative correlation, for YSB minimum temperature showed highly significant positive correlation and for leaf folder afternoon RH (r = -0.693*) showed significant negative correlation for the incidence.

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