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Epidemiological studies of false smut disease of rice (*Ustilaginoidea virens*) in Bihar

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Abstract
False smut or green smut, caused by *Ustilaginoidea virens* is an important emerging disease of rice in India causing 5-85 per cent yield losses in India and 15-50 percent losses in some rice growing districts of Bihar. This disease, not only reduces yield and quality of rice, but also produces large amount of mycotoxins. False smut of rice has great impact on cultivation of different rice varieties and date of sowing. In the present investigations, epidemiological studies were done on five different varieties *viz*., Sahbhagi, Abhishek, Sushak samrat, Sabour ardhajal and IR-64 and four date of sowing (15th June, 25th June, 05th July and 15th July) of rice during 2015-16. The maximum disease severity and incidence were occurred at temperature range of 32-24ºC, relative humidity (88-74%), rainfall (6.67-6.66 mm) and sunshine hrs (6.20-6.29 hrs) both in case of variety Sabour ardhajal and 25th June sown crop whereas, minimum disease incidence and disease severity occurred when temperature and relative humidity was same but their sunshine hrs and rainfall was lower than both Sabour ardhajal and 25th June sown crop in case of Sahbhagi variety and 15th July sowing. It was also revealed that in case of yield, Sabour ardhajal had minimum 31.42 q/ha whereas maximum yield was found in Sushak samrat (42.22 q/ha) and early sowing 15th June sown crop had maximum yield (41.20 q/ha) and late sown 15th July crop had minimum yield of 36.93 q/ha.

Keywords: Date of sowing, Epidemiology, variety, false smut and *Ustilaginoidea virens*.

Introduction
False smut or green smut is a common disease of rice caused by *Ustilaginoidea virens* in rice growing regions of India. Epidemics of false smut disease of rice were reported in Tamil Nadu in India and later in many countries of world (Singh and Pophaly, 2010) [15]. Pannu *et al.*, 2010 [13] also reported losses up to 44 per cent in Punjab. In Uttar Pradesh, yield losses up to 44 per cent were observed by Singh and Dube, 1978 [17]. In some rice growing districts of Bihar, 15-50 percent losses occurs due to false smut of rice when comes as medium to severe form (Laha *et al.*, 2013) [10]. The fungus overwinters in soil by means of sclerotia and chlamydospores. Sclerotia produces ascospores, which are primary source of infection to rice plants, whereas secondary infection may come from air-borne chlamydospores (Ashizawa *et al*., 2010) [2]. Sclerotia can survive in the field for several months (Webster and Gunnell, 1992) [19]. Infection starts in grains of rice before flowering. Infection results in one or more kernels on mature heads of plants being replaced by globose, yellowish-green, velvety smut balls. When smut balls burst open, powdery dark green spores are released (Atia, 2004) [3]. The infection of *U. virens* is favoured by high relative humidity (>90 %) (Bhagat and Prasad, 1996) [4] and temperatures between 25-30°C (Yashoda *et al*., 2000) [20]. Rainfall, high humidity, and soils with high nitrogen content during flowering also favours disease development (Ladhalakshmi *et al*., 2012) [9]. Reports on the effect of rainfall are conflicting, high disease intensity has been attributed to rainfall at heading (Cartwright *et al*., 2002) [5], but the opposite (low rainfall favouring the disease) has also been reported (Dodan and Singh, 1996) [6]. The fungus attacks some of the weed species that commonly occur in rice fields and may also serve as sources of inoculums (Atia, 2004) [3]. Therefore, the present studies were done to know the effect of different varieties and date of sowing of rice on the false smut disease incidence, severity and yield of rice in Bihar.

Materials and methods
Field experiment was conducted in N-5/6 block of research farm of Bihar Agricultural University, Sabour. It is situated at 25º23'N latitudes, 87º07'E longitudes and 37.19m above the mean sea level respectively. The experimental site was rainfed upland and having loam soil type. Preparation of field, planking and other operations were performed by tractor drown implements. Sowing was done by manual hand plough with 30 kg/ha seed rate as per technical

programme. Crop was fertilized by recommended dose of NPK (100:60:40) and zinc sulphate (20 kg/ha) as per required time. Weeding and insecticides application were done at appropriate time for best management practices. Split plot design was used to study the epidemiology of false smut of rice. Gross plot size of 6 × 4 $m^2$was taken for this experiment with 20 cm x 15 cm plant spacing. Here, two type of treatment were used first main plot and second sub plot treatment. Four different date of sowing after 10 days interval (15th June, 25th June, 05th July and 15th July) were taken as main plot treatment and in sub plot treatment five different varieties Sahbhagi (v_1), Abhishek (v_2), Sushak samrat (v_3), Sabour ardhajal (v_4) and IR-64 (v_5) were used. Three replication of each treatment were maintained in the field. To study epidemiology of false smut of rice disease incidence (%) and disease severity index were calculated to relate with meteorological data. Each plot was visited on regular basis for recording observations. The disease incidence was recorded at maturity stages of the plant. Data were recorded visually by observing the symptoms. Five observations were taken from each plot.

Observations

For calculating disease incidence (%) and disease severity index these formulas were used (Singh and Dube, 1978) [17];

Disease incidence (%) or percent infected tillers = No of smutted tillers/ sqm× 100 / Total no of tillers/sqm.

Disease severity index= Per cent infected tillers x Per cent smutted balls

(Percentage of smutted balls = No of smutted balls/panicle × 100 / Total no of grains/panicle)

All meteorological data *viz.*, minimum temperature, maximum temperature, maximum relative humidity, minimum relative humidity, rainfall and sunshine hours (Fig.1) were taken from sowing to harvesting of each variety for different date of sowing through Department of Agro-meteorology, Bihar Agricultural University, Bhagalpur, Sabour and statistical analysis was done by using ANOVA.

Results and Discussion

From present study, it was revealed that the disease incidence and disease severity index of false smut occurred at the temperature (23-32ºC), relative humidity (66-90%), rainfall (5-8 mm) and sunshine (4.81-6.20 hrs). The Table 1 indicated that maximum disease severity and disease incidence (52.83% and 19.54% respectively)occurred at temperature ranged from 31.36-23.14ºC, relative humidity (88.85-73.50%), rainfall (6.66 mm) and sunshine hrs (6.20 hrs) in Sabour ardhajal which were flowered at 25th Sept to 20th Oct than other varieties. whereas, minimum disease incidence and disease severity (14.72% and 17.41% respectively) occurred in Sahbhagi which flowered at 10th Sept to 5th Oct at same range of temperature and relative humidity but low sunshine hrs (4.81 hrs) and high rainfall (7.27 mm) but in case of yield, Sabour ardhajal had minimum 31.42 q/ha whereas maximum yield was found in Sushak samrat (42.22 q/ha). In case of date of sowing, disease incidence and severity were highest in 25th June sown crop which flowered at 15th Sept to 5thOct, when temperature, relative humidity, rainfall and sunshine hrs occurred between 31.44-23.17ºC, 87.48-74%, 6.67 mm and 6.29 hrs (Table 2). Lowest disease incidence and disease severity (15.62% and 23.77% respectively) were found during 15th July sowing which flowered during the time period of 5th Oct to 25th Oct, when rainfall was lower than 0.2 mm besides temperature, relative humidity and sunshine hrs was relatively similar as 25th June sown crop. Crop flowered during 7th Sep to 30th Sep and 25th Sep to 15th Oct had lower disease incidence and severity than crop flowered during the time period of 15th Sept to 5thOct. Here, It was also revealed that 15th June sown crop had maximum yield (41.20 q/ha) and minimum were found in 15th July (36.93 q/ha) crop.

Present studies results were supported by Bhagat and Prasad (1996) [4] who also studied the incidence of false smut of rice in relation to meteorological parameters and revealed that a greater infection occurred at comparatively lower day and night temperatures around 31°C and 25ºC with high precipitation resulting in high relative humidity of 90 per cent. It was also supported by Yashoda *et al*., (2000) [20] that Low maximum temperature (<31°C), low rainfall (<5mm), high minimum temperature (19°C), was found to be favourable for disease development. According to Jia *et al.,* (2014) [8] the effect of rice growth stage, temperature, relative humidity and wetness duration on infection of rice false smut found that late panicle development stages had highest percentage (90.00%)of diseased panicle and highest level of disease (92.90%) was obtained at 25°C and 95 % RH with 120 hrs of wetness duration. But, Singh *et al.,* (1987) found that Incidence is favoured by relatively low (20°C) temperature and high relative humidity (>90%) coupled with well distributed moderate rainfall during flowering, also by late sowing and high soil fertility. Reports on the effect of rainfall were conflicting; high disease intensity had been attributed to rainfall at heading (Cartwright *et al.*, 2002) [5], but the opposite (low rainfall favouring the disease) had been reported (Dodan and Singh, 1996) [6]. Nessa *et al.,* (2015) [11] also found the effect of different flowering times "early" (5th Aug–12thOct), "mid" (17th Oct–23rd Nov) and "late" (4th Dec–28th Dec) when crop sown at different dates in 2014 and 2015, on false smut of rice and found that the highest disease incidence percentage of the false smut of rice was recorded when the crop flowered on 9th and 5th November in 2014 and 2015 during mid-flowering time respectively. Rani *et al.,* (2016) also found that days of 50% flowering had negative correlation with disease variables. The short duration cultivars flowered during 90-100 days showed high disease variables. Osman *et al.,* (2015) [12] also reported that early date of sowing had highest yield than late sowing. Aghamolki *et al.,* (2015) [1] also reported that the crop sown on early date of sowing had better growth and yield components. Walia *et al*., (2014) [18] reported that all rice cultivars taken differed significantly in their yield attributes. Gupta *et al.,* (2016) [7] also revealed that Sushaksamrat was highest grain yielder (44.70 q/ha) and followed by Abhishek (38.20 q/ha).

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Table 1: Relation of weather parameter with disease incidence (%) and disease severity index in different varieties

Varieties	Flowering time	Range of weather parameter						Disease incidence (%)	Disease severity index	Yield
		Temperature		Relative humidity (%)		Rainfall	Sunshine hrs			
		Max	Min	Max	Min					
V_1 (Sahbhagi)	10 Sept to 5 Oct	31.62	24.72	88.50	78.00	7.27	4.81	14.72	17.41	40.33
V_2 (Abhishek)	18 Sept to 17 Oct	31.39	23.49	88.26	74.50	5.79	6.11	15.48	24.59	41.67
V_3 (Sushak samrat)	18 Sept to 17 Oct	31.39	23.49	88.26	74.50	5.79	6.11	16.66	35.56	42.22
V_4 (Sabour ardhajal)	25 Sept to 20 Oct	31.36	23.14	88.85	73.50	6.66	6.20	19.54	52.83	31.42
V_5 (IR-64)	10 Sept to 5 Oct	31.62	24.72	88.50	78.00	7.27	4.81	15.02	27.73	40.50
							SEm±	0.14	0.82	0.56
							CD (P=0.05)	0.41	2.36	1.21

Table 2: Relation of weather parameter with disease incidence (%) and disease severity index at different date of sowing

Date of sowing	Flowering time	Range of weather parameter						Disease incidence (%)	Disease severity index	Yield
		Temperature		Relative humidity (%)		Rainfall	Sunshine hrs			
		Max	Min	Max	Min					
15th June	7 Sept to 30 Sept	31.00	24.78	89.5	81.31	8.96	4.04	15.97	32.73	41.20
25th June	15 Sept to 5 Oct	31.70	24.52	89.37	76.75	7.10	5.63	17.23	43.37	39.73
5th July	25 Sept to 15 Oct	31.44	23.17	87.48	74.00	6.67	6.29	16.32	26.63	39.04
15th July	5 Oct to 25 Oct	31.33	21.21	90.20	66.13	0.41	6.57	15.62	23.77	36.93
							SEm±	0.16	0.92	0.59
							CD (P=0.05)	0.56	3.19	2.06

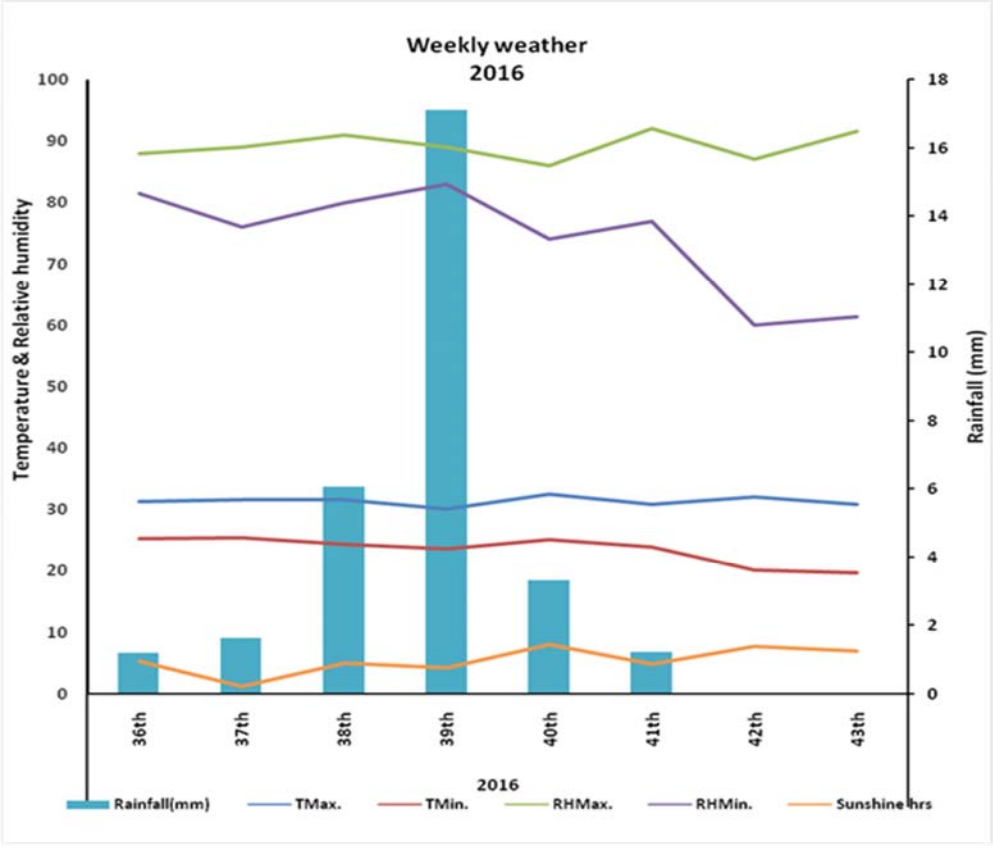

Fig 1: Weekly weather graph of rice crop from the week of flowering to the harvesting of five varieties.

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