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Survey for natural occurrence of sheath rot disease of rice in agro climatic conditions of Bihar

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Abstract
Sheath rot of rice (*Oryza sativa* L.) caused by *Sarocladium oryzae* (Swada) W. Gams & D Hawksw is an important disease of rice inflicting heavy losses in all agro-climatic conditions of Bihar. Survey has been conducted during *Kharif* 2021 and *Kharif* 2022, seasons to observe natural occurrence of sheath rot of rice prevailing in agro-climatic conditions of Bihar in order to assess the recent disease scenario in changing climatic conditions. Different locations of Samastipur, Muzaffarpur, Vaishali, Darbhanga, Saran, Ara and Buxar district were surveyed and it has been observed that Sheath rot were occurring at varying degree of incidence and causing losses to the crop. The incidence of sheath rot was highest amongst all the districts surveyed and was more prevalent in Samastipur district in both *Kharif* 2021 and 2022 season, with 43.2 per cent and 46.7 per cent of disease incidence, respectively, while the lowest disease incidence was recorded in Saran district, with 28.5 per cent and 26.6 per cent during 2021 and 2022. In respect of severity also it was highest (46.7 & 37.6% respectively) in Samastipur district in both the season. Observation from survey report, it had been concluded that sheath rot disease was prevalent in all the areas in the agro-climatic conditions as a whole and was congenial in changing climate for the development of sheath rot disease in Bihar.

Keywords: Survey, Rice, Sheath rot, *Sarocladium oryzae*

Introduction
Rice is the second most important staple food crop of the world consumed by more than half of the world's population. Asian continent itself accounting for 90% of the world production (IRRI, 2019) [4]. China is the leading rice producer followed by India, Indonesia and Bangladesh. The estimated area, yield and production of rice crop in the world is 162.46 million ha, 4.63 metric tonnes per ha and 504.17 million metric tonnes respectively, during 2020-21. Globally, India accounts for 27.08% and 23.99% of the total acreage and production. In Bihar rice is grown in an area about 3.21mha with 6.49 mt and 2019 kg/ha, production and productivity respectively (Ministry of Agriculture & Farmers Welfare, Department of Agriculture, 2020-21).

Although, the crop suffers from many diseases caused by fungi, bacteria, virus, nematodes and other parasites. Among the fungal diseases, sheath rot once a minor and geographically limited disease is becoming major threat and gained momentum in many parts of the world (Bigirimana *et al*., 2015) [1] as well as in India (Saravanakumar *et al.*, 2009) [13]. It is a serious menace to rice cultivation and considered as an important emerging rice production threat causing yield losses ranging from 3-85% depending upon disease severity (Chakravarthy and Biswas 1978) [2] and complete suppression of panicle exertion. Sheath rot of rice is a complex disease that can be caused by various fungal and bacterial pathogens depending on the area, varieties grown, prevailing environmental conditions, farming systems and involvement of other insect-pests.

Several pathogens have been associated with rice sheath rot, but *Sarocladium oryzae* (Sawada) W. Gams and D. Hawksw is a major important seed borne fungal pathogen reported in India. Sheath rot pathogen infects upper most flag leaf sheath that enclose the emerging young panicles during the boot leaf stage. The major symptoms of sheath rot according to Ou, (1985) [10], the lesions are oblong or irregular oval spot and usually expressed as reddish brown discoloration of flag leaf sheath. Early infection affects the panicles, so that it partially emerges. The un-emerged portion of the panicle rots, turning florets red brown to dark brown. Grains from damaged panicles are chaffy and the disease is appropriately known as “empty earhead” and is familiar as “rice abortion” (Kindo, 2012) [6] and it affects seed viability, nutritional and market value (Sakthivel, 2001; Gopalakrishnan *et al*., 2010) [12, 3].

The climatic conditions of state like Bihar is most favourable for rice cultivation in *Kharif* as well as also most congenial for development of many biotic stresses. Several biotic stresses were reported which infecting rice crop and among them brown leaf spot, blast, sheath rot, bacterial blight, sheath blight and false smut are most important in the state causing considerable yield losses. Hence, survey has been conducted during *Kharif* 2021 and *Kharif* 2022, seasons to observe natural occurrence and recent status of sheath rot of rice prevailing in agro-climatic conditions of Bihar in order to assess the recent disease scenario in changing climatic conditions. Different locations of Samastipur, Muzaffarpur, Vaishali, Darbhangha, Saran, Ara and Buxar district were surveyed and data so obtained had been presented in this paper.

Materials and Methods

During the *Kharif* season of 2021 and 2022, a survey was carried out in seven paddy-growing districts in Bihar (Zone I and Zone IIIA) to determine the disease prevalence in changing climatic scenario. Table 1 contains information on the districts and villages.

Farmers' fields were chosen randomly in each of the seven districts; five villages were chosen at random from each district, and five fields were chosen at random from each village. One-square-meter area was randomly selected such that one plot was in the centre of the field and the rest were randomly placed on the four corners leaving 1 m from the border line of each field. The total number of productive tillers were counted in each plant and then counted the number of sheath rot infected panicles and finally computed the sheath rot incidence percentage. Ten plants were randomly selected per one sq. m area and above procedure followed to obtain sheath rot disease incidence percentage and intensity of the disease had been calculated.

Incidence of disease was calculated with the following formulae.

$$\text{Disease incidence} = \frac{\text{Number of infected tiller/hill}}{\text{Total Number of tiller/hill}} \text{ X } 100$$

And Per cent disease index had been calculated with the formulae mentioned under with the help of disease rating scale.

$$\text{Percent disease index (PDI)} = \frac{\text{Sum of all disease rating}}{\text{Total number of tillers observed x Maximum grade}} \text{ X } 100$$

Table 1: Scale used to record disease severity of sheath rot of rice

Scale description	Disease Score
No lesion or spot on flag leaf sheath	0
Spots visible on the tillers upon very careful examination (less than 1% area covered on flag leaf sheath)	1
Spots visible on the tillers upon careful examination (1-5% area covered on flag leaf sheath)	3
Spots easily visible on the tillers (6-25% area covered on flag leaf sheath)	5
Spots present on almost whole of the tillers parts (26-50% area covered on flag leaf sheath)	7
Spots very common on whole of the tillers parts (51-100% area covered on flag leaf sheath) death of plants common, severe yield loss	9

Ref.: Standard Evaluation System For Rice (SES), International Rice Research Institute (IRRI), Nov, 2019

Isolation of sheath rot pathogen:

The leaves showing the typical symptoms of sheath rot were selected and washed with sterile distilled water. Small piece of diseased tissue along with some healthy tissue was cut with the help of a sterile scalpel and surface sterilized with 0.1% sodium hypochlorite solution for one min, rinsed thrice in sterile distilled water and dried with sterilized filter paper. The surface sterilized samples were placed on Potato Dextrose Agar (PDA) medium with the help of sterilized forceps and placed in BOD incubator at 25±2 ^{0}C. The pathogens were isolated from the infected tissue and further purified by hyphal tip method (Lilly and Barnett 1951). Sheath rot pathogen was identified based on cultural and morphological characters of the isolates.

Results and Discussion

Survey was conducted in seven districts of Bihar i.e., Samastipur, Muzaffarpur, Vaishali, Darbhangha, Saran, Ara and Buxar during Kharif 2021 and 2022. Five villages in each districts, *viz.*, Pusa Farm, Birauli, Muriaro, Rampur Santhu, and Hasanpur of Samastipur district; Dholi Farm, Dubaha, Kharauna, Dwarkapur and Saraiya of Muzaffarpur district; Hariharpur, Agrail, Patepur, Bahuara, Mahua and Berai of Vaishali district; Jale, Madhopatti, Bahadurpur, Mohammadpur and Hayaghat of Darbhanga district; Bharpura, Parmanandpur, Pahleja, Nayagaon and Dighwara of Saran district; Kulhariya, Chandwa, Gajrajganj, Shahpur and Bihiya of Ara district and Brahmpur, Kathar, Kuran Sarai, Nawanagar and Churamanpur of Buxar district were selected for this purpose. A total of 35 samples were collected during survey Results had been presented in Table 2. The farmers in the surveyed villages were cultivating the hybrids of different companies, BPT5204, BPT-1001, Mansuri, Nata Mahsuri and Rajendra Bhagwati etc. rice varieties.

From the table 2, when assessed the survey data for the occurrence of rice sheath rot, there was a significant variation across districts and villages during the *Kharif* of 2021 and 2022. Pusa Farm in Samastipur district recorded highest disease incidence of 58.1% & 64.3% as well as highest disease intensities (43.6 & 51.4%) in both the season respectively and lowest incidence was recorded in Parmanandpur of Saran district (26.1% & 19.5) in *Kharif* of 2021 crop season and in Pahleja (23.8%) during *Kharif* 2022 among all the localities surveyed.

As per the current survey, Samastipur district had a higher mean incidence of sheath rot disease (43.2 & 46.7%) in *Kharif* 2021 and 2022 and higher mean disease intensities of 32.5 & 37.6% respectively than other districts in Zone I of Bihar and in Zone IIIA, both Ara and Buxar districts had almost similar sheath rot incidence which varied from 30.8 to 32.8% and intensities varied from 24.4 to 25.2% among the surveyed villages of the both districts.

Survey during *Kharif* 2021 and 2022 in different Agro-Climatic Zones of Bihar

Samastipur: Among the five villages surveyed Pusa Farm recorded highest disease incidence with 58.1% followed by Birauli (48.6%) Murario (38.1%), Rampur Santhu (36.2%) and lowest in Hasanpur (35.1%) during *Kharif* 2021. In *Kharif* 2022 villages Pusa Farm (64.3%) and Birauli (51.2%) recorded highest disease incidence followed by Muriaro (42.9%) and lowest was observed in the villages Hasanpur with 36.9% followed by Rampur Santhu with 38.4% disease incidence. The disease severity in the district varied from 26.4 to 43.6% during the *Kharif* 2021 and 29.5 to 51.4% during the *Kharif* 2022. The mean incidence of the disease was 43.2% & 46.7% and means disease severity was 32.5% & 37.6% respectively during the *Kharif* 2021 and 2022 crop season of the district.

Muzaffarpur: Among five villages surveyed in Muzaffarpur during *Kharif* 2021 the villages Dholi (39.5% & 29.6%) and recorded highest incidence as well as severity respectively followed by Saraiya (38.2% & 28.6%), Dubaha (36.6% & 27.5%), Dwarkapur (34.4% & 25.8%) and lowest in Kharauna (32.1% & 24.1%). In 2022 also Dholi recorded highest incidence as well as severity with 41.5% & 33.2% followed by village Dubaha (37.8% & 30.2%), Saraiya (37.8% & 31.1%), Dwarkapur (35.2% & 28.2%) and least was recorded in Kharauna (34.4% & 27.5%). The mean incidence of the disease was 36.2% & 37.3% and mean disease severity was 27.1% & 30.1% respectively during the *Kharif* 2021 and 2022 crop season of the district.

Vaishali: In Vaishali district the village Mahua recorded highest disease incidence (42.8%) among all the surveyed villages followed by Berai (39.6%) and Bahuara (35.9%), Hariharpur (33.7%) and lowest was recorded in Agrail, Patepur (31.8%) during *Kharif* 2021. In *Kharif* 2022 also, Mahua village recorded highest incidence (45.8%) followed by Berai (40.8%), Hariharpur (36.0%) and Bahuara (33.3%) and lowest was recorded in Agrail, Patepur (29.9%). The disease severity in the district varied from 25.3 to 32.1% during the *Kharif* 2021 and 23.9 to 32.6% during the *Kharif* 2022. The mean incidence of the disease was 36.8% & 37.1% and mean disease severity was 27.6% & 29.6% respectively during the *Kharif* 2021 and 2022 crop season of the district.

Darbhanga: The village Mohammadpur recorded highest disease incidence with 38.7% and 39.1% followed by Madhopatti with 36.1% and 39.1% respectively during the *Kharif* 2021 and 2022. Hayaghat with 35.5% and 38.3% Jalewith 35.4% and 38.4% and lowest was recorded in Bahadurpur villages with 32.9% and 35.3% during *Kharif* 2021 and 2022 respectively. The disease severity in the district varied from 24.7 to 29.0% during the *Kharif* 2021 and 28.3 to 31.3% during the *Kharif* 2022. The mean incidence of the disease was 35.9% & 38.4% and means disease severity was 26.9% & 30.4% respectively during the *Kharif* 2021 and 2022 crop season in this district.

Saran: Among five villages surveyed during *Kharif* 2021 the village Dighwara recorded highest incidence (31.8%) followed by Nayagaon (30.1%), Bharpura (28.2%), Pahleja (26.5%) and lowest was recorded in Parmanandpur (26.1%). The village Dighwara recorded highest incidence (29.5%) followed by Nayagaon (28.7%), Bharpura (26.6%), Parmanandpur (24.5%) and lowest was in Pahleja (23.8%) also during *Kharif* 2022 season. The disease severity in the district varied from 19.5 to 23.9% during the *Kharif* 2021 and 18.4 to 23.4% during the *Kharif* 2022. In this district, the mean incidence of the disease was 28.5% & 26.6% and means disease severity was 21.4% & 20.4% respectively during the *Kharif* 2021 and 2022 crop season.

Table 2: Survey for natural occurrence of Sheath rot disease of rice in *Kharif*, 2021 and 2022 in Different Districts of Bihar

Sl. No	Districts	Localities/ Villages	Disease incidence (%)				Disease severity (%)			
			Kharif, 2021	Mean	*Kharif*, 2022	Mean	*Kharif*, 2021	Mean	*Kharif*, 2022	Mean
1	Samastipur	Pusa Farm	58.1	43.2	64.3	46.7	43.6	32.5	51.4	37.6
		Birauli	48.6		51.2		36.5		41.0	
		Muriaro	38.1		42.9		28.6		34.3	
		Rampur Santhu	36.2		38.4		27.2		30.7	
		Hasanpur	35.1		36.9		26.4		29.5	
2	Muzaffarpur	Dholi	39.5	36.2	41.5	37.3	29.6	27.1	33.2	30.1
		Dubaha	36.6		37.8		27.5		30.2	
		Saraiya	38.2		37.8		28.6		31.1	
		Kharauna	32.1		34.4		24.1		27.5	
		Dwarkapur	34.4		35.2		25.8		28.2	
3	Vaishali	Hariharpur	33.7	36.8	36.0	37.1	25.3	27.6	28.8	29.6
		Agrail, Patepur	31.8		29.9		23.9		23.9	
		Bahuara	35.9		33.3		26.9		26.6	
		Mahua	42.8		45.4		32.1		36.3	
		Berai	39.6		40.8		29.7		32.6	
4	Darbhanga	Jale	35.4	35.9	38.4	38.4	26.5	26.9	30.7	30.4
		Madhopatti	36.8		39.1		27.6		31.3	
		Bahadurpur	32.9		35.3		24.7		28.3	
		Mohammadpur	38.7		39.1		29.0		31.3	
		Hayaghat	35.5		38.3		26.6		30.6	
5	Saran	Bharpura	28.2	28.5	26.6	26.6	21.2	21.4	21.3	20.4
		Parmanandpur	26.1		24.5		19.5		19.6	
		Pahleja	26.5		23.8		19.9		19.1	
		Nayagaon	30.1		28.7		22.6		18.4	

		Dighwara	31.8		29.3		23.9		23.4	
6	Ara	Kulhariya	34.6	32.6	32.9	30.8	25.9	24.4	26.3	24.6
		Chandwa	31.2		29.4		23.4		23.5	
		Gajrajganj	37.0		35.8		27.8		28.4	
		Shahpur	29.9		27.6		22.4		22.1	
		Bihiya	30.2		28.1		22.7		22.5	
7	Buxar	Brahmpur	31.5	32.8	29.8	29.5	23.6	24.6	23.8	25.2
		Kathar	33.5		28.2		25.1		22.6	
		Kuran Sarai	34.9		31.8		26.2		25.4	
		Nawanagar	31.6		29.1		23.7		23.3	
		Churamanpur	32.5		28.7		24.4		22.9	

Ara: Among five villages surveyed in Ara district, Gajrajganj (37.0%) recorded highest incidence followed by Kulhariya (34.6%), Chandwa (31.2%) and Bihiya (30.2%) and lowest was recorded in Shahpur (29.9%) during *Kharif* 2021. In *Kharif* 2022 also the village Gajrajganj (35.8%) and Kulhariya (32.9%) recorded highest disease incidence followed by Chandwa (29.4%), Bihiya (28.1%) and lowest incidence was recorded in Shahpur (27.6%). The disease severity in the district varied from 22.4 to 27.8% during the *Kharif* 2021 and 22.1 to 28.4% during the *Kharif* 2022. In this district, the mean incidence of the disease was 32.6% & 30.8% and means disease severity was 24.4% & 24.6% respectively during the *Kharif* 2021 and 2022 crop season.

Buxar: Among five villages surveyed in the district, Kuran Sarai (34.9%) recorded highest incidence followed by Kathar (33.5%), Churamanpur (32.5%), Nawanagar (31.6%) and lowest was recorded in Brahmpur (31.5%) during *Kharif* 2021. During *Kharif* 2022 also village Kuran Sarai (31.8%) recorded highest followed by Brahmpur (29.8%), Nawanagar (29.1%), Churamanpur (28.7%) and lowest was recorded in Kathar (28.2%). The disease severity in the district varied from 23.6 to 26.2% during the *Kharif* 2021 and 22.6 to 25.4% during the *Kharif* 2022. In this district, the mean incidence of the disease was 32.8% & 29.5% and means disease severity was 24.6% & 25.2% respectively during the *Kharif* 2021 and 2022 crop season.

Overall, there was a significant difference in incidence between districts and villages. Samastipur has the highest disease incidence among the districts (43.2%) followed by Vaishali district (36.76%), Muzaffarpur district (36.16%) which are at par, Darbhanga district (35.9%), Buxar district (32.8%) followed by Ara district (32.6%) and least disease incidence was recorded in Saran district (28.5%) in 2021. During 2022 highest disease incidence recorded in Samastipur (46.7%) followed by Darbhanga district (38.4%), Muzaffarpur district (37.3%), Vaishali district (37.08%), Aradistrict (30.8%), Buxar district (29.5%) and least disease incidence was recorded in Saran district (26.6%).

The findings of this study revealed that disease incidence was higher in Samastipur district during *Kharif* 2021 and 2022 than in other districts in Bihar (Zone I), and that disease incidence differed from village to village within the same district.

The present investigation revealed that the district Samastipur recorded highest disease incidence compared to other districts of the Bihar (Zone I) and also indicated that the disease incidence varied from village to village with in a district. So far no comprehensive survey on the occurrence of rice sheath rots in the districts of different Agro-Climatic Zones of Bihar was conducted. Muralidharan and Rao (1980) [9] reported that sheath rot could cause up to 85% yield loss.

Surveys conducted for rice diseases in districts of Faziabad, Gorakhpur and Varanasi of Uttar Pradesh during *Kharif* and *Zaid* (Summer) 1978 and 1979 revealed the prevalence of diseases in all districts surveyed (Mukerjee and Singh, 1980) [8]. Kang and Rattan (1983) [5] reported the occurrence of sheath rot disease in Kapurthala in Punjab during 1980. Ravat, and Basu also conducted survey on fungal diseases on Swarna Cultivar (MTU 7029) of Rice in Gangetic Alluvial Zone of West Bengal, India and found the varying degree of the sheath rot disease.

Conclusion

The present study concluded that generally sheath rot disease of rice was present in almost all the rice fields surveyed with varied disease incidence as well intensities. The disease was found to be more prevalent in Samastipur district in both 2021 and 2022 *Kharif* season with 43.2 per cent and 46.7 per cent of disease incidence, respectively, while the lowest disease incidence was found in Saran district, with 28.5 per cent and 26.6 per cent in 2021 and 2022. The village of Pusa Farm had the highest incidence (58.1%) of Samastpur district. Parmanandpur Village, on the other hand, had the lowest disease incidence (26.1%) of Saran district in *Kharif* 2021, and in *Kharif* 2022 also, maximum disease incidence was recorded in Pusa Farm (64.3%) of Samastipur district while the lowest disease was found in Pahleja Village (23.8%) of Saran district. In respect of disease severity it was highest (46.7 & 37.6% respectively) in Samastipur district of both the season.

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