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Survey for Major Diseases of Rice in North East Alluvial Plains of Bihar

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A B S T R A C T

Survey has been conducted from *Kharif* 2008 to *Kharif* 2014, i.e. continuously for seven *kharif* seasons to observe natural occurrence of the diseases of rice (*Oryza sativa* L.) prevailing in North East Alluvial Plains (Koshi Zone) of Bihar in order to assess the recent disease scenario of the region in the changing climatic conditions. During the survey of different locations of seven districts categorized as North East Alluvial Plains viz. Supaul, Araria, Kishanganj, Katihar, Purnea, Madhepura and Saharsa of Bihar state, it has been observed that seven diseases of rice *viz.* Brown leaf spot, Blast, Bacterial leaf blight, False smut, Sheath Blight and Sheath rot were occurring at varying degree of incidence and causing severe losses to the crop. During survey, it was observed that the incidence of Brown leaf spot of rice was highest (90%) amongst all the districts surveyed whereas incidence of other mentioned diseases were varying in different districts. The incidence of Brown leaf spot was varied in the range from 40 to 90%, Blast (31-75%), Bacterial leaf blight (12-29%), False smut (5-40%), Sheath Blight (12-45%) and Sheath rot (8-32%) during 2008 to 2014 at above-mentioned different districts. The incidence of almost all diseases were highest in Kishanganj district which was followed by Araria and Katihar district. During continuous survey, it had been concluded that Koshi zone as whole was congenial for the development of all important diseases in rice crop.

Introduction

Rice (*Oryza sativa*) belongs to the genus *Oryza* (Family: Poaceae) which includes two cultivated and more than 25 wild species that are either perennial or annual, and diploid or tetraploid. The cultivated species are *Oryza sativa* L. and *Oryza glaberrima* L. The species *Oryza sativa* is composed of three sub species, *indica, japonica* and *javanica* (Gowda *et al.,* 2003).

Rice is an important crop worldwide, serving as the staple food for half of humanity and additionally being used in industry and for animal feed.

Rice is grown in various agro-ecological zones in tropical and subtropical areas, especially in Asia, the continent accounting for 90% of the world production (IRRI, 2015).

India is one of the world's largest producers of rice, accounting for 20 % of all world rice production. India stands first in area, second in production and productivity preceded by China on these two aspects.

Rice is cultivated under dry, wet and semi dry systems covering diverse ecosystems such as irrigated, rainfed, low and upland, hill, shallow lowland, deep water, semi deep water and saline alkaline etc., spread across many States and Union Territories together numbering 25. Rice production in the country fluctuates in relation to weather during the crop season.

Additionally the major rice production constraints in India are drought and submergence, bacterial blight, leaf blast, sheath blight, weeds, brown plant hopper and poor soil fertility.

Besides these biotic and abiotic stresses poor management practices such as low input use, inappropriate plant spacing, late sowing and selection of wrong cultivars are some of the other technical constraints (Jha *et al*., 2012).

The projected losses due to biotic stresses range from 15 to 85 per cent (Rola and Widawsky, 1998). Diseases are very important constraints for rice production. Occurrence of various diseases in rice varieties grown in India is very common. As a result an average yield loss of 25-30 per cent per annum due to diseases is a regular feature in India (Jha *et al.,* 2012).

Severity of rice pests is influenced both by crop growth and prevailing weather. Study of impact of climate change on rice crop-pest interactions requires carefully collection of data on long term basis.

Here there is scanty of already available historical data from which we could form an approach for partial study of climate change impacts, formulation and implementation of a robust research strategy combining the present scenario of cropping patterns, cultivars, and production and protection practices across heterogeneous locations over times. This paper gives emphasis on study the disease dynamics in relation to climate change in Agro-climatic zone II (Koshi) of Bihar.

Materials and Methods

Description of Study Area i.e. North-East Alluvial Plains of Bihar

Survey has been conducted during *Kharif* 2008 to *Kharif* 2014, i.e. continuously for seven *Kharif* cropping season of major rice growing field of North East Alluvial Plains (Koshi Zone) comprising seven districts viz. Supaul, Araria, Kishanganj, Katihar, Purnea, Madhepura and Saharsa of Bihar state.

Agro-Ecological Situations of the zone

- Climate: warm humid, good for rice wheat, maize and also congenial for disease development.
- Rainfall: 1150 mm Winter rain: 2.1%, summer rain: 9.2%, Early break of monsoon

- Soil: non-calcarious, non-saline, neutral, light alluvial
- Salinity-sodicity hazard due to poor drainage
- Kusaha tragedy in 2008 changed soil scenario
- N**:** Low, P&K : low to medium, Zn & B: Deficient Mn: toxicity

Survey of rice diseases

The survey was started from the year 2008 and it was continued till 2014 viz. for seven years. The survey started in defined way as firstly from Left to Right and secondly from Right to Left in such a way that the entire Kosi region may be surveyed.

The scouting was carried out at the seedling, vegetative and panicle formation stage. The surveyed varieties were local, Rajendra mahsuri and other prevailing variety of the areas.

Disease identification was done based on information on related symptoms with the help of Expert, journals, Books, Monograph and research paper.

Fields of farmers

Five rice growing villages representing the agro-ecology of the identified districts distributed randomly should be selected. In each village, two farmers' fields of near to one acre area are to be fixed for observations.

Assigning fields of farmers as Farm 1 and Farm 2 should be made at time of field selection and same should be maintained from the first observation till the end of season. Care should be taken to select farmers growing common variety (ies) of the region.

Disease incidence has been recorded on the basis of 100 leaves stem/plants selected randomly from each plots.

$$\text{Disease Incidence} = \frac{\text{Number of Leaves / stems infected}}{\text{Total Number of leaves / stems counted}} \times 100$$

Results and Discussion

Extensive surveys were carried out in during *Kharif* 2008 to *Kharif* 2014, i.e. continuously for seven *Kharif* cropping seasons of major rice growing field of North East Alluvial Plains (Koshi Zone) comprising seven districts viz. Supaul, Araria, Kishanganj, Katihar, Purnea, Madhepura and Saharsa of Bihar state. Incidence of the important diseases was recorded. Survey data are presented in Table 1 to 7.

The diseases recorded included, Blast, Brown spots, Sheath blight, Sheath Rot, False smuts and Bacterial leaf blight.

Survey of Rice Diseases

Brown leaf spot: Disease symptoms- The disease causes seedling blight. In mature plant leaf spotting is the most common symptoms. The spots on the leaves and the leaf sheathes are brown, round to oval. They are usually isolated but, in several cases, coalease to form large patches of withered tissue. The grain is also become infected and form the black or dark brown spot on glumes. Neck also infected, neck region becomes brown, and tissue is weakened.

Blast of Rice: Disease symptoms- The lesions due to this disease appear on leaves. Appearance of lesions are small, bluish green flecks. From lesions development of characteristic spindle shaped spot with grey centre and dark brown margin. Disease progression with coalescing of spots. Drying and withering of affected areas. Burning appearance to field after sheath infection.

False Smut of Rice: Disease symptoms- Severe infection occurs on grain. The fungus transforms individual grains into greenish spore balls of velvety appearance. Only a few spikelets in a panicle affected. The fructification replacing the grains represents the conidial growth.

Sheath blight: Disease symptoms- Initial symptoms usually develop on the leaf sheaths at or just above the water level. On the leaf sheath oval or elliptical or irregular greenish grey spots formed which are about 1 cm. long. As the spots enlarge upto 2-3 cm in length, the centre becomes greyish white with an irregular blackish brown or purple brown border. The infection extends to the inner sheaths resulting in death of the entire plant. Older plants and five to six week old leaf sheaths are highly susceptible.

Sheath rot: Disease symptoms- Sheath rot occurs usually at the booting stage of the crop. Initial symptoms are noticed only on the upper most leaf sheath enclosing young panicles. The flag leaf sheath show oblong or irregular greyish brown spots. They enlarge and develop grey centre and brown margins covering major portions of the leaf sheath. The young panicles may remain within the sheath or emerge partially. The affected sheath and panicles rot and abundant whitish powdery fungal growth is formed inside the leaf sheath. The grain discolours and shrivels.

Bacterial Blight of Rice: Disease symptoms- Margin blight symptoms appear on the leaves of young plant as light green to grey-green, water-soaked streaks near the leaf tip and margin. These lesions coalesce and become yellowish-white with wavy edges. Gradually whole leaf affected and then the drying & twisting of leaf tip. Streaks coalesce filling vascular bundle with bacteria. In older plants, the leaves become yellow and then die.

As evident from Table 1 that above mentioned diseases were prevalent in all the localities surveyed. Incidence of the above-mentioned diseases were varied from 15.0 to 90 per cent during *Kharif*, 2008.

During survey, it has been observed that the incidence of Brown leaf spot of rice was highest i.e. 90% in Araria, Kishanganj and Saharsa districts and Brown leaf spot incidence was followed by blast of rice, false smut and bacterial leaf spot. Sheath Blight and Sheath rot disease did not appeared in the surveyed areas.

Same type of trends for incidence of different diseases had been observed during 2009, 2010 and 2011 as evident from table no. 2, 3, and 4.

It was evident from Table 5, 6 and 7 that incidence of these diseases were found in decreasing trend respectively. This might be due to receiving low rainfall during the cropping season resulting the low humidity conditions which is the adverse condition for the development of the disease. It is also evident from the tables that Sheath Blight and Sheath rot disease appeared continuously after 2011 in the surveyed areas as these two disease develops in comparatively low humidity as compared to the other diseases.

These results were corroborated by the finding of earlier workers, who reported some similar observations, Singh *et al.,* (2014) and Kumar and Kumar (2020). It was also evident from the table no. 8 that the mean brown leaf spot and blast disease incidence per cent was maximum i. e 69.3% and 59.7 % respectively in the Kishanganj districts of Bihar where the disease was favoured by the mean maximum temperature, 32.5^{0}C, mean minimum temperature, 24.4^{0}C, mean maximum RH 80.27 %, mean minimum RH 70.8%, Mean Rainfall 390.8mm and the mean No. of rainy days 12 during the cropping season.

Table.1 Scientific Name of Important Diseases of Rice

Sl.No.	Common name	Scientific name
1.	Blast	*Pyricularia oryzae* Cav.
2.	Brown spot	*Bipolaris oryzae* (Breda de Haan)
3.	Sheath blight	*Rhizoctonia solani* Kuhn
4.	Sheath Rot	*Sarocladium oryzae* (Sawada)
5.	False smut	*Ustilaginoidea virens* (Cooke) Takah
6.	Bacterial leaf blight	*Xanthomonas campestris* pv. *oryzae* (Ishiyama) Dye
7.	Leaf streak	*Xanthomonas oryzae* pv. *oryzicola*
8.	Udbatta	*Epheli oryzae*
9.	Bakanae	*Fusarium fujikuroi* Nirenberg
10.	Ufra Disease	*Ditylenchus angustus* Butler
11.	White Tip Disease	*Aphelenchoides besseyi* Dastur
12.	Rice Tungro disease	Rice Tungro Virus
13.	Khaira Disease	Zinc deficiency

Table.2 Survey in the Koshi region to record disease scenario on rice crop during *Kharif* 2008.

Disease (%)	**Locations**						
	Supaul	Araria	Kishanganj	Katihar	Purnea	Madhepura	**Saharsa**
(i) Brown leaf spot	85.0	90.0	90.0	80.0	80.0	85.0	**90.0**
(ii) Blast	70.0	70.0	75.0	55.0	55.0	60.0	**60.0**
(iii) Bacterial leaf blight	25.0	15.0	15.0	20.0	20.0	20.0	**25.0**
(iv) False smut	30.0	15.0	15.0	30.0	30.0	30.0	**35.0**
(v) Sheath Blight	-	-	-	-	-	-	**-**
(vi) Sheath rot	**-**	**-**	**-**	-	**-**	-	-

Table.3 Survey in the Koshi region to record disease scenario on rice crop during *Kharif* 2009

Disease (%)	**Locations**						
	Supaul	Araria	Kishanganj	Katihar	Purnea	Madhepura	**Saharsa**
(i) Brown leaf spot	65.0	65.0	60.0	52.0	50.0	67.0	**73.0**
(ii) Blast	50.0	45.0	55.0	35.0	36.0	46.0	**55.0**
(iii) Bacterial leaf blight	25.0	12.0	10.0	15.0	15.0	17.0	**25.0**
(iv) False smut	20.0	08.0	05.0	15.0	15.0	20.0	**40.0**
(v) Sheath Blight	45.0	35.0	25.0	19.0	20.0	35.0	**25.0**
(vi) Sheath rot	**-**	-	**-**	-	**-**	-	-

Table.4 Survey in the Koshi region to record disease scenario on rice crop during *Kharif* 2010

Disease (%)	Locations						
	Supaul	Araria	Kishanganj	Katihar	Purnea	Madhepura	**Saharsa**
(i) Brown leaf spot	67.0	68.0	64.0	54.0	55.0	69.0	**76.0**
(ii) Blast	52.0	47.0	57.0	38.0	37.0	49.0	**57.0**
(iii) Bacterial leaf blight	22.0	18.0	15.0	18.0	17.0	17.0	**23.0**
(iv) False smut	21.0	12.0	09.0	20.0	21.0	18.0	**31.0**
(v) Sheath Blight	43.0	31.0	23.0	17.0	19.0	31.0	**22.0**
(vi) Sheath rot	-	-	-	-	-	-	-

Table.5 Survey in the Koshi region to record disease scenario on rice crop during *Kharif* 2011

Disease (%)	Locations						
	Supaul	Araria	Kishanganj	Katihar	Purnea	Madhepura	**Saharsa**
(i) Brown leaf spot	83.0	87.0	88.0	81.0	78.0	83.0	**80.0**
(ii) Blast	65.0	69.0	71.0	55.0	55.0	53.0	**51.0**
(iii) Bacterial leaf blight	25.0	26.0	29.0	28.0	27.0	23.0	**24.0**
(iv) False smut	22.0	23.0	25.0	27.0	28.0	23.0	**21.0**
(v) Sheath Blight	-	-	-	-	-	-	**16.0**
(vi) Sheath rot	-	-	-	-	-	-	-

Table.6 Survey in the Koshi region to record disease scenario on rice crop during *Kharif* 2012

Disease (%)	Locations						
	Supaul	Araria	Kishanganj	Katihar	Purnea	Madhepura	**Saharsa**
(i) Brown leaf spot	53.0	62.0	68.0	56.0	59.0	62.0	**60.0**
(ii) Blast	55.0	59.0	61.0	45.0	50.0	42.0	**44.0**
(iii) Bacterial leaf blight	21.0	22.0	25.0	24.0	23.0	20.0	**20.0**
(iv) False smut	29.0	20.0	22.0	26.0	26.0	26.0	**31.0**
(v) Sheath Blight	21.0	29.0	32.0	29.0	22.0	21.0	**32.0**
(vi) Sheath rot	**20.0**	**27.0**	**30.0**	**28.0**	**17.0**	**15.0**	**32.0**

Table.7 Survey in the Koshi region to record disease scenario on rice crop during *Kharif* 2013

Disease (%)	Locations						
	Supaul	Araria	Kishanganj	Katihar	Purnea	Madhepura	**Saharsa**
(i) Brown leaf spot	44.0	53.0	59.0	46.0	48.0	53.0	**48.0**
(ii) Blast	47.0	47.0	52.0	37.0	39.0	32.0	**35.0**
(iii) Bacterial leaf blight	18.0	18.0	18.0	16.0	15.0	12.0	**12.0**
(iv) False smut	21.0	16.0	14.0	18.0	16.0	18.0	**22.0**
(v) Sheath Blight	17.0	19.0	22.0	20.0	14.0	13.0	**23.0**
(vi) Sheath rot	**15.0**	**22.0**	**19.0**	**20.0**	**11.0**	**08.0**	**20.0**

Table.8 Survey in the Koshi region to record disease scenario on rice crop during *Kharif* 2014

Disease (%)	Locations						
	Supaul	Araria	Kishanganj	Katihar	Purnea	Madhepura	**Saharsa**
(i) Brown leaf spot	40.0	48.0	56.0	40.0	44.0	47.0	**40.0**
(ii) Blast	42.0	43.0	47.0	34.0	34.0	31.0	**31.0**
(iii) Bacterial leaf blight	15.0	16.0	17.0	14.0	14.0	12.0	**12.0**
(iv) False smut	17.0	14.0	12.0	14.0	14.0	15.0	**18.0**
(v) Sheath Blight	14.0	14.0	19.0	16.0	13.0	12.0	**18.0**
(vi) Sheath rot	**13.0**	**17.0**	**16.0**	**16.0**	**10.0**	**10.0**	**16.0**

Figure.1 Agroclimatic Zone II (Koshi) of Bihar

Table.9 Influence of meteorological factors on degree of major disease incidence on rice in Koshi region.

Surveyed Districts of Bihar	Mean Disease Incidence (%) (2008-2014)						Mean temperature (^oC)		Mean Relative Humidity (%)		Mean Rainfall (mm)	No. of rainy days
	Brown leaf spot	Blast	Bacterial leaf blight	False smut	Sheath Blight	Sheath rot	Max^m	Min^m	Max^m	Min^m		
Supaul	62.4	54.4	29.8	22.9	20.0	6.9	33.3	24.1	86.0	80.2	243.7	9
Araria	67.6	55.3	18.1	15.4	18.3	9.4	32.1	24.3	81.6	74.6	296.9	11
Kishanganj	69.3	59.7	18.4	14.8	17.3	9.3	32.5	24.4	80.2	70.8	390.8	12
Katihar	58.4	42.7	19.3	21.4	14.4	9.1	32.1	24.5	81.6	74.6	242.3	10
Purnea	59.1	43.7	18.7	21.4	12.6	5.4	32.3	23.8	84.4	78.8	304.4	11
Madhepura	66.6	44.7	17.3	21.4	16.0	6.3	32.7	24.2	83.5	74.5	231.1	9
Saharsa	66.7	47.8	20.1	28.9	19.4	9.7	32.5	24.2	85.6	73.3	230.3	9
SEm ±	**1.62**	**1.69**	**1.23**	**1.74**	**2.05**	**1.10**						
CD at 5%	**4.65**	**4.86**	**3.55**	**5.01**	**5.91**	**3.17**						

The mean bacterial leaf blight and sheath blight disease incidence per cent was maximum i. e 29.8% and 20.2% respectively in the Supaul districts of Bihar where the disease was favoured by the mean maximum temperature, 33.3^{0}C, mean minimum temperature, 24.1^{0}C, mean maximum RH 86.0 %, mean minimum RH 80.2%, Mean Rainfall 243.7mm and the mean No. of rainy days 9.

Similarly the mean false smut and sheath rot disease incidence per cent was maximum i. e 28.9% and 9.7% respectively in the Saharsa districts of Bihar where the disease was favoured by the mean maximum temperature, 32.5^{0}C, mean minimum temperature, 24.2^{0}C, mean maximum RH 85.6 %, mean minimum RH 73.3%, Mean Rainfall 230.3mm and the mean No. of rainy days 9 during the cropping season.

During the survey of rice growing areas of North-East Alluvial Plains of Bihar blast, brown leaf spots, bacterial leaf blight, False Smut, sheath blight and sheath rot diseases were found. The incidence of Brown leaf spot was varied in the range from 40 to 90%, Blast (31-75%), Bacterial leaf blight (12-29%), False smut (5-40%), Sheath Blight (12-45%) and Sheath rot (8-32%) during 2008 to 2014 at above-mentioned different districts. The incidence of almost all diseases were highest in Kishanganj district which was followed by Araria and Katihar district. the mean brown leaf spot and blast disease incidence per cent was maximum i. e 69.3% and 59.7 % respectively in the Kishanganj districts of Bihar where the disease was favoured by the mean maximum temperature, 32.5^{0}C, mean minimum temperature, 24.4^{0}C, mean maximum RH 80.27 %, mean minimum RH 70.8%, Mean Rainfall 390.8mm and the mean No. of rainy days 12 during the cropping season. The mean bacterial leaf blight and sheath blight disease incidence per cent was maximum i. e 29.8% and 20.2% respectively in the Supaul districts of Bihar where the disease was favoured by the mean maximum temperature, 33.3^{0}C, mean minimum temperature, 24.1^{0}C, mean maximum RH 86.0 %, mean minimum RH 80.2%, Mean Rainfall 243.7mm and the mean No. of rainy days 9. Similarly the mean false smut and sheath rot disease incidence per cent was maximum i. e 28.9% and 9.7% respectively in the Saharsa districts of Bihar where the disease was favoured by the mean maximum temperature, 32.5^{0}C, mean minimum temperature, 24.2^{0}C, mean maximum RH 85.6 %, mean minimum RH 73.3%, Mean Rainfall 230.3mm and the mean No. of rainy days 9 during the cropping season.

During continuous survey, it had been concluded that Koshi zone as whole was congenial for the development of all important diseases in rice crop. The disease is favored by long dew period increased by fog, Shade and frequent rain and become worse when temperature is slightly cooler. These diseases are considered the major constraint in rice production and responsible for losses in quantity and quality of harvested product of the region. Heavy nitrogen application and shaded condition also favours to the severity of diseases. Finally, we can conclude that Koshi zone as whole is congenial for the development of diseases in crops. All the areas surveyed in the zone were found affected with the different diseases of rice with varying incidences.

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