Survey and surveillance on major rice diseases severity in Karnataka

ABSTRACT:

Rice blast, sheath blight and Grain discoloration diseases of rice were becoming a serious threat to rice crop in Karnataka. The patterns of spatio-temporal distribution of disease incidence were examined in two seasons (*Kharif* 2012 and 2013) with main objective of statues of rice diseases in paddy growing areas of Karnataka and variability with climatic condition. Most of the fields in the paddy growing areas of Karnataka were diseased, but significant differences in disease incidence occurred among the some sites in paddy growing areas of Karnataka. The leaf blast severity showed that the highest mean per cent disease incidence 37.20 was observed in Mandya district.and sheath blight severity showed that the highest mean per cent disease incidence 41.76 was observed in Yadgir district. The spatio-temporal distribution of grain discoloration incidence in Kharif 2012 and 2013 varied with districts, the maximum disease was in Bellary (33.82% and 31.24%) followed by Koppal (31.78% and 27.16%), for sheath blight, maximum disease was in Yadgir (36.23% and 41.76%) followed by Raichur (27.16% and 30.59%) and maximum leaf blast disease was in Mandya (37.20% and 36.91%) followed by Ramanagar (36.67% and 36.54%) respectively. Many fungi have been isolated from discolored grain, *Curvularia lunata* (Wakker) Boed. were found as a dominant pathogen. Survey and surveillance were serve as a precursor for evolving management strategies against the disease effective for the zone in an integrated way for sustainable development of crop in the state.

Keywords: Survey, Rice diseases, PDI

INTRODUCTION:

Rice (Oryza sativa L.) is considered as the “global grain”. It is the major staple food for more than half of the global population. Asian countries consume about 90 per cent of the rice grown and produced in the world and supplies 50 to 80 per cent calories of energy. Rice anchors food security in the world with challenges of climate change and is grown under wide range of latitudes and altitudes.

In India, rice is cultivated in a wide range of ecosystems viz., irrigated (21.0 m ha), rainfed lowlands (14.0 m ha), rainfed uplands (6.0 m ha) and flood prone (3.0 m ha). The total area under rice in Karnataka is 1.53 m ha with an annual production of 3.63 m tons (Anon., 2020). It is cultivated in command areas of Cauvery basin in South, Tungabhadra (TBP) and Upper Krishna (UKP) project areas in North where transplanting is the major

method of cultivation. In North-eastern Karnataka, major rice area is concentrated in Koppal, Raichur, Yadgir and Bellary districts under TBP area.

The predominant factors contributing to yield loss are both biotic and abiotic factors. Among biotic factors pests and diseases are important. Rice suffers from many diseases caused by fungi, bacteria, viruses, phytoplasmas, nematodes and other non-parasitic disorders etc. Among the fungal diseases, blast [*Pyricularia grisea* (Cooke) Sacc.], sheath blight [*Rhizoctonia solani* Kuhn] and grain discolouration are the more prevalent and destructive ones. Of the diseases, blast, sheath blight and tungro continue to cause huge crop losses in one or the other part of the country. Blast disease has long been known on paddy. Blast is generally considered as the major disease of paddy; because of its wide spread distribution and its destructiveness under favorable conditions. Sheath blight of paddy is potentially a serious threat in many paddy growing areas and this disease could reduce the grain yield by 58.60 per cent depending on environmental conditions, crop stages at which disease appears, cultivation practices, cultivars, application of high doses of nitrogen fertilizers etc (Jagjeet *et al.*, 2021).

Grain discoloration results in seedling mortality and reduction in germination and seedling vigour (Raghu *et al.*, 2020), causing significant yield loss. Thus, the pathogens causing grain discoloration have direct influence on both quantity and quality of seeds. Management of grain discoloration by different fungicides at different stages of flowering and grain filling has earlier been reported. Percentage of seed germination of discolored grains was improved by fungicides by eradicating the seed mycoflora. Discoloration results in poor quality of grain or seed and an important degrading factor. In such seeds disorders may indicate the presence of seed borne pathogen (Raghu *et al.*, 2020).

Keeping in view the above facts, the present investigation on major diseases of paddy was therefore directed to elucidate some of the critical aspects of the disease and the pathogen, with the following well defined objective *viz*., Survey of major diseases of paddy to review the statues of diseases in different climatic conditions of Karnataka state and their variability.

MATERIALS AND METHODS:

The paddy fields under Tungabhadra project (TBP) and Krishna (UKP-CADA), Cauvery belt areas of Karnataka and low land/upland paddy growing areas of Karnataka

(Irrigated maidan area-North, Irrigated maidan area-South, Southern transitional area, Hilly area and Coastal area) were selected for the present research study.

The grain discoloration, leaf blast and sheath blight were chosen as major disease of paddy of this area because they affect a hierarchy of plant tissues in a growing crop canopy and cause cumulative loss to the total factor productivity of the paddy crop. These diseases are also getting influenced to the changing micro climatic conditions of the growing crop.

A fixed plot survey was conducted during 2012-13 and 2013-14 in intensive paddy growing areas of Tungabhadra project (TBP), Krishna (UKP-CADA) area, and Cauvery belt and other paddy growing areas of Karnataka (Irrigated maidan area-North, Irrigated maidan area-South, Southern transitional area, Hilly area and Coastal area) to know the incidence and severity of blast, sheath blight and grain discolouration. In each village 3 fields and in each field, randomly ten hills were assessed for the incidence of diseases and the incidence of diseases was observed using scales as given below:

Chart 1. The SES scale for scoring leaf blast disease of paddy (IRRI, 2002)

Score	Per cent leaf area covered
0	No lesion
1	Small brown specks of pinhead size
2	Larger brown specks
3	Small, roundish to slightly elongated, necrotic grey spots, about 1-2mm in diameter, with brown margin
4	Typical blast lesions elliptical, 1-2 cm long, usually confined to the area of the 2 main veins infecting less than 2% of the leaf area.
5	Typical blast lesion infecting less than 10% of the leaf area
6	Typical blast lesion infecting 11 – 25% of the leaf area
7	Typical blast lesion infecting 26 – 50% of the leaf area
8	Typical blast lesion infecting 51 – 75% of the leaf area and many leaves dead
9	All leaves dead

Chart 2. The SES scale description for scoring sheath blight disease of paddy (IRRI, 2002)

Grade	Relative lesion height
0	No infection
1	Vertical spread of the lesion up to 20% of plant height
3	Vertical spread of the lesion up to 21 – 30% of plant height
5	Vertical spread of the lesion up to 31 – 45% of plant height
7	Vertical spread of the lesion up to 46 – 65% of plant height
9	Vertical spread of the lesion up to 66 – 100% of plant height

Chart 3. The SES scale description for scoring grain discolouration disease of paddy (Negi and Das, 2003)

Grade	Relative lesion height
0	Healthy
1	Light to dark brown dot like spot
2	Dark black discoloration
3	Dark brown discoloration
4	Light pink to light brown discoloration

Per cent disease index (PDI) was calculated by using the below mentioned formula given by Wheeler (1969).

$$PDI = \frac{\text{Sum of all the disease ratings}}{\text{Total number of leaves examined}} \times \frac{100}{\text{Max. Disease grade}}$$

Per cent incidence was calculated by using the formula,

$$= \frac{\text{No. of infected plants}}{\text{Total no. of plants observed}} \times 100$$

During survey of the major paddy growing areas of North Eastern Karnataka *viz*., Tungabhadra Project, UKP-CADA and Cauvery belt of South Karnataka and other paddy growing areas of the state (Irrigated maidan area-North, Irrigated maidan area-South, Southern transitional area, Hilly area and Coastal area) were considered for measuring the variability in the spatial and temporal incidence and spread of blast, sheath blight and grain discoloration in paddy. Further, based on the data collected on basic geographical features of the area, cultivation practices and the disease incidence/ spread, GIS mapping was done to draw inference on interrelationship between various factors by using ArcGIS software. The spatial patterns of paddy diseases were assessed by means of assessing the spread of diseases from plot to plot. Temporal analysis was done by considering incidence of major diseases of paddy with special emphasis on grain discolouration disease by fixed plot survey of same area for two years.

Fixed plot survey was carried out in major paddy growing districts *viz.*, Yadgir, Raichur, Koppal, Bellary, Davangere, Shimoga, Hassan, Chikamagalur, Udupi, Uttara Kannada, Dakshina Kannada, Kodagu, Mysore, Chamarajanagar, Mandya and Ramanagar districts of Karnataka during *Kharif* of 2012-13 and in each district, two-three taluks were selected and five villages were selected in each taluk. Further in each village three fields were selected to record the incidence of major diseases of paddy were recorded using stranded scale (Chart 1 for leaf blast; Chart 2 for sheath blight & Chart 3 for grain discoloration) and to study the spatial and temporal variability of the disease.

Initially each of the farmers field were marked in to four to five transects based on the visible symptoms of grain discoloration, leaf blast and sheath blight while traversing through the field. Further in each of the transects ten hills were selected randomly. Within these selected symptoms were identified visually and observations were recorded to calculate the severity index based on the number plants affected with grain discoloration, leaf blast and sheath blight.

During survey, symptoms of the disease were studied thoroughly. Infected leaf samples from all the areas of survey were collected for isolation of the pathogen and for further studies.

RESULTS:

An intensive fixed plot survey was carried out during *Kharif* 2012 and *Kharif* 2013 in different paddy growing areas of Yadgir, Raichur, Bellary, Koppal, Davangere, Shimoga, Hassan, Uttara Kannada, Chikamagalur, Mysore, Mandya, Ramanagar, Chamarajnagar, Kodagu, Dahshina Kannada and Udupi districts. Plots were visited and observations were drawn on disease incidence during September-December on *Kharif* crops and symptoms produced different pathogen was recorded.

The survey results of 2012 and 2013 for grain discoloration severity showed that the highest mean per cent disease incidence 33.82 was observed in Bellary district with 30.35 per cent disease index followed by Kopal district with 31.78 per cent disease incidence and 30.63 per cent disease index. Least disease incidence 17.65 of grain discoloration and 14.83 per cent disease index were recorded in Hassan district showed in (Table 1 and 2).

The survey results of 2012 and 2013 for sheath blight severity showed that the highest mean per cent disease incidence 41.76 was observed in Yadgir district. Least disease incidence 14.09 of sheath blight per cent disease incidences were recorded in Kodagu district showed in (Table 1 and 2).

The survey results of 2012 and 2013 for leaf blast severity showed that the highest mean per cent disease incidence 37.20 was observed in Mandya district. Least disease incidence 14.14 of leaf blast per cent disease incidence were recorded in Dakshina Kannada district showed in (Table 1 and 2).

The patterns of spatio-temporal distribution of disease incidence were examined in two seasons (*Kharif* 2012 and 2013). The distribution map of survey sites in the two study years are depicted. Most of the fields in the paddy growing areas of Karnataka were diseased, but significant differences in disease incidence occurred among the some sites in paddy growing areas of Karnataka (Irrigated maidan area-North, Irrigated maidan area-South, Southern transitional area, Hilly area and Coastal area).

The spatio-temporal distribution of per cent grain discoloration incidence in *Kharif* 2012 and 2013 varied with districts *viz*., Yadgir (21.48% and 21.66%), Raichur (24.58% and 23.30%), Koppal (31.78% and 27.16%), Bellary (33.82% and 31.24%), Davanagere (19.80% and 20.72%), Shimoga (21.39% and 22.92%), Uttara Kannada (21.66% and 20.72%), Hassan (19.39% and 17.65%), Mandya (20.05% and 19.28%), Mysore (19.51% and 18.71%), Ramanagar (22.25% and 21.17%), Chamarajnagar (21.09% and 19.57%), Kodagu (20.25% and 19.73%), Chikamagalur (17.54% and 19.53%), Dakshina Kannada (21.45% and 20.73%) and Udupi (22.79% and 21.76%) (Table 1 and 2.).

The spatio-temporal distribution of sheath blight incidence in *Kharif* 2012 and 2013 was varies with districts, Yadgir (36.23% and 41.76%), Raichur (27.16% and 30.59%), Koppal (25.65% and 26.94%), Bellary (26.47% and 25.32%), Davanagere (19.65% and 21.53%), Shimoga (21.68% and 20.13%), Uttara Kannada (19.23% and 20.29%), Hassan (15.45% and 15.66%), Mandya (19.26% and 18.84%), Mysore (25.17% and 27.07%), Ramanagar (23.07% and 27.79%), Chamarajnagar (19.27% and 20.32%), Kodagu (14.09% and 15.90%), Chikamagalur (18.34% and 17.86%), Dakshina Kannada (15.73% and 16.49%) and Udupi (16.40% and 19.34%) (Table 1 and 2).

The spatio-temporal distribution of leaf blast incidence in *Kharif* 2012 and 2013 was varies with districts, Yadgir (23.43% and 27.08%), Raichur (30.00% and 30.23%), Koppal (29.13% and 29.15%), Bellary (21.12% and 21.06%), Davangere (21.54% and 20.48%), Shimoga (23.14% and 21.08%), Uttara Kannada (24.30% and 20.06%), Hassan (20.31% and 20.26%), Mandya (37.20% and 36.91%), Mysore (36.22% and 34.95%), Ramanagar (36.67% and 36.54%), Chamarajnagar (34.74% and 35.16%), Kodagu (21.40% and 20.56%), Chikamagalur (22.39% and 21.85%), Dakshina Kannada (15.27% and 14.14%) and Udupi (18.01% and 18.67%) respectively (Table 1 and 2).

Location of the sample is believed to reflect valuable information due to the apparent spatial correlation quantifiable in terms of separation distance and direction. Samples taken close together are expected to be more alike than samples far apart. The spatio-temporal distribution of grain discoloration incidence in *Kharif* 2012 and 2013 varied with districts, the highest was in Bellary district (33.82% and 31.24%) which comes under irrigated maidan area of North-Karnataka and lowest was in Chikamagalur district (17.54% and 19.53%) which comes under Hilly area and with respect to sheath blight, the highest incidence was in Yadgir district (36.23% and 41.76%) which comes under irrigated maidan area of North-Karnataka and lowest was in Kodagu district (14.09% and 15.90%) which comes under Hilly area and the highest leaf blast incidence was in Mandya district (37.20% and 36.91%) irrigated maidan area of South-Karnataka and lowest was in Dakshina Kannada district (15.27% and 14.14%) which comes under Coastal area of Karnataka.

Table 1. Disease incidence of grain discoloration, sheath blight and leaf blast diseases of paddy in Karnataka

Districts	Taluka	No. of villages	No. of fields	Grain discoloration				Sheath blight		Leaf blast	
				2012		2013		2012	2013	2012	2013
				PDI	PI	PDI	PI	PI	PI	PI	PI
Yadgir	Yadgir	05	15	17.93	21.56	18.31	21.26	34.93	38.66	23.03	29.20
	Shahapur	05	15	17.85	21.02	19.46	23.48	40.63	39.48	22.03	25.24
	Shorapur	05	15	20.28	21.87	19.44	20.23	33.14	47.13	25.22	26.81
	Mean			**18.69**	**21.48**	**19.07**	**21.66**	**36.23**	**41.76**	**23.43**	**27.08**
Raichur	Raichur	05	15	21.83	21.81	18.42	21.62	26.87	34.32	24.70	28.52
	Manvi	05	15	22.78	23.37	20.84	24.03	24.53	37.14	28.25	31.24
	Sindhnur	05	15	26.96	28.23	20.26	23.64	28.88	27.37	31.91	32.38
	Devadurga	05	15	22.49	24.89	20.54	23.91	28.34	23.54	35.14	28.76
	Mean			**23.52**	**24.58**	**20.02**	**23.30**	**27.16**	**30.59**	**30.00**	**30.23**
Koppal	Gangavathi	15	30	35.08	36.78	27.86	29.73	29.57	33.49	31.67	32.47
	Koppal	05	15	26.17	26.78	22.03	24.59	21.73	20.38	26.59	25.83
	Mean			**30.63**	**31.78**	**24.95**	**27.16**	**25.65**	**26.94**	**29.13**	**29.15**
Bellary	Bellary	05	15	25.14	28.704	27.264	29.828	24.6	28.205	13.352	14.994
	Hospet	05	15	39.02	42.45	32.70	35.93	32.89	24.78	25.62	24.54
	Siraguppa	05	15	26.88	30.31	24.74	27.97	21.93	22.96	24.38	23.64
	Mean			**30.35**	**33.82**	**28.23**	**31.24**	**26.47**	**25.32**	**21.12**	**21.06**
Davanagere	Davangere	05	15	20.46	23.00	18.67	21.17	20.51	22.35	23.87	23.59
	Harihar	05	15	14.15	16.60	17.74	20.26	18.78	20.70	19.20	17.36
	Mean			**17.31**	**19.80**	**18.21**	**20.72**	**19.65**	**21.53**	**21.54**	**20.48**
Shimoga	Shimoga	05	15	18.80	20.54	15.33	17.81	18.33	19.72	17.60	17.04
	Tirthahalli	05	15	22.26	24.69	21.98	25.07	16.40	25.98	22.82	19.14
	Bhadravati	05	15	17.96	20.13	21.21	24.34	26.01	17.85	24.72	24.35
	Hosanagar	03	09	17.98	20.19	21.43	24.46	25.99	16.97	27.42	23.78
	Mean			**19.25**	**21.39**	**19.99**	**22.92**	**21.68**	**20.13**	**23.14**	**21.08**

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Uttara Kannada	Sirsi	05	15	17.04	19.87	15.90	18.58	18.47	19.29	22.83	20.17
	Mundgod	05	15	20.79	23.97	19.63	22.54	18.40	19.70	24.37	20.37
	Yellapur	05	15	18.50	21.13	17.85	21.04	20.83	21.88	25.71	19.64
	Mean			**18.78**	**21.66**	**17.79**	**20.72**	**19.23**	**20.29**	**24.30**	**20.06**
Hassan	Hassan	05	15	12.96	16.98	12.66	15.04	14.45	15.50	15.46	17.25
	Alur	05	15	20.62	24.59	17.77	20.88	15.79	16.31	20.04	21.15
	Sakleshpur	04	12	12.74	16.59	14.05	17.03	16.12	15.18	25.43	22.39
	Mean			**15.44**	**19.39**	**14.83**	**17.65**	**15.45**	**15.66**	**20.31**	**20.26**
Mandya	Mandya	05	15	19.28	22.41	19.62	22.15	23.08	18.28	39.03	38.85
	Pandavapura	05	15	14.11	16.61	13.24	15.26	16.68	18.75	34.04	34.32
	Malavalli	04	12	18.01	21.14	17.91	20.44	18.01	19.48	38.52	37.56
	Mean			**17.13**	**20.05**	**16.92**	**19.28**	**19.26**	**18.84**	**37.20**	**36.91**
Mysore	Mysore	05	16	17.81	20.76	16.00	18.94	25.41	25.00	35.61	34.78
	Nanjangud	05	16	16.92	19.74	15.26	18.38	30.54	29.11	35.52	31.46
	T.Narsipur	05	17	15.09	18.04	15.93	18.82	19.55	27.10	37.54	38.60
	Mean			**16.61**	**19.51**	**15.73**	**18.71**	**25.17**	**27.07**	**36.22**	**34.95**
Ramanagara	Ramanagara	05	15	19.06	21.21	19.14	21.36	22.03	32.65	37.60	35.92
	Kanakapura	05	15	21.24	23.28	18.76	20.98	24.11	22.92	35.73	37.15
	Mean			**20.15**	**22.25**	**18.95**	**21.17**	**23.07**	**27.79**	**36.67**	**36.54**
Chamarajanagar	Chamarajanagar	05	15	16.88	20.22	15.52	17.67	14.98	17.43	35.11	35.99
	Yalandur	05	15	18.62	21.96	20.53	20.63	16.56	18.54	34.94	36.90
	Kollegal	05	15	17.74	21.08	17.30	20.42	26.27	24.99	34.16	32.60
	Mean			**17.75**	**21.09**	**17.78**	**19.57**	**19.27**	**20.32**	**34.74**	**35.16**
Kodagu	Madikeri	05	15	16.85	18.94	17.13	19.74	11.61	15.24	18.89	19.73
	Virajpet	07	19	19.40	21.55	17.27	19.71	16.57	16.56	23.90	21.39
	Mean			**18.13**	**20.25**	**17.20**	**19.73**	**14.09**	**15.90**	**21.40**	**20.56**
Chikamagalur	Chikamagalur	05	15	15.42	17.99	13.67	16.69	17.92	13.70	14.59	13.24
	Koppa	05	15	17.12	19.72	16.26	19.22	17.43	19.79	21.95	21.26

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	Mudigere	05	15	13.77	14.91	19.72	22.68	19.66	20.09	30.64	31.04
	Mean			**15.44**	**17.54**	**16.55**	**19.53**	**18.34**	**17.86**	**22.39**	**21.85**
Dakshina Kannada	Mangalore	05	15	18.24	21.28	17.22	20.26	16.63	17.51	14.64	14.59
	Bentval	05	15	18.90	21.61	18.21	21.19	14.83	15.46	15.89	13.68
	Mean			**18.57**	**21.45**	**17.72**	**20.73**	**15.73**	**16.49**	**15.27**	**14.14**
Udupi	Udupi	05	15	18.38	21.56	15.85	19.27	16.87	19.39	17.91	17.47
	Karkal	05	15	20.72	24.02	21.06	24.25	15.92	19.28	18.10	19.86
	Mean			**19.55**	**22.79**	**18.46**	**21.76**	**16.40**	**19.34**	**18.01**	**18.67**

PDI= per cent disease index, PI= per cent disease incidence

Table 2. Disease incidence of grain discoloration, sheath blight and leaf blast diseases of paddy in Karnataka

PDI= per cent disease index, PI= per cent disease incidence

Rice growing ecosystem	District	Grain Discoloration				Sheath Blight		Leaf Blast	
		2012		2013		2012	2013	2012	2013
		PDI	PI	PDI	PI	PI	PI	PI	PI
Irrigated maidan area (North)	Yadgir	18.69	21.48	19.07	21.66	36.23	41.76	23.43	27.08
	Raichur	23.52	24.58	20.02	23.30	27.16	30.59	30.00	30.23
	Koppal	30.63	31.78	24.95	27.16	25.65	26.94	29.13	29.15
	Bellary	30.35	33.82	28.23	31.24	26.47	25.32	21.12	21.06
Southern transitional area	Davanagere	17.31	19.80	18.21	20.72	19.65	21.53	21.54	20.48
	Shimoga	19.25	21.39	19.99	22.92	21.68	20.13	23.14	21.08
Irrigated maidan area (South)	Hassan	15.44	19.39	14.83	17.65	15.45	15.66	20.31	20.26
	Mandya	17.13	20.05	16.92	19.28	19.26	18.84	37.20	36.91
	Mysore	16.61	19.51	15.73	18.71	25.17	27.07	36.22	34.95
	Ramanagar	20.15	22.25	18.95	21.17	23.07	27.79	36.67	36.54
	Chamarajnagar	17.75	21.09	17.78	19.57	19.27	20.32	34.74	35.16
Hilly area	Kodagu	18.13	20.25	17.20	19.73	14.09	15.90	21.40	20.56
	Chikamagalur	15.44	17.54	16.55	19.53	18.34	17.86	22.39	21.85
	Uttara Kannada	18.78	21.66	17.79	20.72	19.23	20.29	24.30	20.06
Coastal area	Dakshina Kannada	18.57	21.45	17.72	20.73	15.73	16.49	15.27	14.14
	Udupi	19.55	22.79	18.46	21.76	16.40	19.34	18.01	18.67

DISCUSSION:

In studying plant disease epidemics, quantifying and understanding the spatial pattern of disease establishment and spread is fundamental to understand disease dynamics, because spatial pattern reflects the environmental forces acting on the dispersal and life cycles of a pathogen (Ristaino and Gumpertz, 2000 and Suzuki *et al*., 2003; Zheng *et al*., 2023).

Field spatial variability was dynamic in inter and intra growing seasons. Temporal variability occurs both intra-seasonally (that is, time dependent in day steps) and inter-seasonally (that is, time dependent in year steps), respectively. Location of the sample is believed to reflect valuable information due to the apparent spatial correlation quantifiable in terms of separation distance and direction. Samples taken close together are expected to be more alike than samples far apart (Ahmad *et al.*, 2023; Li *et al*., 2022).

The spatio-temporal distribution of grain discoloration incidence in Kharif 2012 and 2013 varied with districts, the highest was in Bellary district (33.82% and 31.24%) and lowest was in Chikamagalur district (17.54% and 19.53%) which comes under Hilly area which comes under irrigated maidan area of North-Karnataka. Mathew Baite *et al.*, (2019) reported the grain discolouration of rice in Cuttak , where the overall incidence of the disease ranged from 25 to 92%. Although the severity of disease was varied to a greater extent in all the regions of North Eastern Karnataka. However the extent of disease incidence was noticed in all localities it may be due to use of same variety viz., Sonamahsuri (BPT-5204) and favorable environmental conditions prevailing over the locality could attributed to maximum disease incidence (Amoghavarsha *et al*., 2022).

The highest sheath blight incidence was in Yadgir district (36.23% and 41.76%) which comes under irrigated maidan area of North-Karnataka with an annual rainfall of 600 mm and with intensive cropping of BPT-5204 variety with high rate of NPK fertilizer. In contrast to above findings, Kapse *et al.* (2012) disease initiation and its corresponding meteorological data reveal that disease by Rhizoctonia solani was initiated during 3rd week of September when temperature ranged from 19.9 to 33.2 °C with humidity 72.00 to 88.00 per cent and 13.9 mm rainfall. Maximum disease was noticed up to 4th week of October with average incidence 19 per cent and corresponding temperature was 25°C and relative humidity 67 per cent and lowest was in Kodagu district (14.09% and 15.90%) which comes under Hilly area. The rate of disease increase at the onset of the epidemics was higher in the dry

than in the rainy season, but was afterwards higher in the rainy than in the dry season (Balanagouda, *et al*., 2021).

The highest leaf blast incidence was in Mandya district (37.20% and 36.91%) irrigated maidan area of South-Karnataka and lowest was in Dakshina Kannada district (15.27% and 14.14%) which comes under Coastal area of Karnataka.

The leaf blast incidence distributed in south transition zones encompassing Mandya, Chamarajanagar, Ramanagar and Mysore. Even though, the pathogen belonged to same race group variability was expressed by their differential ability to infect on to other differentials as indicated. The blast pathogen race area equally, widely distributed. The transition zone comprised of variable incidence which may be due to wide host genetic base observed in this zone. Cultivation of various high yielding varieties and many rice land races contribute great selection pressure on the pathogen. However, the pathogen expressed its virulence spectrum irrespective of geographical locations (Rajan Sharma *et al*., 2021).

The distribution of paddy disease varied with agro-ecological zones of Karnataka. The paddy disease frequency was more in irrigated maidans of Karnataka than the coastal and hilly areas. The irrigated maidan‟s (North) of Karnataka were high frequency of grain discoloration and sheath blight incidence, the area comprises of an annual rainfall of 600mm with mostly black cottony soil. Similarly, seasons with limited rainfall but heavy dew are conducive to stronger epidemics (Mathew Baite *et al.*, 2019).

The irrigated maidan‟s (South) of Karnataka were high frequency of leaf blast incidence, the area comprises of an annual rainfall of 778mm with red sandy to loamy soils, while coastal and hilly area comprises of an annual rainfall of 1600-3600mm.

Association with leaf blast, neck blast and nodal blast stages are correlated by the inoculation at leaf and panicle emergence stage. The similar results were by Alam *et al*, (2022). whereas seasons with limited rainfall but heavy dew are conducive to stronger epidemics. An example of intra-seasonal temporal variability is the day-to-day change in climatic parameters, whereas an example of inter-seasonal temporal variability is the change in plant infestation patterns between growing seasons (Zhang *et al*., 2002).

CONCLUSION:

Survey on occurrence, severity and spread of diseases of rice in major rice growing areas of Karnataka state revealed that disease is a major problem of zones among the sixteen districts. The more severity of rice diseases might be due to the highly favorable factors like application of excessive doses of nitrogenous fertilizers, intermittent drizzles, cloudy weather, high relative humidity (>90%), low night temperature, period of survey. Large scale cultivation of susceptible varieties as mono crop continuously on the same field might have increased the possibility of perpetuating the pathogen in the crop debris. The present study may serve as a precursor for evolving management strategies against the disease effective for the zone in an integrated way for sustainable development of crop in the state.

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