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A Comprehensive Survey and Predictive Framework for Brown Spot Diseases in Rice Cultivation

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Abstract
Rice cultivation is the principal activity and source of income for millions of household around the globe and several countries of Asia. In Rajasthan rice is grown largely under rain fed and irrigated conditions. One of the important constraints in achieving higher rice yield is losses caused by abiotic and biotic factors. Amongst the biotic factors plant disease are the most important factors which result in considerable and economical crop losses every year. The diseases may appear at any stage of development of plant, attacking the seed sown, root system, foliage, stalk, leaf sheath, inflorescence and even the developing grain. The present study area, The Bundi district, is situated in the south-eastern part of Rajasthan. The survey study thus gives advance knowledge of disease infestations in the area and this could help to plan cropping patterns and to get best advantage of control measures.

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Introduction

Hundreds of millions of people world-wide depend on rice as a staple food. A crop failure for any reason, poses a real threat of starvation (Te Beest *et al* 2007). Rice cultivation is the principal activity and source of income for millions of household around the globe and several countries of Asia. Except of course, for Antarctica, every continent of the planet produces rice with over one hundred twenty two countries currently growing the crop (Kenmore 2003). In Rajasthan rice is grown largely under rain fed and irrigated conditions. One of the important constraints in achieving higher rice yield is losses caused by abiotic and biotic factors. (Rohini *et al* 2013). Amongst the biotic factors plant disease are the most important factors which result in considerable and economical crop losses every year (Asghar *et al* 2007). The rice crop is subjected to more than forty diseases, which are responsible for low yield of rice in the world. The diseases may appear at any stage of development of plant, attacking the seed sown, root system, foliage, stalk, leaf sheath, inflorescence and even the developing grain (Shajia Iram *et al* 2003).

Study Area

The word survey is derived from two Latin words 'Sur' = over and Video = to see, meaning there by a general view', and inspection' or collection of data for mapping. The surveyed area is situated in Rajasthan state. Rajasthan is the largest state of the India and is located in the northwest part. Rajasthan is situated between $23^0$3' to $30^0$12' N latitude and $69^0$3' E to $78^0$17' E longitude, covering an area of 3,42,274 sq km, which accounts for eleven percent of the total area of the country. It is mostly a dry sandy desert but also has fertile plains, plateau, forest and hills rising as high as 1200 meters (4000 ft.) above sea level, with Mount Abu as the highest point between the Himalaya and the Nilgiris.

The maximum length of the state is 869 km from west to east and about 826 km from north to south. It represents the shape of a Rhombus. The present study area, The Bundi district, is situated in the south-eastern part of Rajasthan. It is located at $24^0$49'11'' to $25^0$53'11'' North latitude and $75^0$30' to $76^0$21'30'' East longitude. The total area of the district is 5765.45sqkm and it has an average elevation of 268 meters (879ft.). It is bounded in the north by Tonk district, in the

west by Bhilwara and on the south west by Chittorgarh districts. The river Chambal forms the southern and eastern boundaries separating the Bundi and Kota territories. The shape of the district may be described as an irregular rhombus. The length of the district from east to west is about 110 km and about 104 km from north to south. Bundi district ranks twenty second among the existing 33 districts of Rajasthan from the point of view of area and account for 1.62% of the state. The land is drained by the Mangali, Ghoda Pachad and Taleda rivers and its tributaries. The district is surrounded by the Aravali ranges. The district is generally dry except during the monsoon and winter rain. The average maximum temperature is 42.6 degree Celsius. Mean daily temperature is above 25 degree Celsius. Normal annual rainfall is 76.41 cm and the average relative humidity is generally about 60 percent.

The period from April to the end of June constitutes the hot season when the maximum temperature shoots up to 46^0C. The cold season lasts for about three and a half months from November to the end of February, when the temperature falls up to 3^0C. The mansoon season starts in the middle of July.

Bundi district is also known as “Chotti Kashi” or “City of step wells” or “rice bowl of the state”. The present study area is predominantly an agricultural region with an agrarian economy. The district is rich to grow Paddy crop. In the year 2025 approximately 17000 to 20000 hectare area of this district was under rice cultivation. In Bundi, rice is an important source of earning because of existence of many rice industries and export of rice. Since the climatic conditions are congenial for the spread of fungal infection in the Bundi district, it has been choosen as the study area. Survey of fungal pathogens associated with paddy crop was carried out in this area.

The Brown spot disease caused by *Helminthosporium* species was one of the principle causes of the Bengal famine of 1942-43. The disease induced losses up to 30% in weight of rice grain in Punjab. Singh and Khare (1986) surveyed four regions of Madhya Pradesh, India and collected 62 samples of seed borne fungi of paddy and found brown spot disease caused by *Helminthosporium* species as a principal disease of the area (Bidyalakshmi *et al* 2010) reported rice brown leaf spot as the most common foliar fungal diseases of rice in Manipur.

Material and Method

In the present investigation an intensive survey of the fungal pathogens with special reference to *Helminthosporium* associated with *Oryza sativa* was conducted at various localities viz. Ajjanda, Arnetha, Radi, Kapren, keshavraipatan, Gandoli (Tehsil-Keshavraipatan), Laban, Deikhera (Tehsil Indragarh), Gardara, Hattipura, Bardha, Dolara, Matunda, Namana, Talera (Tehsil Bundi), Satoor (Tehsil Hindoli) and Karwar (Tehsil Nainwan) covering the major rice growing areas of the Tehsils of Bundi district, during Kharif season of 2024-2025 (from July to November).

Plant Sampling Technique and Storage of Samples

Each surveyed locality of paddy growing area was divided into different zones of approximately the same area, by grouping. In each zone, five rice fields were selected, randomly. In each field, ten sampling units of 3x3 feet area were laid. A total of 50 plant samples (healthy and infected) were selected from 10 sampling units (5 plants from each unit), kept in sterilized plastic bags and brought to laboratory. On the basis of morphological symptoms healthy and infected plants were separated. Infected plant samples were washed thoroughly under tap water. The plants were kept in refrigeratior at 4 degree Celsius temperature for further processing. Identification of the fungal pathogens was again confirmed by microscopic preparations of the stained infected plant parts. For this purpose infected plant parts were taken, thoroughly washed and finely sectioned. The sectioned pieces were stained with cotton blue and mounted in lactophenol and then observed under microscope for further confirmation of the pathogens on rice.

Identification of Fungal Disease on Rice

The fungal diseases, on the field collected rice plant samples, were identified on the basis of morphological symptoms using standard journals, manuals and keys (Subramanium 1956 and Barnett 1972) for identification of plant pathogen and these samples were assessed for the occurrence of fungal diseases in the above said localities.

Disease Incidence

The occurrence and incidence of brown spot disease is calculated on rice plant samples by using the disease rating scale of 0-5 developed for foliar diseases (Anonymous 1996).

O =no symptoms.
1 = 1 – 5 % (Few) spots on <50% of leaves
2 = 5 – 20% spots on <50% of leaves
3 = 5 – 20%spots on >50% of leaves
4 = 20 – 50% spots on <50% leaves
5 = >50% spots on >50% leaves

The formula used for calculation of Percent disease incidence is as follows:

$$\text{Percent disease Incidence (PDI)} = \frac{\text{sum of individual disease rating}}{\text{Total number of leaves observed}} \times \frac{100}{\text{Maximum Rating}}$$

Loss in the yield due to blast disease was assessed in terms of loss in grain weight as compared to healthy plants at each locality.

Observation

Table 1: Occurrence of Brown Spot Fungi on Rice, in Bundi district, Rajasthan.

S. No.	The	Location	No. of Sampling Unit	No. of Plant Samples Studied	Brown Spot
1	K. Patan	Ajjanda	10	50	-
2		Arnetha	10	50	+
3		Radi	10	50	-
4		Kapren	10	50	+
5		K. Patan	10	50	+
6		Gandoli	10	50	+
7	Indargarh	Laban	10	50	+
8		Deikhera	10	50	+

9	Bundi	Gardara	10	50	+
10		Hattipura	10	50	-
11		Bardha	10	50	+
12		Dolara	10	50	+
13		Matunda	10	50	-
14		Namana	10	50	+
15		Talera	10	50	+
16	Hindoli	Satoor	10	50	+
17	Nainwan	Karwar	10	50	-
18	Total		170	850	12

+ = Occurrence of disease in the area. - = Absence of same disease in the area.

Brown spot disease prevailed in the 12 surveyed localities viz. Arnetha, Kapren, KeshavraiPatan, Gandoli, (Tehsil–eshavrai Patan), Laban, Dei Khera (Tehsil -Indragarh), Gardara, Bardha, Dolara, Namana, Talera (Tehsil- Bundi) and Stoor (Tehsil -Hindoli).

Symptoms of Diseases

In Brown spot disease symptoms were present on the aerial parts of the plant. Symptoms appeared as lesions (spots) most prominent on the leaf blade and glumes. The disease appeared first as minute brown dots, which later became oval to circular. Later the several spots coalesced and the leaf dried up. Internally the pathogen grew both intra and inter cellular, in the plant tissues and produced conidia. The conidiophores, bearing conidia, arised as lateral branches from hyphae and emerged out through stomata of leaf. Conidiophores were short erect and dark brown to olivaceous. Conidia were olivaceous brown slightly curved, tapering towards the ends and septate. The taxonomic position of the pathogen *Helminthosporium oryzae* Breda de Hann. is as follows:-

Kingdom – Fungi
Phylum – Deuteromycota
Class –Deuteromycetes
Order - –Moniliales
Family - Dematiaceae
Genus – Helminthosporium
Species – Helminthosporium oryzae

Table 2: List of Fungicides used commonly in surveyed area for the control of Blast disease

S. No.	Commercial Name	Chemical Name	Dose in Amount	Time of Spray
1	Silicon Plus	Hexaconazole 5%EC	35ml/lt/ha	After 45 days of transplantation
2	Cypra Plus	Gypermethrin 25% EC	20ml/16lt/ha	90 days after transplantations
3	Mantra	Imidacloprid 17.8% SL	5ml/16lt/ha	120 days after transplantations
4	Combi Plus	Carbendazim 12% + Mancozeb 63% WP	50gm/16lt/ha	At emergence of neck for neck blast
5	Machete	Carbendazim50WP	2.5g/kg seed	For seed treatement
6	Netiva	Propinazole25EC	16ml/16lt/ha	At ear emergence
7	Dupond	Hexaconazole5EC	32ml/lt/ha	At foliar stage for leaf blast

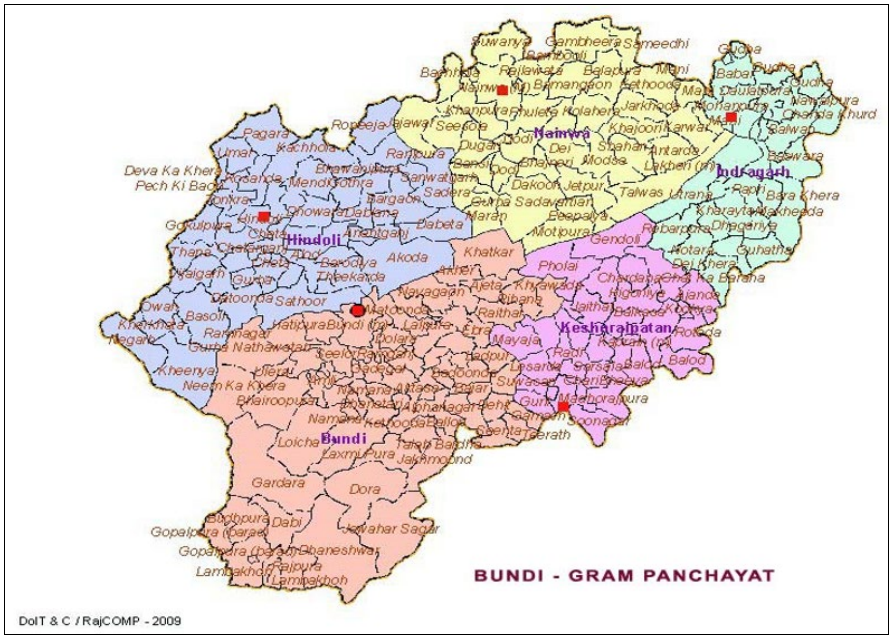
The Curative measures applied for the management of disease caused by fungal pathogen are different fungicides. In local practice, products used by farmers are listed in table-2 These fungicides are variously used by farmers in different localities as per requirement. Thus at present the management of disease is dependent on the use of chemical methods i.e. use of fungicide only. So the use of cheap and ecofriendly control methods is the need of hour.

Result and Discussion

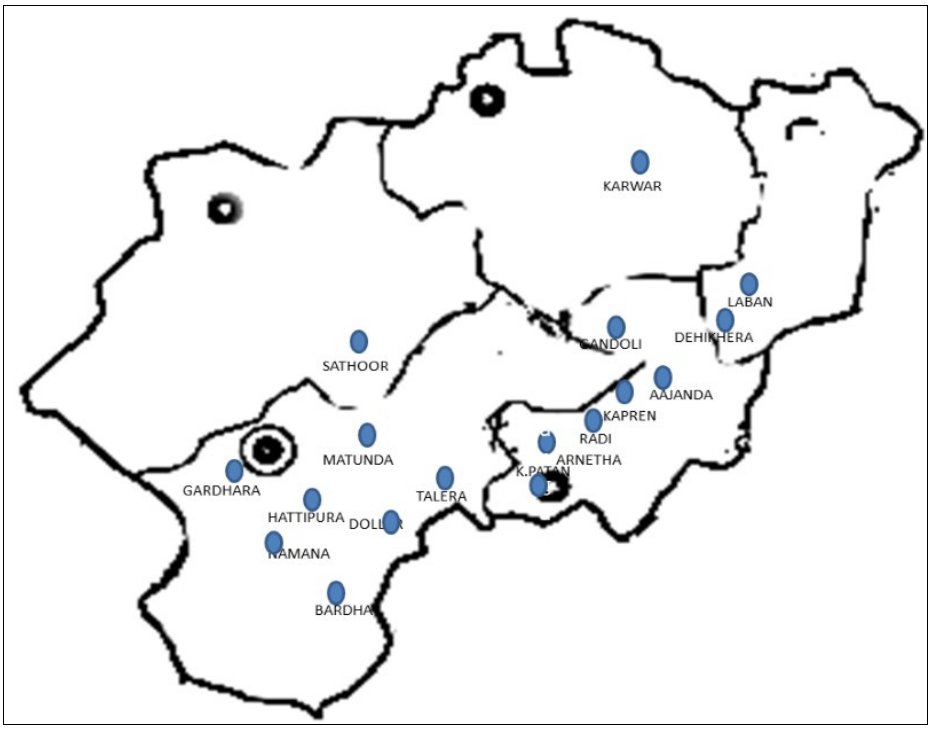
The present investigation was aimed to find out the occurrence and distribution of fungal diseases of rice and specially brown spot disease on rice plant in all the seventeen localities of Bundi district during Kharif season of year 2024-2025. The occurrence of the above said diseases in the study area may be due to the favourable climatic conditions, amount of rainfall in the area, moderate temperature, relative high humidity and suitable soil conditions.

Brown spot disease is particularly noticeable when the crop is produced in nutritionally deficient or otherwise unfavorable soil conditions. Susceptibility is reported to increase with age. Rice crop is found most susceptible to infection at flowering and grain-filling stages. Disease development is favoured by high relative humidity (86-100 %) and the optimum temperature for growth of pathogen is between 16 and 36°C. Leaves found to be wet for 8-24 hours for infection to occur.

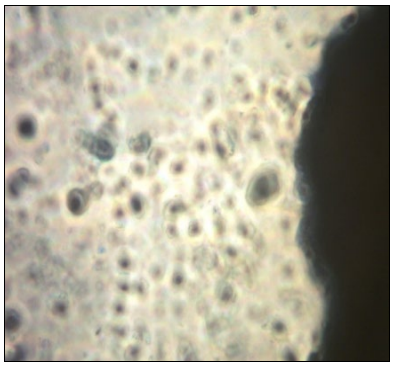
Inspite of the use of different fungicides as curative measures for diseases, there was repeatedly occurrence of the above said diseases in the area. This means that fungicides are insufficient to control the pathogens in the area. Again, the use of chemical control measures are harmful to plants, land and environment. So there is alarming need of some ecofriendly control measures to be used against the fungal pathogens of rice. The survey study thus gives advance knowledge of disease infestations in the area and this could help to plan cropping patterns and to get best advantage of control measures.



Study Area in Bundi District



Symptoms on leaf



T. S. Leaf

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