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EVALUATION OF POPULAR HIGH YIELDING RICE VARIETIES OF ASSAM AGAINST RICE GRAIN DISCOLORATION (RGD) DISEASE COMPLEX

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ABSTRACT

The Rice Grain Discoloration (RGD) disease complex can be considered as an emerging threat to rice cultivation leading to the loss of production and productivity of rice annually. Although the disease was initially considered as a minor disease, it has become a serious problem for rice growers of Assam especially in the present times. However, no significant information is available explaining the status of the rice varieties against the disease. Hence, the present study was undertaken where twelve popular high yielding rice varieties of Assam were evaluated against the disease. The maximum percent disease incidence (PDI) was recorded to be in the variety Mahsuri with a disease incidence of 12.33%, while the lowest was observed in Manohar Sali with a disease incidence of 5.66%. Study on the degree of discoloration revealed that the variety Ranjit showed highest point discoloration of 77%, whereas the highest partial and complete discoloration was observed in Bahadur (38%) and Dholi (36%), respectively. The present study provides an insight towards the susceptibility status of the popular rice varieties of Assam, India against the disease.

Key words : Rice Grain Discoloration (RGD), Disease complex.

Introduction

Rice (*Oryza sativa* L.) is the most important staple food of more than 60 percent of population in India. It provides livelihood and food security to more than two third population of the country (Adam *et al.*, 2018). It is a well known fact that the global population is increasing every year and has been predicted to exceed 8 billion by 2025. It has also been estimated that the production of rice needs to be increased by 40% in order to meet the increasing food demands by 2030 (Khush, 2005; Yadav *et al.*, 2018; Jena *et al.*, 2018). Rice is susceptible to a wide range of pests and diseases which affects the crop in all its growth stages. Moreover, the changing climatic conditions coupled with diverse ecologies and agricultural practices have led to emergence and re-emergence of several pests and diseases in rice (Ou, 1985). Some of the major diseases of rice in India are rice blast, brown spot, sheath blight, bacterial blight and tungro. In addition to that several minor diseases like sheath rot, stem rot, bakane, narrow brown spot, bacterial leaf streak, false

smut and rice grain discoloration have emerged as major problem in the recent years (Raghu *et al.*, 2018; Jena *et al.*, 2018). Amongst all these emerging diseases, the Rice Grain Discoloration (RGD) has become a serious problem for rice cultivators in recent times. RGD is widely distributed across Asia, Africa and Latin America causing significant loss to the quality and quantity of rice (Raghu, 2020).

RGD is known to be caused by a wide range of biotic as well as abiotic factors. The change in cropping practice, introduction of high yielding varieties, favorable weather conditions, increased fertilizer application have great impact on it (Yadahalli and Konnur, 2018). Some of the common abiotic factors associated with the disease are high temperature, delayed or low rainfall, unpredictable hailstorms and high humidity after flowering and so on. Although several abiotic factors are involved for grain discoloration in rice, the biotic factors play a major role. The biotic factors include a wide diversity of fungal and bacterial pathogens and saprophytes. Discoloration of rice

grains serves as a visible indicator of seeds having lower quality and association with a plethora of microorganisms (Chandramani and Awadhiya, 2014). Chhabra and Vij (2019) reported that over 59 genera and 99 species of fungi are associated with the disease. Some of the common and predominant fungal genera associated with RGD are *Bipolaris* sp., *Curvularia* sp., *Pyricularia* sp., *Fusarium* sp., *Phoma* sp., *Dreschlera* sp., *Helminthosporium* sp., *Rhizopus* sp., *Penicillium* sp., *Aspergillus* sp., *Alternaria* sp., *Nigrospora* sp., *Chaetomium* sp., *Tilletia* sp. and so on (Ou, 1985; Sharma *et al.*, 1987; Mian and Fakir, 1989; Mancini *et al.*, 2016; Arshad *et al.*, 2009).

The entire North Eastern India including Assam is known as the repository of a diverse rice germplasm and valuable gene systems (Sharma *et al.*, 1971). Rice being the staple food of the natives of North East India, it is cultivated widely across the geographical location. In Assam, rice is cultivated in more than 25 lakh hectares of land (Dutta *et al.*, 2023). It has become a matter of concern for the rice growers in recent times as the incidence and severity of RGD disease is increasing year after year. So far, there are no such reports stating the severity status of the disease in the local varieties of Assam and North Eastern India. Hence, the present study was undertaken where some of the short, medium and long duration popular rice varieties of Assam were screened against RGD disease complex.

Materials and Methods

Geographical location of the experimental site

The present study was undertaken during the year 2022 and 2023 at AAU- Assam Rice Research Institute (AAU-ARRI), Titabar, Jorhat, Assam, India which is situated at latitude and longitude of 26° 51'N and 94° 16E, respectively. A total of 12 of popular rice varieties of Assam namely Mahsuri, Manohar Sali, Gitesh, Bahadur, Ranjit, Shraboni, Lachit, Dholi, Numoli, Basundhara, Luit and Disang were considered under the study. For *in-vitro* experiments, 500g of each of the 12 varieties were collected from freshly harvested grains in a properly labelled zip lock bag and brought to the Plant Pathology Laboratory of AAU-ARRI, Titabar. All the samples were stored at room temperature for further trials.

Estimation of disease incidence

For estimation of disease incidence, a total of 100 rice grains were randomly picked from the collected rice samples and the grains that were discoloured were counted based on visual observation. The experiment was conducted in five replicates and in two seasons, *Kharif*,

2022 and *Kharif*, 2023 and the average was calculated out. The disease incidence was then calculated using the following formula:

$$\text{Disease incidence \%} = \left(\frac{\text{Number of infected grains}}{\text{Total number of grains}} \right) \times 100$$

Estimation of percent discoloration

As RGD disease is known to be caused by multiple pathogens showing different degrees of discoloration, hence, the percent discoloration was estimated in order to understand the severity of the disease of a particular rice variety. Hundred discoloured grains from each variety were carefully picked and categorized as point, partial or complete discoloration. The experiment was conducted in three replicates and in two seasons, *Kharif*, 2022 and *Kharif*, 2023. The percent discoloration was then calculated using the following formula.

$$\text{Discoloration (point/partial/complete) (\%)} = \left\{ \frac{\text{No. of discoloured grains (point/partial/complete)}}{\text{Total no. of grains counted for each sample}} \right\} \times 100$$

Results and Discussion

Details of rice varieties taken under study

The Rice Grain Discoloration (RGD) disease complex is one of the emerging diseases of rice in the changing climatic scenario. A total of 12 popular rice varieties of Assam were evaluated against RGD in the present study, the details of which are shown in Table 1 and Fig. 1. Amongst these varieties, Mahsuri, Manohar Sali, Gitesh, Bahadur, Ranjit are long duration rice varieties with a duration of 140-160 days, whereas Shraboni, Lachit, Dholi, Numoli, Basundhara are medium duration varieties with a duration of 130-135 days and Luit and Disang are popular short duration varieties having a duration of around 100-110 days. The grain type of Mahsuri, Gitesh, Ranjit, Lachit, Dholi, Basundhara and Disang are medium slender whereas the grain type of Manohar Sali, Shraboni, Numoli and Luit are short bold. Similarly, the grain type of Bahadur was found to be short bold in nature.

Considering the popularity of these varieties, Ranjit and Bahadur are the most widely produced and consumed varieties of Assam contributing around 3685 crores to the economy of the state (Dutta *et al.*, 2023). Gitesh on the other hand is a popular variety as unlike other high yielding varieties; no significant yield reduction has been observed even when the variety is transplanted in delayed conditions. This plasticity in the time of transplanting as popularized the variety in the flood prone areas of Assam which covers more than 50% of the total rice growing area of the state (Chetia *et al.*, 2023). The mid duration high yielding varieties like Shraboni, Lachit, Dholi, Numoli,

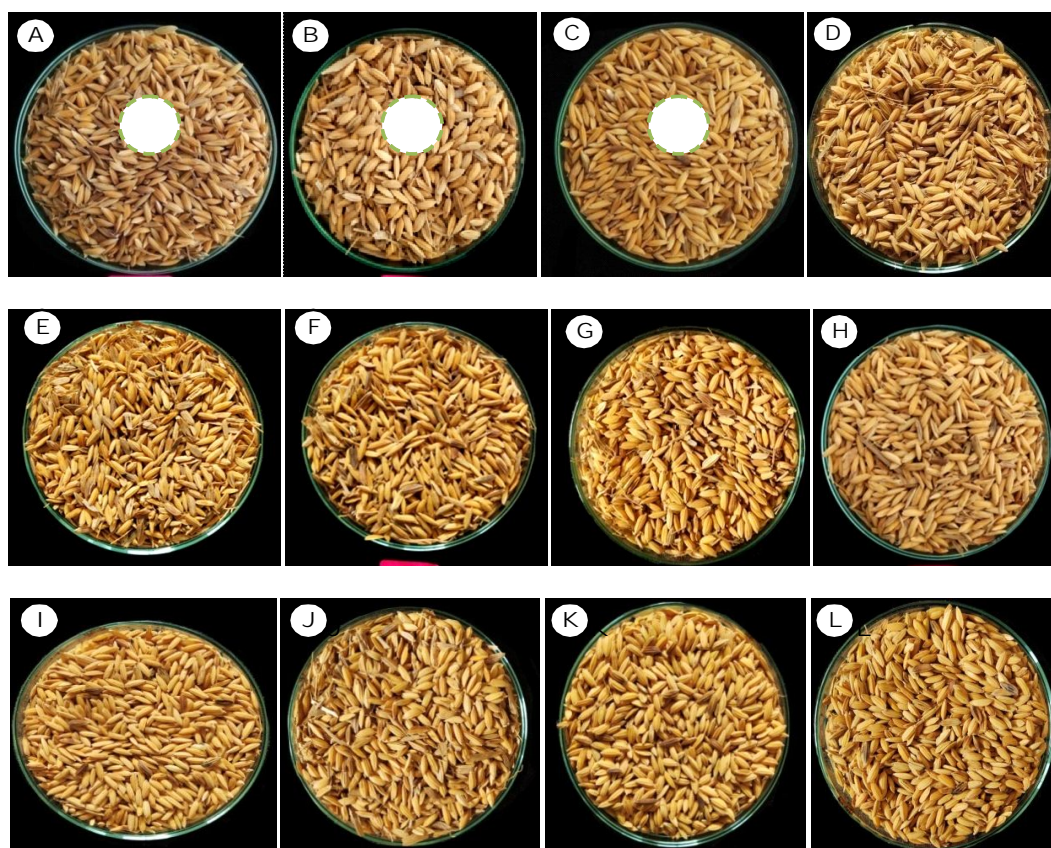


Fig. 1 : Different rice varieties taken under study: A) Mahsuri, B) Manohar Sali, C) Ranjit, D) Shraboni, E) Dholi, F) Numoli, G) Gitesh, H) Luit, I) Disang, J) Bahadur, K) Basundhara, L) Lachit.

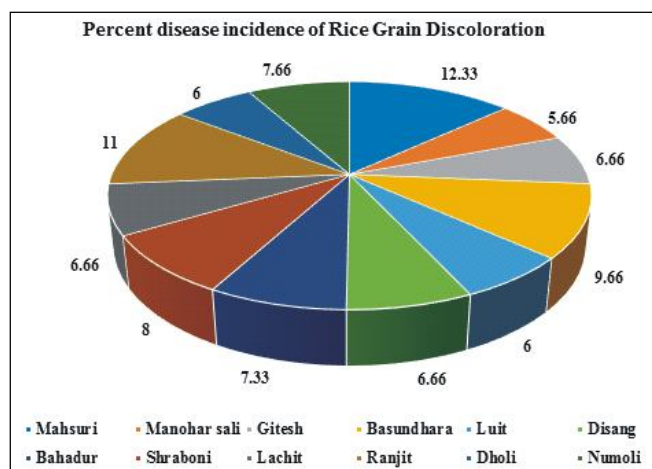


Fig. 2 : Percent disease incidence of Rice Grain Discoloration.

Basundhara are popular as these varieties provides a duration advantage of around 15-20 days allowing timely sowing of the Rabi crops after harvest of rice. Numoli and Dholi are fairly recent varieties developed from AAU-ARRI, Titabar which was notified during 2021 by the Central Varietal Release Committee (CVRC). Apart from being high yielding, the variety Dholi has another unique characteristic as it can withstand submergence for around 12-14 days. As flood is a recurring problem of the state, the short duration varieties like Luit and Disang

are highly feasible for recommendation in these areas as these varieties can be harvested before the onset of flood if grown early during February to April and grown after recession of flood late in the *Kharif* season (Chetia *et al.*, 2023).

Assessment of percent disease incidence and percent discoloration

The percent disease incidence was estimated in 12 *indica* rice varieties in two consecutive years and five replications (Fig. 2). Discolored grains and healthy grains were selected and separated based on visual observation (Fig. 3). Based on the results it was found out that the highest percent of disease incidence was seen in variety Mahsuri (12.33%) followed by Ranjit (11.00%) and the lowest was seen for Manohar Sali (5.66%). Per cent disease incidence RGD was significant for all the variety. The variety Mahsuri is known to be highly susceptible to both blast and brown spot disease of rice. Both these diseases are seed borne in nature and are also major causal agents of grain discoloration in rice. Manohar Sali on the other hand is widely known for being somewhat resistant towards all the major diseases of rice. The same was observed for RGD disease as well. The short duration varieties Luit and Disang showed relatively low

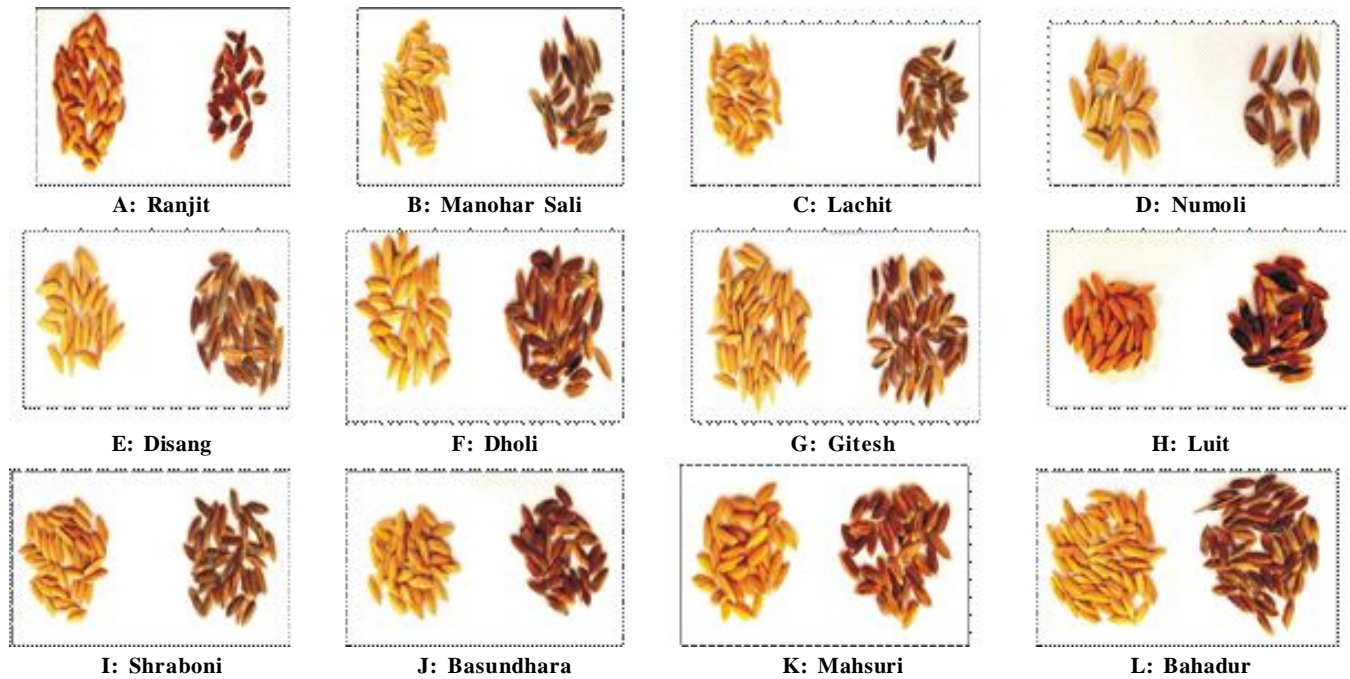


Fig. 3 : Healthy and infected rice grains of different rice varieties due to rice grain discoloration.



Fig. 4 : Rice panicles infected with RGD.

disease incidence of 6.0% and 6.6%, respectively. It was observed that the duration of the varieties and grain type had no significance with the severity of the grain discoloration disease in the tested rice varieties.

RGD disease complex is widely known to cause different degree of discoloration and based on its symptoms as well as pathogens associated, they are categorized as point, partial and complete discoloration (Raghu *et al.*, 2020). Hence, in order to understand the severity of RGD disease in the 12 tested *indica* rice

varieties, the percent discoloration was determined as shown in Table 2 (Figs. 4, 5 and 6). It was observed that the variety Ranjit showed the highest point discoloration percentage (77%) which is followed by Numoli (72%). The lowest point discoloration was observed in Bahadur (37%). Similarly, highest partial discoloration percentage was recorded in Bahadur (38%) followed by Lachit (36%) and the lowest was recorded in the variety Numoli (9%). The rice variety Dholi on the other hand showed highest complete discoloration percentage (36%), which was followed by Mahsuri (27%). Further, the lowest complete discoloration percentage was observed in Shraboni and Ranjit with 7%.

Similar studies were conducted by Butt *et al.* (2011), where they studied five Basmati rice varieties against seed borne microflora where they observed 27%, 19%, 17%, 16% and 14% found associated with the seeds of Basmati kernel, Basmati-385, Basmati-370, Basmati-198 and KS-282, respectively. They also reported four fungal species namely *Fusarium moniliforme*, *Alternaria* sp., *Helminthosporium* sp. and *Curvularia* sp., which were associated with the disease. Habib *et al.* (2012) on the other hand tested 8 coarse and 7 fine grained varieties of rice against seed borne microflora. They reported that the predominant pathogen infecting the rice grains was *Helminthosporium oryzae* and in the coarsed grain rice varieties, the percent infection caused by *H. oryzae* was 28.11% in case of agar plate method and 17.014% in case of blotter paper method. In fine grained varieties, the percent infection caused by *H. oryzae* was as high



Fig. 5 : A discolored and a healthy rice grain.

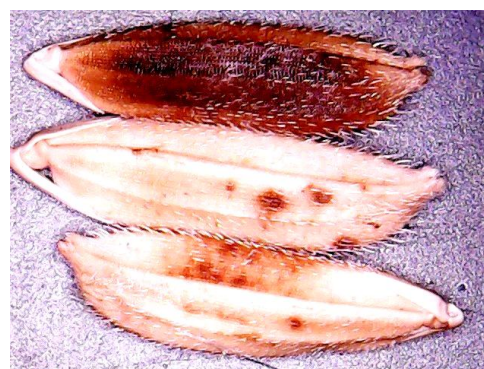


Fig. 6 : Rice grains showing point, partial and complete discoloration.

Table 1 : Details of rice varieties taken under the study.

| S. no | Variety | Duration | Grain Type |
|-------|--------------|-----------------------|-----------------|
| 1. | Mahsuri | Long(140-145 days) | Medium, Slender |
| 2. | Manohar Sali | Long(155-160 days) | Long, Bold |
| 3. | Gitesh | Long(155-160 days) | Medium, Slender |
| 4. | Bahadur | Long(155-160 days) | Short, bold |
| 5. | Ranjit | Long (155-160 days) | Medium, Slender |
| 6. | Shraboni | Medium (135 days) | Long, Bold |
| 7. | Lachit | Medium (130 days) | Medium, Slender |
| 8. | Dholi | Medium (135 days) | Medium, Slender |
| 9. | Numoli | Medium(135 days) | Long, Bold |
| 10. | Basundhara | Medium(130 -135 days) | Medium, Slender |
| 11. | Luit | Short (100 days) | Long, Bold |
| 12. | Disang | Short (100 days) | Medium, Slender |

Table 2 : Effect of rice grain discoloration on different rice varieties.

| S. no. | Variety | Point Discoloration (%) | Partial Discoloration (%) | Complete Discoloration (%) |
|--------|--------------------|-------------------------|---------------------------|----------------------------|
| 1 | Mahsuri | 48.00 | 25.00 | 27.00 |
| 2 | Manohar Sali | 52.00 | 28.00 | 20.00 |
| 3 | Gitesh | 67.00 | 18.00 | 15.00 |
| 4 | Basundhara | 59.00 | 32.00 | 9.00 |
| 5 | Luit | 60.00 | 32.00 | 8.00 |
| 6 | Disang | 63.00 | 26.00 | 11.00 |
| 7 | Bahadur | 37.00 | 38.00 | 25.00 |
| 8 | Shraboni | 65.00 | 28.00 | 7.00 |
| 9 | Lachit | 52.00 | 36.00 | 10.00 |
| 10 | Ranjit | 77.00 | 16.00 | 7.00 |
| 11 | Dholi | 36.00 | 28.00 | 36.00 |
| 12 | Numoli | 72.00 | 9.00 | 19.00 |
| | S.Ed (±) | 1.106 | 2.511 | 1.478 |
| | CD (P=0.05) | 2.295 | 1.210 | 3.069 |

Data are mean of two years and three replications.

as 40.47%. Moreover, it was observed that the percent infection of seed borne fungi was much higher in fine grained varieties than the coarse grained varieties. A total of 15 hybrid rice varieties of Bangladesh were evaluated against seed borne pathogens by Ora *et al.* (2011) where they identified 12 fungal pathogens associated with the disease namely *Xanthomonas oryzae*, *Rhizopus stolonifer*, *Aspergillus spp.*, *Fusarium moniliforme*, *Phoma sp.*, *Bipolaris oryzae*, *Curvularia lunata*, *Penicillium sp.*, *Alternaria tenuissima*, *Nigrospora oryzae*, *Chaetomium globosum* and *Tilletia barclayana*. They also observed that the lowest pathogenic incidence was recorded in the varieties showed lowest rotten seed, dead seed and highest seed germination and seedling vigour index. A detailed study on RGD disease complex was conducted by Raghu *et al.* (2020), where they evaluated 20 medium bold (MB); medium slender (MS); short bold (SB); short slender (SS); long bold (LB); long slender (LS) rice varieties for two seasons. From the study they observed that the maximum percent disease incidence was observed in Swarna Sub-1 with an average PDI of 39.42%. They also observed point, partial and complete discoloration patterns along with deterioration in test weight, germination percent, seedling vigour and activities of seed quality enzymes.

Although, there are a few studies in India and abroad which indicates the severity of RGD disease in various rice varieties, the present study mainly focuses on a thorough screening of the high yielding popular rice varieties of Assam against the disease.

Conclusion

The rice grain discoloration (RGD) disease complex has become an emerging problem of Assam causing yield losses every year. Rice being the most important crop of Assam, it is the need of the hour to understand the susceptibility status of the most popular rice varieties of the state against the disease. Hence, in the present study, a total of 12 most popular high yielding rice varieties were screened against the disease wherein both the disease severity and the disease incidence were determined. However, in the future it is important to determine the major biotic and abiotic factors responsible for the disease in Assam and establish the most suitable sustainable management practices that shall be effective in managing the disease in the state.

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