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Brown Spot Resistance in Rice : A Review

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ABSTRACT

Rice is suffering from several fungal diseases among them brown spot caused by Bipolaris oryzae is important. Rice brown spot (BS) is a chronic disease that affects millions of hectares of rice. Chaetomium cochliodes proved to be a new antagonistic fungus against brown leaf spot of rice. BS is by far one the strongest yield reducers amongst rice diseases today. Analysis of brown-spot infected control plants suggested that C.miyabeanus represses plant photosynthetic processes and nitrate reduction in order to trigger premature senescence and cause disease. Biological products formulated from Ch cochliodes were tested to control brown leaf spot of rice. Host plant resistance to disease is an effective and economical way to manage BS. Spot formation has been analyzed mainly using mutants. Many mutants exhibiting spontaneous cell death have been reported in various plants, including Arabidopsis, maize, barley, and rice.Three rice genes, Spl7, Spl11, and Spl18, have been cloned and characterized. BS is conventionally perceived as a secondary problem that reflects rice crops that experience physiological stresses, e.g. drought and poor soil fertility, rather than a true infectious disease.
Keywords : Brown Spot, Bipolaris Oryzae, Chaetomium Cochliodes, Biological Products

I. INTRODUCTION

Brown spot disease, caused by the fungus Bipolaris oryzae (Breda de Haan) Shoemaker, is one of the most destructive diseases in rice and is of great importance in several countries. Brown spot is still widely reported in India (Chakrabarti, 2001; Reddy et al., 2011), as well as in some parts of south and southeastern Asia (Savary et al., 2000a,b). The pathogen affects millions of hectares worldwide every year and yield losses in relative terms vary widely from 4 to 52% (Barnwal et al., 2013). The second most abundant element in the Earth's crust, silicon (Si) can comprise up to 70% of the soil mass in the form of silicate minerals and water-soluble orthosilicic acid. orthosilic acid is readily taken up by the plant roots and loaded into the xylem by a specific transporter system (Ma and Yamaji, 2006). Via the xylem, silicic acid is transported to the shoots, where it is constantly polymerized either as silica in the cell or as an insoluble, subcuticular silica layer outside the cell. To date, dozens of studies have documented the ability of Si to enhance plant growth and yield and it is the only nutrient that is not detrimental when accumulated in excess (Epstein and Bloom, 2009). The important diseases occur in susceptible variety of rice are rice blast caused by Magnaporthe grisea (Pyricularia oryzae) and brown leaf spot caused by Drechslera oryzae (Helminthosporium oryzae). Kanokmedhakul et al.(2006) stated that Ch globosum could produce antimycobacterial anthraquinone chromanone compound and disktopiperazine alkaloid and antifungal Azaphilones from Ch cupreum ncluding bis-spiro-Azaphilones and azaphilones from Ch cochliodes (Thohinung et al., 2010). research during the previous two decades indicates another potential option for rice disease management through the use of biocontrol agents (Mina et al., 2013; Gade, 2013; Ramteke et al., 2011; Balai et al., 2013). A several biocontrol agents namely Pseudomonas fluroscence, Bacillus subtilis, Trichodermaspp. have been found effective against major rice diseases caused by fungal pathogens. (Vasudevan et al., 2002). The present investigation was undertaken for the management of Brown spot disease of rice by using safer fungicides and some bioagents. Disease diagram sets have been developed to aid in visual assessments of plant disease severity (Godoy et al., 2006; Lima et al., 2011; Spolti et al., 2011; Yadav et al., 2013). Typically, disease diagrams display the particular pattern of lesions of a specific disease on the unit of assessment and each diagram of the set represents a specific severity as percentage (James, 1971). Then, the rater uses the diagram set as a guide to estimate severity to the nearest percentage, which still requires that the rater interpolates and extrapolates to assign an appropriate value to the specimen (Madden et al., 2007).

II. METHODS AND MATERIAL

Importance of Brown Spot

Brown spot is still widely reported across India (Reddy et al., 2010) and more generally in the South and South-East Asian countries (Savary et al., 2000a). It causes yield losses that, on average, are in the range of 10 % of the attainable yield wherever it occurs (Savary et al., 2000b,2006) in the lowlands of tropical and subtropical Asia. Therefore, BS is by far one the strongest yield reducers amongst rice diseases today. Further, there is indication that BS is becoming more frequent and severe as drought is becoming more frequent (Savary et al., 2005), perhaps due to increased variability in rainfall.

Host Plant Resistance (HPR)

Host plant resistance to disease is an effective and economical way to manage BS. However, breeding efforts have emphasized acute diseases such as leaf blast and bacterial blight rather than chronic diseases such as BS (Savary et al., 2011) despite the importance of BS.

Biological Control of Brown Spot

Seed treatments with Trichoderma viride or T.harzianum have reduced disease by 70 % (Biswas et al., 2010). Over 70 % disease reduction has been achieved too from the use of selected Pseudomonas spp. isolates (Joshi et al., 2007;Ludwigetal, 2009). Direct foliar application. Harzianum has also been reported to reduce the disease intensity and significantly improve grain yield, total grain carbohydrate and protein, in addition to a significant improvement in the total photosynthetic pigments in rice leaves (Abdel-Fattah et al., 2007).

Red-Light-Induced Resistance to Brown Spot

When the leaves were kept under natural light or in the dark. The protective effect was also observed in intact rice plants inoculated with B. oryzae; the plants survived under red light, but most of them were killed by infection under natural light or dark condition. Red light did not affect fungal infection in onion epidermis cells or heat-shocked leaves of rice, and it did not affect cellulose digestion ability; this suggested that the protective effect is due to red-light-induced resistance. In addition, the degree of protection increased as the red light dosage increased, regardless of the order of the red light and natural light period, indicating that red-light-induced resistance is time dependent.the results suggest that the tryptophan and phenylpropanoid pathways are involved in the red-light-induced resistance of rice to B. oryzae (Roxana et al., 2014).

Primary metabolism plays a Role in Molding Silicon-Inducible Brown Spot Resistance

Analysis of brown-spot infected control plants suggested that C. miyabeanus represses plant photosynthetic processes and nitrate reduction in order to trigger premature senescence and cause disease. In Si-treated plants, however, these pathogen-induced metabolic alterations are strongly impaired, suggesting that Si alleviates stress imposed by the pathogen. Interestingly, Si also significantly increased photorespiration rates in brown spot-infected plants. Even though photorespiration is often considered a wasteful process, recent studies indicate that this metabolic bypass also enhances resistance during abiotic stress and pathogen attack by protecting the plant's photosynthetic machinery. In view of these findings,our results favor a scenario whereby Si enhances brown spot resistance by counteracting C. miyabeanus-induced senescence and cell death via increased photorespiration. Moreover, our results shed light onto the mechanistic basis of Si-afforded disease control and support the view that in addition to activating plant immune responses, Si also can reduce disease severity by interfering with pathogen virulen (Jonas et al., 2015).

Bio-formulation of Chaetomium Cochliodes for Controlling Brown Leaf Spot of Rice

Crude extracts from Ch cochliodes using hexane, ethyl acetate and methanol at 1,000 ppm could significantly inhibited the inoculum production of rice pathogen 93.85 per cent which ED50 value was 66.45 ppm when compared to the control (0 ppm). Ch cochliodes was formulated in different forms for applying to control brown leaf spot of rice. Biological products formulated from Ch cochliodes were tested to control brown leaf spot of rice caused by D oryzae. Result showed that biopowder formulation gave significantly highest to control leaf spot and highest plant growth when compared to the non-treat control, followed by applying crude extract of Ch cochliodes, benlate and spore suspension of Ch cochliodes. Moreover, bio-powder formulation gave significantly increased in plant growth over 44 % and followed by crude extract of Ch cochliodes, spore suspension of Ch cochliodes and benlate (Kasem,2014).

Characterization of the Rice Canopy Infested with Brown Spot Disease

Based on the field hyperspectral data from the analytical spectral devices (ASD) spectrometer, we characterized the spectral properties of rice canopies infested with brown spot disease and selected spectral regions and bands sensitive to four severity degrees (severe, moderate, light, and healthy). The results show that the curves' variation on the original and the first- and second-order derivative curves are greatly different, but the spectral difference in the near-infrared region is the most obvious for each level. Specifically, the peaks are located at 822, 738, and 793 nm, while the valleys are located at 402, 570, and 753 nm, respectively. The sensitive regions are between 430-520, 530-550, and 650-710 nm, and the bands are 498, 539, and 673 nm in the sensitivity analysis, while they are in the ranges of 401-530, 550-730 as well as at 498 nm and 678 nm in the continuum removal (Zhao, 2012).

III. RESULT AND DISCUSSION

Management of brown spot disease

For the management of the disease an experiment was conducted at Instructional Farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal during 2010-11 and 2011-12 by using Trichoderma viride isolate 5 @ 100 kg, 200kg and 400 kg per ha, as basal application with FYM @1.2 ton at final land preparation, Seed treatment with Bavistin @ 1g/kg of seeds, Drenching of Bavistin @ 1g/litre of water as basal application, Spraying of Bavistin @ 1g/litre of water for three times at an interval of 15 days starting from 30 days after sowing, Seed treatment with Bavistin @ 1g/kg of seeds + Drenching of Bavistin @ 1g/litre of water as basal application + Spraying of Bavistin @ 1g/litre of water for three times at an interval of 15 days starting from 30 days after sowing and Seed treatment with Emissan-6@ 2g/kg of seed (Sarkar, 2014).

Chromosomal locations of a gene underlying heat-accelerated brown spot formation

Spot formation has been analyzed mainly using mutants. Many mutants exhibiting spontaneous cell death have been reported in various plants, including Arabidopsis, maize, barley, and rice (Lorrain et al. 2003). Three rice genes, Spl7, Spl11, and Spl18, have been cloned and characterized (Mori et al., 2007; Yamanouchi et al., 2002; Zeng et al., 2004), and Spl5 has been fine-mapped (Babu et al., 2011). Spl5, Spl11, and Spl18have been suggested to play important roles in disease resistance (Babu et al. 2011; Mori et al., 2007; Zeng et al., 2004). On the other hand, lesions in spl7mutant plants are likely necrotic rather than directly associated with HR cell death, and are caused by environmental stresses such as high temperature (Yamanouchi et al., 2002). Spl7encodes a heat stress transcription factor (HSF), which is crucial for increasing plant tolerance to cell death in response to high temperature (Yamanouchi et al., 2002). HSFs bind to heat shock elements in the promoters of heat shock protein (HSP) genes and transcriptionally induce heat stress response (Wu, 1995).

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