Introduction

In India, rice (*Oryza sativa* L.) is cultivated in 42 million hectares under four major ecosystems *viz.*., irrigated (19 million hectares), rainfed lowland (14 million hectares), flood prone (3 million hectares) and rainfed upland (6 million hectares) ecosystems (Prasad et al 2001). Rice is one of the most important cereal crops, which serves as staple food for more than two-thirds of the world’s population. Rice is affected by a number of biotic and abiotic factors that cause disease and reduce yields. A few of them cause concern as epidemic outbreaks, either frequent as in blast and bacterial leaf blight, or discontinuous and occasional as in sheath blight, tungro virus, brown spot, sheath rot and grain discolouration, or rare as in false smut, and in stem and foot rots. Some pathogens pose problem in only one or a few farm fields where the entire crop may be affected. Even these sporadic epidemics that occur in an extremely restricted area pose a threat to farm production and farmers’ livelihood. Once the causal agent of a disease has been correctly identified, it is possible to develop plans to manage disease. Today we can draw on this vast store of knowledge to help us in our efforts to manage rice diseases. Intelligent rice disease management is an economic necessity. Together with need-based fertilizer and disease management, it is a form of insurance that helps to guarantee the farmer a profitable yield. It helps to prevent wide fluctuations in yield. It also helps to prevent disastrous epidemics and famines. During the past five decades, our efforts have been aimed at understanding and combating rice diseases, primarily through host plant resistance breeding with selected donors. Numerous varieties have been released for commercial cultivation in different ecosystems in India by the Central Sub-Committee
for Variety Release (for more than two states) and State Sub-Committee for Variety Release (for individual state). Among from rice diseases, four major diseases viz., rice blast and sheath blight (fungal diseases), bacterial leaf blight and tungro virus cause serious concern as often their epidemics drastically affect rice production. The major rice research focus has been on preventing grain yield losses due to devastating attacks from these four pathogens.

Rice blast *Pyricularia oryzae* (telomorph *Magnaporthe oryzae* (Hebert) Brarr) Couch and Kohn) been one of the most serious diseases of rice in India and other rice growing countries, often significantly reducing yields. *Magnaporthe oryzae*, a taxon recently segregated from *M. grisea*, a species complex of haploid ascomycetous fungi (Couch and Kohn 2002). This study conclusively demonstrated that there are two species within the present circumscription of *M. grisea*. Because the name *M. grisea* is nomenclaturally tied to isolates from *Digitaria*, the scientifically correct name for isolates from *Oryza* and other grasses is *M. oryzae*. Rice blast disease causes severe loss of yield in all the ecosystems (Rajarajeswari and Muralidharan 2006). Therefore, the name *Pyricularia oryzae* or *M. oryzae* is used for all the isolates that caused rice blast disease in this study. Blast continues to be a threat to realizing yield potential in cultivars in all the rice ecosystems (DRR 1975-2014).

Sheath blight disease is caused by the fungus, *Rhizoctonia solani* Kuhn (telomorph *Thanetophorus cucumeris* Frank Donk.). It is widely prevalent, particularly in irrigated rice ecosystem but seldom assumes epidemic proportions. The asexual phase of
the pathogen actually incites the disease in plants just above the water line in fields to cause damage to yields. The disease appears in moderate to severe intensities in a few states like Andhra Pradesh, Assam, Kerala, Orissa and West Bengal. Although sheath blight occurs, its impact on rice yields is demonstrated to be relatively less in the country when judged against blast. Losses from sheath blight in irrigated ecosystem may be around one tonne per hectare (Muralidharan et al 2003a).

Bacterial blight is caused by *Xanthomonas oryzae* pv. *oryzae* (Ishiyama) Swigs et al. Symptoms of bacterial leaf blight disease appear from the tip or edges of leaves as yellow water soaked and undulating lesions parallel to the veins that later turn to straw yellow colour. The disease initially starts from either one or both sides of leaf margin. As the disease progresses, the drying spreads downwards and inwards of leaf blade causing drying and death of the leaf. Often amber coloured bead-like bacterial exudates are present on lesions. In systemic infection, seedlings wilt and die. Grains are either partially filled or become chaffy (Rajarajeswari et al 2005). After the introduction of dwarf, high-yielding variety TN1, which was known for susceptibility to bacterial blight, the disease assumed greater importance in India.

Rice tungro virus disease is transmitted by insects. Viruliferous green leafhoppers *Nephotettix virescens* Distant., *N. nigropictus* Stahl. and *Recilia dorsalis* Motsch., introduce the virus into rice leaves when they probe to suck nutrients. Thus, a tungro-infected plant suffers from damage caused by both virus and the insect vector. Tungro virus disease occurs if a susceptible crop, virus inoculum and green leafhoppers to carry
virus as vectors, are available in a rice field. The disease attracted the public attention for the first time following an epidemic outbreak in the eastern parts of Uttar Pradesh, Bihar, and West Bengal (Raychaudhuri et al. 1967). Later, the disease apparently moved towards peninsular India during 1977. Severe tungro virus disease outbreaks threatened rice production in Andhra Pradesh and Tamil Nadu during 1984. Regular production oriented survey records clearly established the discontinuous occurrence of tungro in the country (Muralidharan et al. 2003c).

**Statement of the problem**

Over the years rice germplasm sources have been meticulously evaluated for locating resistance to various pathogens. Many donors possessing high levels of resistance to one or more pathogens have been identified and then used in breeding programs to develop high-yielding cultivars possessing resistance (Muralidharan and Reddy 2004b). Several of these commercial cultivars like Aditya, Rasi, Tulasi, Vikas etc, have contained blast (Prasad et al. 2011). Besides these, different state variety release committees have so far released over 250 cultivars resistant to *P. orizae*. So far no rice culture has been found to be resistant to *R. solani* infection. Only T 141, OS 4, BCP 3, Saibham, Buhjan, Saduwee, Remadja, Ta-Poo-Cho-Z, Nangmons 4, Athebu, Phoure and ARC 15368 have been identified as donors expressing moderate resistance to sheath blight pathogen. Pankaj, Swarnadhan and Vikramarya exhibit a good degree of tolerance to sheath blight (Prakasam et al. 2013). Donors identified for resistance to bacterial leaf blight are BJ 1, TKM 6, Lacrose-Zenith-Nira, Java 14, Wase-aikoku and Sayaphal. Some of the commercially cultivated bacterial leaf blight resistant cultivars are Ajaya, PR 4141, PR
114, Swarna, MTU 4870, HKR 120, IR 36, IR 64 and Saket 4 (Laha et al 2009). Many rice cultivars possessing resistance or tolerance to tungro virus in fields have been released by different states for commercial cultivation (Muralidharan et al 2003c; Krishnaveni et al 2009) like Nidhi, Vikramarya, IET 8565 and IET 8902 that prevented yield losses from tungro. More than 1035 rice cultivars have been released in the country since the introduction of IR 8 and Jaya in 1966 possessing resistance to one or more pathogens and high yield potential (Rani et al 2011; Prasad et al 2011; DRR 1965-2014).

In spite of the release of so many cultivars possessing resistance to pathogens and high grain yields for commercial cultivation, outbreaks of diseases occur every year to cause yield losses (DRR 1975-2014). Diseases in plants are caused by an interaction between host, pathogen and environment. A disease on a single plant under a set of conditions is altogether different from that on a group of plants or on a population of plants. Generally, large populations of plants are cultivated in a crop species or, in a cultivar. Reaction of large populations of presumably different kinds of plants to a large population of pathogen under a range of macro- or micro-climate, nutritional, and soil or water status can produce confusing set of observations on the level of resistance or susceptibility. Evidence on co-evolution of host and pathogen suggest for the presence of large variability in both host and pathogen. This variability must be dynamic i.e., continuously undergoing change, if the two organisms are to exist without eliminating each other (Muralidharan 2005). It is, therefore, essential to evaluate critically all the high-yielding cultivars released for commercial cultivation to farmers to understand the stability or instability of resistance imparted in them and grain yields.
**Objectives and Methodology**

The main objective of this study will be to select representative high yielding cultivars released over the years and re-evaluate critically for yield and the level of resistance to pathogens. Over a hundred such cultivars will be re-assed in replicated repeat tests, using well established screening facilities in green house and fields, for resistance to blast and sheath blight (two fungal pathogens), bacterial leaf blight and tungro virus diseases. All these cultivars will be grown in field plots for estimating the yield in three kharif and two rabi seasons. Data will be systematically collected on plot yield, single plant yield and panicle number/hill, grains/panicle, grain weigh, and straw weight to precisely estimate grain yields per hectare. Simultaneously all the available data on reaction tests on resistance/susceptibility to the four pathogens and the grain yields of these varieties as recorded and claimed at release will be gathered. This old recorded data will be compared with the data from the present study to find changes if any in the performance of released varieties to pathogens and to grain yields. Such detailed studies will enable a clear understanding on the stability of released high-cultivars for disease resistance and grain yield.