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RESEARCH ARTICLE

A REVIEW ON VARIOUS MANAGEMENT METHOD OF RICE BLAST DISEASE

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ABSTRACT

Rice (*Oryza sativa*) is native to Asia and grown worldwide. Rice feeds more than 50 % of the world population Rice is predominant staple food for 17 countries in Asia and provides 20 % of world's dietary energy supply. So, among cereal it considered as most significant crop. Both biotic and a-biotic factors adversely affect crop and yield. Among them, 70 to 80 % of annual rice yield is lost due to blast disease. Higher statical data of blast disease is threat to growing population on food security. The objective of this review is to know the different methods of controlling blast diseases. Management of blast can be done through various methods but eco-friendly, integration of various cultural, Nutrient, chemical biological and botanical is best. Recent Research has been made in biological, botanical, Resistance development and Nutritional management but development of variety and Biological are best option. Isoprothiolane at 1.5 ml/l and Tricyclazole 22 % + Hexaconazole 3% SC (thrice from booting stage at weekly interval) are best chemical whereas *Pseudomonas fluorescens* strain Pf1 @ 10g/kg, SPM5C-1 and SPM5C-2 (aliphatic compounds obtained from Streptomyces sp), Bacillus tequilensis (GYLH001) and pseudomonad EA105 effectively inhibit the growth of *M. oryzae*. more than 100 R gene are identified as Resistance in Blast. Gene Pyramiding and use of multilines varieties is efficient and able to overcome pesticide hazards. Neem extract 4ml/15ml, Coffee arabica@25%, Nicotiana tabacum@10% are effective but garlic extract @higher doses and neem extract @ 4ml/15 ml are best for complete control. 4 g Si/L in green house condition observed greatest reduction of blast incidence. Several forecasting model predicts probable disease outbreak and reduces crop losses. Similarly, burning of residues and flooding make unfavorable condition to pathogen.

KEYWORDS

Rice Blast, Management Method.

1. INTRODUCTION

Rice (*Oryza sativa*) is a cereal crop and belongs to family Graminae which is native to Asia. East and South Asia are the main regions for rice production in the world. China (over 210 million metric tons) is the world leading rice producer followed by india, Indonesia, Bangladesh, Vietnam and rest of the world (FAO, 2017). Rice is predominant staple food for 17 countries in Asia and provides 20 % of world's dietary energy supply which is higher than wheat (19%) and maize (5%) (FAO, 2004). in coming years it is expected that demand for rice is increasing sharply. The research conducted by Food and Agricultural Policy Research Institute shows that demand for milled rice can be expected to 496 million tons in 2020 A.D. Moreover, Asian populations are still in remarkable poverty line where considerable unmet demand for rice. In spite of it great important production has remained low. Both abiotic and biotic factors adversely affect the crop and causes extensive losses to the yield. Drought, cold, acidity, salinity are abiotic factors while pests, weed and diseases are biotic factors (Onyango, 2014). More than 70 % diseases have been caused by Fungi, viruses, bacteria and Nematode (Zhang et al., 2009). Among various Rice diseases blast is the most destructive disease in the world (Miah et al., 2013). Globally, it causes 70 to 80 % yield loss of Rice (Nasruddin and Amin, 2013). Rice blast disease is caused by fungus named *Pyricularia oryzae* (Koutroubas et al., 2009). *Pyricularia oryzae* caused damaged to leaf and panicle of rice which indicates that it causes damaged to both vegetative as well as reproductive stages (Seebold et al., 2004). The attacked Panicle results in partially filled or unfilled grains (IRRI, 2014). Moreover, Blast in epidemics form results in complete loss of rice seedlings in bed (Chaudhary and DN, 1998). Being rice blast pathogen seed borne, it is difficult to manage easily (Hubert et al., 2015). Moreover, virulence diversity of blast pathogen makes difficulties in breeding for resistance (Marangoni et al., 2013). So, we must follow the management practices to control it.

2. MATERIAL AND METHOD

This paper was based on review of various literature related with blast diseases and its management. Collected information was arranged and findings from them are summarized and presented in texts, table with conclusion.

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3. MANAGEMENT

3.1 Cultural management

Involve all practices from sowing to after harvesting. Burning of residues prevents over wintering of pathogen but it is not able to prevent source of inoculums (Zeigler et al., 1994).

3.2 Nutrient management

Soil with high organic matter and biological activities shows better fertility status which prevents infection (Luong et al., 2033). So that, Nutrient management plays a significant role in Rice blast disease control. In Nutrient management, Nitrogen (N) and silicon (Si) elements affect disease incidence and development. Several studies have shown that heavy used of Nitrogen fertilizer increases susceptibility of rice plant to blast (Kingsolver et al., 1984; Kurschner et al., 1992). So, Application of Nitrogen in Split doses reduced excessive vegetative growth during early season and reduced blast severity (Templeton et al., 1970). Moreover, Researched on effect of Nitrogen fertilizer and it relation with blast diseases also supported the split-N treatment for susceptible cultivar (Long et al., 2000). Mention that wetness of leaf increased neck blast rapidly (Sere et al., 2011).

Silicon is commonly known as "beneficial element" for plants (Raij and Camargo, 1973). Research shows that Application of silicon to soil results in localized in leaf surface which act as a physical barrier against blast (Ishiguro, 2001). Accumulation of more silica on the shoots of rice results in less incidence of blast (Seebold et al., 2001). The experiment conducted in a green house, at the Universidadae Federal de Uberlandia, MG it was observed that greatest reduction of blast incidence at 4 g Si/L, regardless of solution pH (Guilherme et al., 2008). Moreover, Silicon application shows potential towards blast resistance but do not increases yield of rice (Sireger et al., 2016). Silicon is expensive in application against blast which is economically non viable. So, locally available straws of rice genotypes have high silicon content which is best for farmer level application. So, Silicon is one of the best nutrient management for blast resistance. Similarly, Flooding of rice field creates anaerobic condition which eliminates diseases as water makes unfavorable condition to pathogen (Koutroubas and Ntanos, 2008). Water seedling reduced transmissions of disease from seed to seedling. Among cereals Rice is most susceptible and it has low ability to tolerate water loss results into rice blast attacks.

3.3 Chemical Management

Farmers depend on chemical pesticides for management of blast. Experiment conducted by Jamal et. al concluded that Mancozeb is effective against blast at 1000 ppm and 10,000 ppm (Jamal-u-ddin et al., 2012). A group researchers reported that foliar spray of Isoprothiolane at 1.5 ml/l decreased blast which was followed by carpropamid and carbendazim (Varma and Santhakumari, 2012). With the application of isoprothiolane both grain and straw yield was increased as compared to other control. Chemical management practices are neither practical nor environmentally familiar. Experiment conducted by Magar et al in Chitwan, Nepal concluded that combination of Tricyclazole 22 % + Hexaconazole 3% SC in Thrice from booting stage at weekly interval showed highest disease control (87.03 % and 79.62 % in leaf and neck blast respectively) and highest grain yield(4.23t/ha) (Magar et al., 2015). Earlier also revealed that Captan and Acrobat controlled rice blast (Haq et al., 2015).

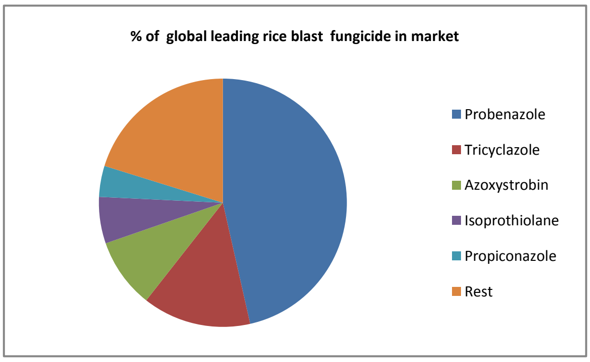

Figure 1: Global market of leading Rice blast fungicides

Source: Adopted from (McDougall, 2007; Skamnioti and Gurr, 2009).

The rest of fungicides are Benomyl, Carbendszim 12%+Mancozeb 63%, Iprobenfos, Capropamid, Hexaconazole, Tebuconazole etc (Kapoor and Singh, 1982; Venkata and Muralidharan, 1983; Gohel and Chauhan, 2015; Motoyama et al., 1999; Prasanna et al., 2011; Ghazanfar et al., 2009).

3.4 Biological Management

Earlier, *Pseudomonas fluorescens* strains were used as control of soil borne pathogens controlled foliar disease but powder formulation having long shelf life is more beneficial (Weller, 1988; Gnanamanickam and Mew, 1992). So, Later Studies on biocontrol of rice blast showed that powder formulation of *Pseudomonas fluorescens* strain Pf1 at 10g/kg inhibit the growth of rice blast (Vidhyasekaran et al., 1997).

Table 1: Efficacy of *Pseudomonas fluorescens* strains Pf1 against rice blast control in rice (cv IR50) under field trial condition Greenhouse condition

	Treatment	
DAS	P. fluorescens	Control
21	1.2^a	8.2^b
45	2.6^a	7.2^b
60	6.5^a	7.8^a
75	7.1^a	7.0^a

Figure in above shows disease intensity in grade values (0-9 Scale)^a and LSD at P =0.05 for comparing means in column is 1.8. Among Fungus, Genus Streptomyces belongs to Actinomycetes alone occupied 50 % of total actinomycetes and it produced 75% of total bioactive molecule (Xu et al., 1996; Demain, 2000). SPM5C-1 and SPM5C-2 were two aliphatic compounds obtained from Streptomyces sp. PM5 were evaluated under invitro and invivo conditions resulted into remarkably inhibition of mycelial growth of P. oryzae (Vaiyapuri et al., 2006).

Table 1: Activity of compounds obtained from Streptomyces sp. PM5 in agar diffusion test using PDA against P. oryzae in lab

Zone of inhibition (cm)		
SPM5C-1	SPM5C-2	Control
2.6 ± 0.17^a	0.4 ± 0.1	0

Above inoculated with P. oryzae were incubated at 21 ± 1°C for 9 days and 28 ± 2°C for 5 days and a are means of all values. Moreover, Culture filtrate product of Streptomyces sp. PM5 completely inhibited conidial germination of P. oryzae (Prabavathy, 2005). Besides that, studies revealed that Bacillus subtilis strain B-332, 1Re14, 1Pe2, 2R37 have antagonistic activity against P. oryzae (Yang et al., 2008). Similarly, Research on biological control of blast by the use of *Streptomyces sindeneusis* isolate 263 in green house resulted in inhibition of P. *oryzae* (Ebrahimi Zarandi et al., 2009). Similarly, another fungus *Trichoderma* spp.inhibited mycelia growth of blast fungus (Quazzani et al., 1998). In the very recent research carried out in China, it was proved that endophytic strain of Bacillus tequilensis named GYLH001 isolated from Angelica dahurica has great potential as a biological control of rice blast (Li et al., 2018). Angelica dahurica is extensively used traditional medicine in China (Hou et al., 2018). Similarly, Bacteria isolated from rice soil it was found that pseudomonad EA105 most effectively inhibited growth of *M. oryzae* (Spence et al., 2014). In comparison with other practices Biological control has minimal prejudicial effects on environment (Hyakumachi et al., 2014).

3.5 Forecasting

Forecasting system helps in prediction of probable disease outbreak or intensity and management of it (Agrios, 2005). A major purpose of forecasting system is to reduce uses of chemical practice and provide accurate prediction before crop losses in environment safety and time efficient way (Taylor et al., 2003). Generally Diverse modeling approaches is used for disease prediction in plants. But for better understanding purposes other approaches are followed in recent times. Support Vector Model (SVM) is tools which offered a prediction of plant disease which is better than conventional REG approaches (Kaundal et al., 2006). SVM is first web server for rice blast prediction which is great boon for plant science community and farmers.

Table 2: Different forecasting model used to predict blast disease (Neck and Leaf)

Forecasting Model	First developed	Reference
BLASTCAST	Japan	(Ohta et al., 1982).
BlLASTL	Japan	(Hashimoto et al., 1982).
BLASTAM	Japan	(Hayashi and Koshimizu, 1988).
Forecasting model in Taiwan	Taiwan	(Tsai and Su, 1984).
PYTRICULARIA	Netherland	(Gunther, 1986).
Leaf blast Simulation model	Philippines	(Torres, 1986).
PYRNEW	Indonesia	(Tastra et al., 1987).
LEAFBLAST	Korea	(Choi et al., 1988).
EPIBLA	India	(Manibhushanrao and Krishnan, 1991).
BLASTSIM.2	Philippines	(Calvero and Teng, 1991).
EPIBLAST	Korea	(Kim and Kim, 1993).
BLASTSIM	-	(Calvero and Teng, 1992).
DYMEX and CLIMEX	Australia	(Lanoiselet et al., 2002).
BLASTMUL	Japan	(Ashizawa et al., 2005).
Machine Learning Technique	India	(Kaundal et al., 2006).
Online information System	Korea	(Kang et al., 2010).
EPIRICE	Korea	(Savary et al., 2012).
Modified EPIRICE	Korea	(Zhang, 2007).

3.6 Botanical Management

Chemical practices are highly effective and low-cost management but has adverse impact on environment and it also makes rice blast more drug resistance (Slusarenko et al., 2008). Farmers of poor country cannot meet the expense of chemical pesticides. Under Integrated management practices plant extracts can be used. Garlic juice reduced the blast disease caused by P. *oryzae* in rice (Fiona et al., 2005). Allicin compound obtained from garlic successfully inhibited blast fungus (Rajappar et al., 2001). Similarly, another Plant extract like Neem extract reduced growth of *P. oryzae* (Hajano et al., 2012). It was found that extract of garlic, neem and calatropis with three different doses were tested against blast it was found that only garlic extract at higher doses and neem extract @ 4ml/15 ml medium completely reduced growth of P. *oryzae* as compared to calatropis and controlled (Hajano et al., 2012).

Table 3: Inhibitory effects of aqueous extracts of different plants against P. oryzae in %

Plant extract	Inhibitory effect (%)
Coffee arabica@10%	81.12
Coffee arabica@25%	89.4
Nicotiana tabacum@10%	80.35
Aloe vera@25%	79.45
Chrysanthemum coccineum@25%	78.83

Source: (Hubert et al., 2015).

Confirmed that plant extracts were not phyto-toxic to rice seedlings So, it can be used for rice seed treatment purpose to manage rice blast disease (Hubert et al., 2015).

3.7 Use of Resistant cultivar

Management of blast by using resistant cultivar is sustainable and eco-friendly approach. Earlier, nearly 100 different resistance gene and > 350 QTLs of which 23 resistance genes have been identified, mapped and cloned and functionally validated (Fukuoka et al., 2014). Generally, in developments of varieties rice breeders use vertical and horizontal resistance. Varieties develops from vertical resistance are controlled by few major genes which is not durable but gene pyramiding of several vertical resistance gene confer durable blast resistance (Liu et al., 2004; Hittalmani et al., 2000). Environment influences the expressions of varieties develop from horizontal resistance and thus result in durable resistance (Suh et al., 2009). Using of different multilines varieties effects in blast control (Koizumi et al., 1996). Some of multilines varieties are Nipponbare, Toyonishiki, Sasanishiki etc (Horisue et al., 1984; Nakajima, 1994; Matsunaga, 1996). Use of resistant cultivar is efficient method and also to overcome pesticide hazards. Genetic engineering also contributes on sustainable disease resistance as well (Coca et al., 2004).

4. Conclusion

Labor cost and time factor are major causes which makes unable to complete control of blast disease. For the productive results and increase in production of rice we must followed integrated management of rice blast. Isoprothiolane @ 1.5 ml/l and Tricyclazole 22 % + Hexaconazole 3% SC (thrice from booting stage at weekly interval) are best chemical, *Pseudomonas fluorescens* strain Pf1 @ 10g/kg, SPM5C-1 and SPM5C-2 (aliphatic compounds obtained from Streptomyces sp), Bacillus tequilensis (GYLH001) and pseudomonad EA105 effectively inhibit the growth of *M. oryzae*. Gene Pyramiding and use of multilines varieties is efficient and able to overcome pesticide hazards. Neem extract 4ml/15ml, Coffee arabica@25%, Nicotiana tabacum@10% are effective, garlic extract @higher doses and neem extract @ 4ml/15 ml are best for complete control. 4 g Si/L in green house condition observed greatest reduction of blast incidence. Among them development of variety and Biological are best option.

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