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Mini Review

Different Approaches for Management of Brown Spot (*Helminthosporium oryzae*) Disease in Rice (*Oryza sativa*) in Nepal

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Abstract

Worldwide, more than 3.5 billion people depend on rice for more than 20% of their daily calories intake. Rice is suffering from several fungal diseases among them brown spot caused by *Bipolaris oryzae* is important. Rice brown spot is a chronic disease that affects millions of hectares of rice. *Cochliobolus miyabeanus* (formerly known as *Helminthosporium oryzae*) is a fungus that causes brown spot disease in rice. This disease was the causal agent of the Bengal famine of 1943 that usually occurs on the host leaves and glume, as well as seedlings, sheaths, stems and grains of adult host plants. The severity of this disease is increasing rapidly that cause huge loss in yield. Different approaches can be implemented for management of brown spot in rice. Fungicides, such as iprodione, propiconazole, azoxystrobin, and carbendazim are effective in management of brown spot disease. Poonam variety showed the maximum disease severity of 51.47% and Kabeli show the lowest disease severity of 24.94%. Among the different fungicides, (Propiconazole 25 EC) at the rate of 2 ml/lit water showed significantly lowest AUDPC value. Our study primarily focused on management of brown spot of rice in Nepal through different approaches that are relevant to present situation of farmer.

Keywords: Brown Spot; Bipolaris Oryzae pathogen;Trichoderma, fungicide

Introduction

Rice (*Oryza sativa)* is one of the most important cereal crops of Nepal (Karki *et al*., 2018). Rice covers 15, 52,469 ha of total cultivated land, with the production of 52, 30,327 mt and the productivity of 3.37 t/ ha in Nepal (MoAD, 2012). The terai region (60-900 masl) contains 69.73% of the total rice area and contributes 73.24% of total rice production. Hills (900-1500 masl) and mountains (1500-2750 masl) have 25.82% and 4.44% of total rice area producing 23.71% and 3% of rice production (MoAD, 2012; Moradi *et al*., 2015). Brown spot, a devastating disease, caused by *Bipolaris oryzae L*. is the most important biotic constraint of rice production occurring in almost all the rice growing land in the World. Because of its devastating nature, widespread distribution and existence of several physiological races of the pathogen *(Bipolaris oryzae*), brown leaf spot disease is the most serious disease of rice (Arshad *et al*., 2008). It caused Bengal Famine in 1942, with yield loss of 50-90%, which resulted in death of 2 million people due to starvation. The pathogen can infect both seedlings and mature plants with the coleoptile, leaves, leaf sheath, panicle branches, glumes, and spikelets (Webster and Gunnell, 1992). The disease is responsible for reduction in leaf area index (LAI), early senescence of the diseased plants, reduction in number of tillers, reduction in shoot elongation and lowered quality and weight of individual grains (Vidhyasekaran *et al*., 1973; Klomp, 1977). The disease is also known as poor rice farmer's disease because it occurs mostly in deficient and poor soils (Agarwal, 1989; Mia, 1998; Zadoks, 2002). Temperature, relative humidity and amount of rainfall during the crop season influence the development (Dhaliwal, 2018). The management of the brown spot can be done mainly through resistant varieties, chemicals, biological, cultural, etc.

Pathogen

Breda de Haan in 1900 first described the fungus as *Helminthosposium oryzae* which was transferred to

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Drechslera oryzae by Subramanian and Jain (1966). Shoemaker (1959) referred it to *Bipolaris oryzae* as most of the conidia germinate from two end cells. The fungus produces inter and intra-cellular mycelium, which develops as greyish brown to dark brown mat on the infected tissues.

Favourable Condition for Pathogen

- Relative humidity (greater than 90%)
- High dose of Nitrogen
- Optimum temperature, for infection range from 22 to 30°c and relative humidity of over 92% (Percich *et al*., 1997).
- Leaf must be wet for 8-24 hours.

Source of inoculum

Seed, collateral hosts, rice straw or stubble

Damage Symptoms

The pathogen attacks the crop from seedling to milk stage. The symptoms appear as minute spots on the coleoptile, leaf blade, leaf sheath and glume, being most prominent on leaf blades and glumes. On leaves, typical spots are brown in colour with grey or whitish centre, cylindrical or oval in shape resembling sesame seeds usually with yellow halo while young spots are small, circular and may appear as dark brown or purplish brown dots (Fig. 1). The fungus also produces brown or grayish brown spots on the neck region as compared to blackening in case of neck blast (Sunder *et al*., 2014).

Different Methods of Management of Brown Spot in Rice

Biological Method

Biological method of management is emerging as an alternative to the noxious chemical pesticide which has attained importance in modern agriculture to curtail the hazard of intensive use of toxic chemicals. Commercially available antagonistic *Pseudomonas* and *Trichoderma* species can suppress diseases by direct effect on the pathogen through mycoparasitism, antibiosis, and competition for iron/nutrients or by improving plant immunity through induced resistance (Singh *et al*., 2005). Isolates of *fluorescent Pseudomonas* from soil reduced the fungal growth and brown spot incidence (Ray *et al*., 1990). The bio-control agents viz., *Trichoderma harzianum, T. viride, Bacillus subtilis* and *Pseudomonas fluorescens* are rapidly used for 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). *T. 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).

Cultural Method

Use of resistant variety: Poonam variety showed the maximum disease severity of 51.47% and kabeli had the lowest disease severity of 24.94% (Shrestha *et al*. 2017). The screening of fourteen rice varieties against brown leaf spot disease revealed that none of the varieties was immune. Among them, only HJ-G1 and HJ-G2 were found moderately resistant. Highest grain yield (5.10 t/ha) was found in HJ-G1 with least disease severity of 21.73%. Also, HJ-G1 had the lowest AUDPC values in all observation dates, with a total AUDPC value of 614.8. So, it is recommended to use HJ-G1 variety because it has highest yield in comparison to other varieties as well as tolerant to disease (Basnet, 2009; Adhikari, 2013).

Use of cow urine: Use of Cow urine as a bio-fungicide instead of fungicide is an alternative was to manage brown spot disease which is cost effective, can reduce environmental pollution and enhance the safety of agricultural produce and maintain agricultural sustainability. Nautiyal and coworkers reported controlling of plant pathogenic fungi like *Colletotrichum capsici, Sclerotium rolfsii, Alternaria alternata, Penicillium species, Rhizoctonia solani, Phytophthora palmivora, Helminthosporium* using cow dung and urine. The varying fertility levels were unable to show the suppression of the brown spot disease whereas the varying concentrations of cow urine spray showed positive impact on that disease suppression. The 100% cow urine spray was able to minimize the brown spot score but the control treatment exhibited maximum disease score (Sadhukhan and Bohra 2018).

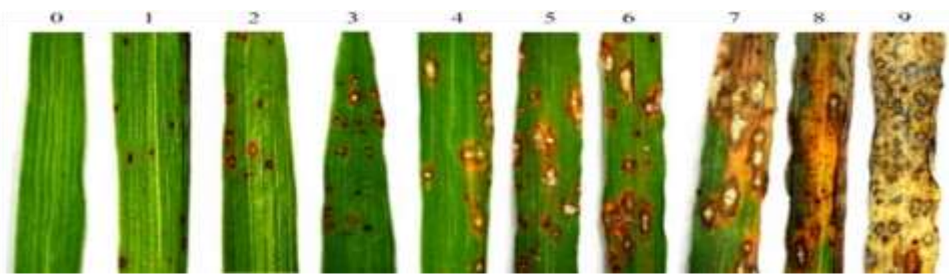

Fig. 1. Scale for the scoring of brown leaf spot of Rice (IRRI, 2009)

Use of LCC method of nitrogen management: The disease is known to occur in resource poor farmers' fields where there is deficiency of water supply and nitrogenous fertilizers (Zadoks, 1974). Leaf colour chart (LCC) is known as one of the important innovation in the agricultural sector of the world. It was the first time prepared by scientists of Japan. They used this for estimation of chlorophyll formation rate in the rice (Oryza sativa L.) crop and then more various investigations on leaf colour chart were done which showed that it is important for better nitrogen management. N deficiency can easily be rectified with no devastation of plant parts.

Chemical Method

The application of the fungicides is the most effective management option for the control of brown spot of rice . The use of fungicides, such as iprodione, propiconazole, azoxystrobin, trifloxystrobin, and carbendazim are effective in disease management. Three different chemical fungicides; SAAF® (Carbendazim 12% + Mancozeb 63%), Tilt® (Propiconazole 25 EC) & Bavistin® (Carbendazim 50% W.P.) at three different doses of 1.5, 2 & 2.5 g (or ml) and a control plot. Among the different fungicides, Tilt® at the rate of 2 ml/lit water showed significantly lowest AUDPC value (373.7) followed by SAAF® at 2 gm/lit (374.9) while the highest value was shown by Bavistin® at 2gm/lit (590.1).Similarly, highest economic yield was obtained in SAAF® at 2gm/lit (5.220 t/h) followed by Tilt® at 2ml/lit water (5.210t/ha) and the lowest in Bavistin® at 1.5gm/lit (3.320t/ha). So, among different chemical fungicides, SAAF® at 2gm/lit being efficient, economical and easily accessible, farmers could be suggested for reducing the disease severity and subsequent increase in the yield of rice.(Shrestha *et al*. 2017). The efficacy evaluation of different chemical fungicides available in the market against brown leaf spot disease of rice showed that application of propiconazole for management of brown spot in field was most effective in both reducing the diseases severity and economic yield than other tested fungicides. So, propiconazole was recommended for the farmers (Poudel *et al*. 2019).

Physical Method

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-lightinduced 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).

Conclusion

Rice is the 1st staple food grain crop of Nepal and has a significant role in food security of the Nepalese people**.** The disease has been reported to occur in all the rice growing countries including Japan, China, Burma, Sri Lanka, Bangladesh, Iran, Africa, South America, Russia, India, North America, Philippines, Saudi Arabia, Australia, Malaya and Thailand (Gangopadhyay, 1983; Ou, 1985; Khalili *et al*., 2012). Foliar application of *T. harzianum* has been shown to reduce the disease intensity and significantly improve grain yield, total grain carbohydrates and proteins in addition to a significant improvement in the total photosynthetic pigment in the rice leaves. Cow urine as a bio fungicide and growth regulator is a gold to the poor farming communities and it is a key from waste to wealth innovation. Application of propiconazole for management of brown spot in field was most effective in both reducing the diseases severity and economic yield so, propiconazole was recommended for the farmers. Highest grain yield (5.10 t/ha) was found in HJ-G1 with least disease severity of 21.73% so HJ-G1 is recommended for Chitwan farmer.

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