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MANAGEMENT OF CEREAL DISEASES IN BANGLADESH: A REVIEW

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ABSTRACT

Bazlur Rashid AQM, Rahman MME, Islam MJ, Hossain MA (2011) Management of cereal diseases in Bangladesh: A review. *Int. J. Sustain. Crop Prod.* 6(2), 36-41.

The management practices of major diseases occurring in Bangladesh in different important cereal crops such rice, wheat, maize, barley, millets etc. were reviewed. The number of major and minor diseases reported were rice-31, wheat-20, maize-20, millets-10, barley-13, surghum-5, oat-3. The important disease management practices followed were cultural, chemical, biological, IDM and development of host resistance. The researches on disease management through biotechnology and molecular level have been prioritized while development of eco-friendly sustainable varieties of the crops has been in progress. Most of the research works on the disease management were carried out in different research institute like BARI, BRRI, BAU etc. and the findings have been published in different national and international journals, proceedings and in the presented papers in various workshops and conferences.

Key words: *cereal, disease, management, eco-friendly, review*

INTRODUCTION

Bangladesh is one of the best agricultural countries of the world. Cultivable fertile flat land and agro-climatic conditions are very congenial for growing more than one hundred various types of crops round the year. Similarly the situation is also congenial and favourable for the pathogens to various diseases of the crops. As a result, diseases are the important constraints towards production of sustainable higher yields. With the strategic development in other biological sciences, the plant pathological research and development have been in much progress throughout the world. It is the time now to look in to the back of our envelope how far we have carried and how to proceed more to the world perspective in the area.

With the intensification of crop diversification various disease management technologies have also been developed. Various research organizations have been doing such important research at their own jurisdictions. But the time demands the accumulative achievement report. This paper describes the intervention of researches carried out so far on different aspects of management of various diseases of our various cultivable crops in the country.

The important cereal crops in Bangladesh include rice, wheat, maize, barley, millets etc. Considerable works have been carried out on the management of different aspects of important diseases of these crops since early steps of plant pathological research in the country.

Bangladesh Rice Research Institute (BRRI) is the pioneer research organization in the country dealing with various aspects of cultivation and production of rice, the most important cereal staple food crop occupying about 77% of the total cropped area and constituting about 67% of the total agricultural production (Anonymous 2005) also providing 76% calories and 66% of the daily protein intake of the people (Kabir Miah *et al*. 2005). However, the Plant Pathology Division of BRRI has also been assigned to deal with the diseases of rice.

Seven fungicides, namely, Arasan, Bavistin, Brassicol, CGA 49104, Dithane M-45, Homai and Vitavax were evaluated for their efficacy in controlling seed borne fungi of rice. For this, seeds were treated with the fungicides at 3 g/kg seeds. Among the fungicides Dithane M-45 was found to be the best in reducing almost all the associated fungi considerably. Vitavax was also found equally effective. Bavistin was very good against *T. padwickii* and also ineffective against *Drechslera* and *Curvularia* (Anonymous 1984). When the chemicals were sprayed in the field either at flowering, milk or dough stage. It was noted that percentage of healthy grain was higher when sprayed at flowering stage. Association of *T. padwickii*, *G. oryzae* and *Cladosporium* sp. was lowest in the grain sprayed with Bavistin (Anonymous 1985). Eight fungicides and the combinations of any two at 1:1 (w/w) proportion at 3 g/kg seed were used for treating rice seeds with natural infection of *G. oryzae* (31%). All the fungicides and their combinations effectively controlled the fungus from the seed. Most of them gave complete control (Mia *et al.* 1985). *Gerlachi oryzae*- infected seeds with 10 and 12% moisture content were treated with different fungicides and stored up to 300 days. Parasa-one, Topsin M, Bavistin, Fundazol and Dithane M-45 were found to retain their effectiveness against the fungus throughout the storage period. In case of other fungicides the effectiveness was found to be reduced with the increase of the storage period. However, against seed-borne *D. oryzae* only Parasan-one retained its fungicidal properties throughout the storage period (Mia 1985). The efficacy of nine fungicides as seed treatment was evaluated both in the laboratory and in the pot culture. Under lab conditions Rovral, Lirotect M and Vitavax were found good at controlling all of the seven fungi effectively. In pot culture Rovral was found to be the best in increasing healthy seedling. Lirotect M and Vitavax were also found promising. Total seed-bome pathogen in blotter test and seedlings with healthy coleoptile was inversely and significantly correlated (Islam 1990).

Complete control or significant reduction of seed-borne infection of five pathogens of wheat namely, *A. tenuis, A. flavus, C. lunata, D. sorokiniana* and *F. semitectum* was achieved in the lab by treating seeds with each of the three doses 0.25, 0.35 and 0.50% of the six fungicides. Complete control of *A. tenuis, C. lunata, D. sorokiniana* and *F. semitectum* was obtained by 0.50% of Panoctine/CG 450, Vitavax-200 and Vitavax-300. Homai gave complete control of *A. flavus* (Ali and Fakir, 1982). Attempts were made to control seedling blight of wheat caused by seed-borne *D. sorokiniana* through chemical seed treatment of artificially inoculated seeds. Fungicides tested were Benlate, Benlate T-20, Homai, Vitaax-200 and Vitavax-300, all at 0.25% of the seed wt. In terms of percent infected plants there was no significant difference among the treatments as well as control. However, Homai and Vitavax-200 showed lower infection (Anonymous 1981). Efficacy of seed treatment with six fungicides was tested in the laboratory against seed-borne fungi of wheat. In controlling *D. sorokiniana,* Baytan 10 DS, Vitavax-200 and Vitavax-300 were found most effective. Incidence of *C. lunata* was found to reduce considerably by the test fungicides. However, none of the fungicides was found effective against *A. tenuis.* All the fungicides increased seed germination. During the following year the experiment was repeated, where seeds were treated with the fungicides at 0.25% of the seed weight. All of the chemicals were found to reuduce the degree of infection under laboratory condition. Among them Vitavax-200 gave the best result followed by Vitavax-300, Baytan 15 DS, Captan, Baytan 10 DS and Baytan 15 DS (0.1%). Under field conditions maximum germination was also recorded in Vitavax-200 treatment. In the subsequent years Vitavax-200 again was also found most effective and gave complete control of the fungus (Anonymous 1985). Under field conditions spraying of Dithane M-45 at 2.25 kg/ha at weekly intervals has also been reported to be partially effective in controlling the seed-borne *Drechslera sorokiniana* in wheat (Bazlur Rashid *et al.* 1987).

Fungicides of different groups have been tried on a highly susceptible cultivar Morocco but the propiconazoles and tebuconazoles were found most effective to combat the disease with significant yield increase. Seedling blight caused by *B. sorokiniana* is one of the factors for low plant population in the farmers' field, particularly in wet soils. Early planting and seed treatment with Vitavax-200 (Carboxin + Thiram) have been found effective and recommended for reducing the incidence of the disease. Foot and root rot disease of wheat is generally noticed in relatively heavier and poorly drained soils. Although variabilities were observed among genotypes, genetic resistance has not yeat been found. Some of the advanced lines were found promising under artificially inoculated condition and further studies are under-way for confirmation of the results. Clean cultivation, planting in optimum time, seed treatment with Vitavax-200 and soil application of inorganic chemicals like calcium carbonate and calcium nitrate were found effective. Soil drenching with Vitavax-200 and Cheshunt compound at seedling stage also minimized the disease incidence effectively, followed by Terraclor and Apron. Organic substrates colonized with bio-control agent *Trichoderma harzianum* were found promising in controlling foot and root rot disease. Black point is a common disease of wheat seeds occurring in almost all varieties with varying degrees of infection. The disease becomes severe if rainfall occurs followed by crop lodging during the latter part of grain filling stage. Alteration in percent crude protein and mineral composition, and reduction in seed germination were observed dur to black point infection. In a study carried out under artificial inoculation with *B. sorokiniana,* few lines showed moderate resistance against black point infection. As many as nineteen fungi were identified to be associated with the seeds collected from major wheat growing locations. The most predominant fungus was *B. sorokinana*, which was followed by *A. alternata, Curvularia lunata* and *Fusarium* spp. Fungicidal seed treatment showed that Vitavax-200 controlled the black point fungi most effectively followed by Rovral, and improved germination of black pointed seeds significantly. Among the spray fungicides, propiconazole was found effective in reducing incidence of the disease. In a study conducted during storage of wheat seeds, it has been observed that the population of field fungi and seed germination decreased and those of storage fungi such as *Aspergillus* and *Penicillium* increased with the progress of storage period.

Fungicidal seed treatment against seed-borne fungi of Kaon indicated that all three associated fungi *viz. C. lunata, D. setatiae* and *F. semitectum* were eliminated totally by Vitavax-200, and *D. setariae* and *F. semitectum* were completely controlled by Dithane M-45 (Barma and Fakir, 1980).

The sporadic research works on rice diseases have also been carried out in some other academic and research organizations such as BAU, BINA etc. Ten major and eleven minor diseases of Aus, T. Aman and Aus rice have been surveyed and monitored by BRRI all over the country (Montezar *et al.* 2007). The survey and monitoring consisted identification of the diseases and their epidemiology, screening the rice varieties/lines development of control measures, standardization of molecular methods of identifying races, training on disease management of farmers and extension personnel, and collaborative researches with other national and international organizations.

Disease incidence and severity were identified based on rice cultivars, seasons, and locations along with other environmental conditions. Among the identified diseases tungro, head blight, blast, bacterial blight, brown spot, bakanae, ufra, leaf scald, stem rot and sheath rot were recorded as major. Disease incidence was high in Aus and T. Aman than Boro. Some diseases appeared major in one area but minor in another location. Some varieties

were identified as resistant and others as susceptible based on management and environmental conditions. Bakanae was prevalent in all the growing seasons irrespective of varieties starting from seedling to tillering stage. Brown spot was recoded in upland and light soils having low water holding capacity.

Through screening method a total of 14,342 rice varieties/lines from Bangladesh, Philippines (IRRI) and other countries were evaluated and 3,625 entries were recorded as resistant to moderately resistant to blast, bacterial blight, sheath blight and tungro diseases. Besides, breeding materials under different trails of selection, as well as germplasm materials were evaluated in respective nurseries. Among 650 entries, 334 appeared resistant to moderately resistant to stem rot disease. Two BRRI lines were identified as resistant to root knot in deep water rice *Sclerotium oryzae sativae* was found the most virulent causing stem rot disease. In natural screening, local varieties like Kachamota, Kataktara, Kalijira, Sadapankaij, IR36 appeared resistant to blast disease and Kumragoir, a local variety was found highly resistant to tungro.

Tilt, Homai, Benlate and Topsin M were found to be effective to reduce sheath rot. Urfa was controlled by Carbofuran, Agridhan, Mocap applied in soil or root. Neem leaf dust, bonkalmi leaf dust, neem cake, sesame cake and Furadan were found effective against Root knot disease. Tungro could be managed by controlling vector with Nogos and Furadan from seedling to tillering stage. Damping off could be managed through the use of seeds with strong vigor and by avoiding standing water on seedbed up to seven days after sowing. It was recorded that brown spot disease increased at lower fertilizer rate than 80-60-40 NPK/ha. Soil amendment with wheat bran and seed treatment with Vitavax and Brassicol were found promising for seedling blight management. Botanicals like, neem cake, neem leaf dust also found effective against seedling blight disease. For the management of blast Fundajol, Chemophane, Fongoren, Hinosan were effective. Homai, Bavistin, Knowin, Tecto, Chemofane were found good for sheath blight control. Homai, Bavistin, Tilt and Tecto were identified effective against sheath rot disease. Tilt, Homai, Benlate and Topsin-M performed good against stem rot.

Interactions among diseases, pathogens and species of the pathogen were identified. Three species of sheath blight pathogen *Rhizoctonia oryzae R. solani*, *Rhynchorporium oryzae* (Perfect stage) were identified causing different symptoms causing sheath blight, sheath spot and aggregate sheath spot respectively. Strong interactions among the species were also observed. Moreover, artificial inoculation of the rice plant with *R. Oryzae* followed by *R. Solanae* resulted to reduce the incidence of sheath blight. Positive relationship between tungro and sheath rot was observed.

In molecular activities, methods for DNA fingerprinting were standardized for identifying race of the seed borne rice pathogens (*Fusarium* spp., *Pyricularia* spp.).

Department of Plant Pathology, Bangladesh Agricultural University has been working with plant disease problems in the country. So far, more than five hundred graduate students (MS and Ph.D.) completed their thesis oriented research based degrees with multifarious discipline of plant disease control.

Searches for resistance sources in rice against different fungal diseases and BLB has been carried out among the local and introduced germplasms. Mechanism of resistance in rice against Tungro virus has been studied. Cause and epidemiology of different rice diseases have been studied. Integrated management of sheath blight, BLB and brown spot was investigated. Different fungicides, nutrient elements and plant extracts have been evaluated for controlling the diseases. Association of seed borne pathogens and their control by applying physical, chemical and biological means were performed (Ismail Hossain 2007).

Kamal and Hossain (2007) emphasized genetic engineering approach to achieve durable resistance. They reported that disease resistance by using biotechnological tools would be a challenging and exciting research area in the coming decades. In the near future, the cloning of many specific and broad-spectrum resistant genes can be anticipated. Disease resistant genes control pathogens at a low phenotypic cost by inducing programmed cell death by hypersensitive reaction due to the response of the pathogens. Genetic transformation is one-step process of introducing novel genes into a desirable genetic background of important crops. Because it is a fast and efficient system, it will create improved varieties faster that the pathogen can overcome the resistance. Developing transgenic crops helps shortening breeding time.

Table 1. Diseases of cereal crops in Bangladesh

Crop	No. of diseases	Major diseases	Minor diseases
Rice	31	13	18
Wheat	20	5	15
Maize	28	5	23
Millets	10	3	7
Barley	13	3	10
Sorghum	5	5	0
Oat	3	2	1
Total	110	36	74

Source: Malaker *et al.* 2007

Malaker *et al.* (2007) reported the management of five important disease of wheat. The disease are Bipolaris leaf blight (BpLB) or spot blotch (*Bipolaris sorokiniana*), leaf rust (*Puccinia triticina*), seedling blight (*B. sorokiniana*), foot and root rot (*Sclerotium rolfsii*), and black point (*B. sorokiniana, Alternaria alternata*). In recent years, BpLB has become the most destructive biotic stress for wheat production in the country. Yield losses due to this disease were estimated to be 15-30% in susceptible cultivars and can be even more under late planted condition. The disease appears at the seedling stage and increases with plant age reaching to its maximum towards physiological maturity. Germplasms from diverse origins have been screened against the disease, but materials with high degree of resistance or immunity are lacking. Lines with moderate degree of resistance and good agronomic trait were selected and included in the crossing block for hybridization. The new wheat varieties such as Sourav, Gourab, Shatabdi, Sufi, Bijoy and Prodip are tolerant to this disease while moderate to high susceptibility have been developed in the old cultivars including Kanchan that covers the major wheat growing area. A number of chemical fungicides were tested in controlling BpLB, but the propiconazoles were found effective with yield advantage of 20-25% in susceptible variety like Kanchan. Leaf rust is considered as the second most important disease of wheat. The disease usually appears in mid-February. Wheat planted at optimum date escapes the severity of the disease. Yield losses due to leaf rust are usually less but can be severe in a susceptible variety is grown and infection occurs early in the crop season. So far leaf rust has not appeared in an epidemic form in Bangladesh, but there is no guarantee that it will not appear on a large scale and inflict severe damage in future, particularly if a new virulent race is developed in the pathogen population. The disease is controlled mainly through genetic resistance. Available germplasms from different sources and segregating generations are routinely screened against the disease through artificial inoculation of urediospores collected and preserved in the preceding year. Most of the new varieties and advanced wheat lines are resistant to this disease but the old variety Kanchan released in early 1980s has become moderately susceptible. In collaboration with wheat program in India and CIMMYT, three leaf rust pathotypes were identified in twenty-two samples and six leaf rust resistance genes were identified in the cultivars and advanced lines of Bangladesh. The pathotypes are 77-4 (125R23-1), 77-2 (109R31-1) and 104B (29R23), the former being the most predominant one. The resistance genes are *Lr1, Lr3, Lr10, Lr13, Lr23* and *Lr26*, which occurred either singly or in combination with one of the other detected genes. Strong leaf rust resistance genes such as *Lr9, Lr19* and *Lr24* have been collected from abroad and are being utilized in the hybridization program to transfer into widely adapted high yielding genotypes.

Maize suffers from five major disease under the agro-ecological conditions of Bangladesh (Malaker *et al.* 2007). These diseases are seed rot and seedling blight, leaf blight, downy mildew, stalk rot and ear rot. A number of seed and soilborne fungi were found involved in the causal complex of seed rot and seedling blight, such as *Pythium, Fusarium, Rhizoctonia, Diplodia, Helminthosporium, Collectotrichum, Aspergillus* and *Penicillum.* Use of healthy seed, sowing at optimum soil moisture and temperature (above 13^0C), and seed treatment either with Vitavax-200 or Thiram have been recommended to control the disease. Leaf blight is caused by *Drechslera turcium* and *D. maydis.* Available lines and varieties from home and abroad were screened against this disease, and quite a few have been found to possess moderate levels of resistance. Lower doses of nitrogen and early planting have some effect in reducing the disease severity. Cultivation of resistant varieties like Suvra, Mohar and BARI hybrids, burning of stubbles in the field and spraying with either propiconazole or carbendazim were found effective against leaf blight. Downy mildew caused by *Selerospora* spp. was found to be minimized through use healthy seeds and spraying with metalaxyls like Ridomil MZ-72. Stalk rot of maize is caused by a number of fungi such as *Gibberella zeae, Fusarium moniliforme, Diplodia maydis, Colletotrichum graminicola* and *Pythium aphanidermatum,* and two bacteria *viz.*, *Erwinia* spp. and *Pseudomonas* spp. Use of healthy seeds, balanced fertilization, destruction of stubbles, crop rotation and seed treatment with Vitavax-200 or Thiram were found effective in reducing the disease. Ear rot is also caused by many fungi such as *Diplodia maydis, Gibberella zeae, Fusarium moniliforme, Nigrospora oryzae* and *Penicillium* spp. The disease becomes aggravated due to insect infestation, bird damage and crop lodging, and ultimately seed quality is seriously affected. Crop protection against insects and birds, crop rotation and stubble destruction have been found to minimize the disease. Storage rot of maize (*Aspergillus, Penicillium* and *Rhizopus*) can be reduced to a large extent if clean and dry (<15% moisture) seeds are preserved in air-tight containers.

In barley, leaf blight caused by *B. sorokiniana* is considered to be the most serious disease. Yield losses of 13-23% have been estimated under field condition. Available materials have been screened but most of them showed moderate to highly susceptible reaction. Among the fungicides tested, the propiconazoles were found most effective. Foot and root rot (*S. rolfsii*) is a major disease of barley and occurs with varying degrees of incidence depending upon variety and soil condition. Incidence of foot and root rot was found higher in heavy-textured soils compared to light-textured ones. Germplasms were screened and some have been found tolerant. Soil drenching with Vitavax-200 or Cheshunt compound, and seed treatment with Vitavax-200 or Captan were found effective. Millets (cheena and kaon) were mainly screened against Drechslera leaf spot (*Drechslera* spp.) and foot rot (*S. rolfsii*). Some of the lines were disease free and quite a few were found tolerant to both the

diseases. Seed treatment with Vitavax-200 and soil drenching with Cheshunt compound were found effective in controlling the foot rot disease.

DISCUSSION AND CONCLUSION

One of the most important aspect of cereal disease management is to consider the method of dissemination of the causal pathogen. Seed-borne diseases are therefore, coincidentally and economically the most damaging. Because the pathogens can be disseminated and reached very easily from one place to any short or long distance fields through the seeds. Therefore, their appropriate management practices should be evolved through generating data from practical research activities. Development eco-friendly integrated management methods are the crying need at present.

Disease management through manipulation of cultural practices is a very old practice. Nevertheless it has been reported to be very effective for a number of seed borne disease in some crops. The use of bio control agents for the management of the diseases has been started in the country recently and proved to be effective as well. The integrated management practices along with the development of eco-friendly varieties are now a days optimistic approaches in the cereal disease management practices. In the recent national workshop on the strategic intervention of plant pathological research in the country held at Bangladesh Agricultural Research Institute, Gazipur the eminent researchers of Bangladesh (Fig. 1) opined to proceed with more modern scientific endeavours towards contemporary management system of plant diseases and sustainable augmentation of cereal crop production in Bangladesh.

Fig. 1. Participants of the national workshop on Strategic Intervention on Plant Pathological Research in Bangladesh. February 11-12, 2007, BARI, Gazipur, Bangladesh

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