JUST AGRICULTURE
multidisciplinary e-Newsletter

Seed Mycoflora of Paddy

Longjam Boris Singh

M.Sc. Plant Pathology, Plant Pathology Section,

College of Agriculture, Nagpur, PDKV, Akola

ARTICLE ID: 105

Paddy (*Oryza sativa* L.), the world's most important food crop, is the staple food for about four billion people i.e., half of the humankind on the planet. It is cultivated in a wide range of climatic conditions spanning from 44°N in North Korea to 35°S in Australia and from six feet below sea level (such as in Kerala, India) to 2700 feet above sea level in the Himalayas. The crop occupies a significant position in the culture and heritage of many Asian countries. In India, it is the staple food for more than 65% of population, thereby, it is pivotal to food and livelihood security of people, directly contributing to attainment of Sustainable Development Goal (SDG). Paddy is nutrient rich and serves as a good source of the B vitamins viz. thiamine, riboflavin and niacin. Levels of dietary fibre, minerals and B vitamins are highest in the bran. The paddy endosperm is rich in carbohydrate and contains a fair amount of digestible protein, composed of an amino acid profile that compares favourably with those of other grains The amino acid profile of paddy is high in glutamic and aspartic acids, but low in lysine.

The paddy plant is a member of *Poaceae* (old *Gramineae*) family, and it is an annual crop. The two major paddy varieties grown worldwide today are *Oryza sativa indica* and *Oryza sativa japonica*. The two cultivated paddy species, *Oryza sativa* L. and *O. glaberrima* belong to a species group called *Oryza sativa* complex together with the five wild taxa, *O. rufipogon*, *O. longistaminata*, *O. barthii*, *O. glumaepatula* and *O. meridionalis*. Paddy is probably a descendent of wild grass that was most likely cultivated in the foothills of the far Eastern Himalayas. The paddy grain is tightly enclosed by the lemma and palea. The pericarp is the outermost layer which envelopes the caryopsis and is removed when paddy is milled and polished. The embryo lies at the ventral side of the spikelet next to the lemma. The plumule is enclosed by a sheath known as coleoptile and the radicle by the coleorhizae. Being a tropical

climate crop, paddy cultivation can be done in temperate and sub-tropical climate under humid conditions. A high temperature, humidity and sufficient rainfall with irrigation facilities are the primary requirements of paddy cultivation. It also needs bright sunshine with temperature ranging between 20 and 40ºC. It can tolerate temperature up to 42ºC.

In many cultures of the world, paddy is the central part of people's life and culture. It forms the staple food in many countries such as China, Japan, Malaysia, Sri Lanka, Philippines, and Mexico along with India. The cultivation of paddy provides employment for over 200 million households. It is one of the primary sources of income for the countries in the developing world. Globally, paddy production amounts to approximately 508.7 million tonnes.

Historical Background of seed mycoflora:

- In 1775 Tillet, a French botanist, showed that stinking smut or hill bunt of wheat was caused by a poisonous substance contained in the dust sticking on the seed surface, though documentation for the transmission of plant pathogens through seed came relatively late.
- In 1807 Prevost, proved that stinking bunt was caused by a parasitic fungus.
- In 1903 Smith, published the illustrated notes on fungi found on germinated farm seeds in the UK.
- In 1920 Chen, published a monograph on internal fungal parasites of agriculture seeds.
- In 1923 Dorogin, from USSR, publish the instructions for testing seeds to determine the presence of seed-borne fungal pathogens associated with various crop seeds in the USSR and in 1924, analysis of seed crop for plant pathogens was made compulsory in the USSR.
- The term Seeds Health was coined in 1928 during the fifty International Seed Testing congress held in Rome, Italy, and the Seed Health committee (SHC) was created to deal with seed- borne diseases. The SHC was renamed as Plant Disease Committee (PDC) in 1931 till 2002 again and has been changed to SHC.
- In 1931 Orton, from West Virginia, published a bibliography of seed-borne parasites.
- In 1951 Machacek, and his co-workers compiled a list of fungi found on seeds of wheat in Canada.
- In 1966 International Seed Testing Association, published the first set of rules for seed health testing which are being followed by European, Asian, and African countries. The

JUST AGRICULTURE
multidisciplinary e-Newsletter

information about the different methods of seed health testing was fragmented, and till then no consolidated account of different methods of seed health testing was available.

- In 1967 Malone and Musket, in a review of the development of seed pathology, made a mention of Bessey who drew the attention on the fungi associated with seeds during seeds germination.
- First International Symposium of seed pathology was held in Denmark in 1982.
- In 2007 Shetty, an outstanding Indian Seed Pathologist from University of Mysore, Karnataka, India was honoured with 'Seed Health Award', Morogoro, during 1st International Symposium on Seed Health, held at University of Sokoine, Tanzania for his immense contributions in Seed Health and Seed Quality Control for developing countries. In India, second International Symposium on seed health in Agriculture Development was held in 2008, at Asian Seed Health Centre, University of Mysore, Karnataka where Robert Mabagala from Sonatine University of Agriculture, Morogoro, Tanzania was honoured with 'Seed Health Award' to his outstanding contribution in Seed Quality Control and making policies to supply quality seed to farmers to strengthen the quality seed production and yield of the crop in Africa.

Impact of mycoflora

Globally, approximatively 500 million tons of milled paddy grains have been produced during the 2019-2020 marketing year. Area under paddy cultivation is 166 Mha which is about 10 per cent of crop land globally. The production and consumption are concentrated in Asia mainly in China and South-East Asia in particular. China is the largest producer, accounting for 30 per cent of the production, followed by India (24%), Bangladesh (7%), Indonesia (7%), Vietnam (5%) and Thailand (4%). In terms of consumption, China is the largest consumer (29% of the global consumption), followed by India (21%), Bangladesh (7%), Indonesia (7%), Vietnam (4%) and the Philippines (3%).

In India, paddy is the staple food for about 800 million people and plays a major role in diet, economy, employment, culture, and history. It is the staple food for more than 65 per cent of Indian population contributing approximately 40 per cent to the total food grain production, thereby, occupying a pivotal role in the food and livelihood security of people.

JUST AGRICULTURE
multidisciplinary e-Newsletter

India grows paddy in 43 Mha which is 22 per cent of crop land with production of 112 million tons (Mt) of milled paddy and average productivity of 2.6 t/ha.

In India, paddy is cultivated throughout the country, providing livelihood to 67 million (40 per cent) rural population. The crop is grown in highly diverse conditions ranging from hills to coasts. Primarily a kharif crop, it is cultivated round the year in one or the other parts of the country. Over the years, area under paddy cultivation has increased about 1.5 times, however production has increased more than five times. With this, India has not only achieved self-sufficiency in paddy but also produces surplus to export. The leading paddy producing states are West Bengal, Uttar Pradesh, Punjab, Odisha, Andhra Pradesh, Bihar, and Chhattisgarh.

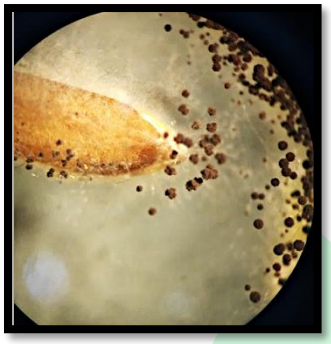
In Maharashtra, paddy is an important crop and is grown over an area of 1.45 Mha hectares with an annual production of about 4.10 million tons. The state's average productivity is 2.82 t/ha. Though the area under paddy cultivation has decreased marginally by 0.02 per cent, the production has increased by 0.93 per cent. The productivity has also risen by 0.95 per cent in the state.

In Eastern Vidarbha Zone district during 2011-2012, area under paddy cultivation was 7409 (00 ha) with annual production of 11026 (00 tonnes) with an average productivity of 1488 kg/ha. The important paddy growing region in Eastern zone of Vidarbha are Bhandara, Chandrapur, Gadchiroli and Gondia in Maharashtra. During the year 1995-96, Bhandara, Chandrapur, Gadchiroli and Gondia districts which are major paddy producing area of Eastern Vidarbha, contributed about 90 per cent of total production and covered nearly 6.00 lakh hectares area with an annual production of approximately 96.7 lakh tones.

For any seed-borne disease, it is important to understand the following things:

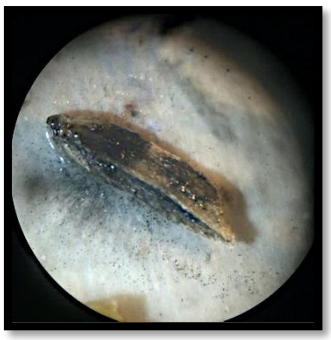
(a) The structure of the pathogen population
(b) Determine whether individual strains
(c) How quickly the pathogenic strains adapt to their host plant
(d) How rapidly they might adapt to change in the cultivars grown
(e) Whether alternative hosts are significant to the life cycle or disease dissemination

JUST AGRICULTURE
multidisciplinary e-Newsletter

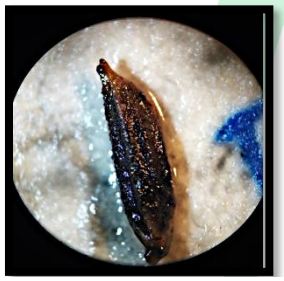


Aspergillus niger

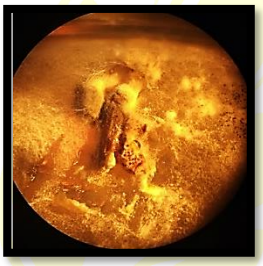
Aspergillus flavus



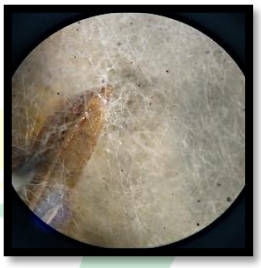
Curvularia lunata



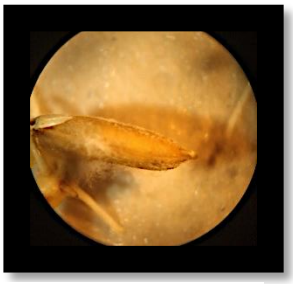
Bipolaris oryzae



Rhizoctonia solani



Rhizopus sp.



Sarocladium oryzae

Fusarium moniliforme

Fusarium solani

Cladosporium sp.

Fig. Mycoflora associated with paddy

JUST AGRICULTURE
multidisciplinary e-Newsletter

In India, paddy crop easily succumbs to various foliar, soil, seed borne and seed transmissible diseases. The important mycoflora associated which are responsible are Alternaria alternata, *A. padwickii, A. longissima, Aspergillus niger, Curvularia oryzae, C. lunata, Bipolaris oryzae, Fusarium moniliforme, F. semitectum, F. oxysporum, F. solani, Pyricularia oryzae* and species of *Phoma, Cercospora, Chaetomium, Sclerotium, Penicillium, Myrothecium* and *Colletotrichum*. Grain discoloration caused by mycoflora such as *B. oryzae, A. padwickii, M. grisea (P. oryzae), F. moniliforme, F. graminearum, S. oryzae* and *C. oryzae* caused reduction in seed viability and such seeds on planting usually exhibit pre or post emergence death of seedlings. *Alternaria alternata* (causes ashy grey discoloration) and *Bipolaris oryzae* (causes black discoloration with dark brown spots on seeds) are found mostly on the seed coat and endosperm region of the seeds. Various fungal pathogens alone or in combination also causes grain discoloration of which *Curvularia geniculata* causes eye shaped spots, *Fusarium* spp. *(Fusarium oxysporum, Fusarium moniliforme*) are responsible for pink discoloration and *Sarocladium oryzae* accounts for light brown discoloration. All these fungi found are in embryo, seed coat and endosperm of the seeds and caused varied degrees of infection. *Rhizoctonia solani*, which causes sheath blight, reduces grain yield, quality and increased lodging of plants. *B. oryzae* is one of the most common fungus responsible for seed discoloration causing light brown to black spots in rice cultivar. Pyricularia infected seeds can be the primary source of inoculum for blast disease. Rice blast (*Pyricularia oryzae*) and brown spot (*Bipolaris oryzae*) are of significant economic importance. Outbreaks of rice blast and brown spot diseases are a serious and recurrent problem in all rice growing regions of the world. It is estimated that each year enough of rice is destroyed by rice blast alone to feed 60 million people. Brown spot disease causes severe yield loss in 1942 in West Bengal popularly known as Bengal famine and yield loss reaches up to 90 per cent in certain areas.

Thus, mycoflora associated with paddy grain cause reduction in the yield of rice as much as 75 per cent in severely affected regions due to reduction in grain weight, floret sterility, inhibition of seed germination, reduction of stands, as well as the year-to-year transmission because of the seed borne nature of the pathogen. They have direct influence on both quality and quantity of seeds. Infected seeds are not preferred for quality seeds, posing a

JUST AGRICULTURE
multidisciplinary e-Newsletter

serious problem in seed certification and marketing. Moreover, seed mycoflora causes loss of approximately 2.5 million tons of rice annually due to diseases.

Conclusion

Quality and quantity of paddy seeds are affected by many seed mycoflora. The affected seeds become discoloured, lesser weight than normal unaffected seeds, lesser germinability and produce toxins in them which are involved. Among the important characteristics of seed quality, purity, germination, high yielding potentiality and seed health quality are of major importance. Paddy seeds may be affected by phytopathogenic fungi causing pre and post infections and considerable quality losses viz., seed abortion, seed rot, seed necrosis, reduction or elimination of germination capacity, nutritive value and seedling damage have been reported.

Seeds are the carrier of fungi externally or internally borne or both. The variety intensity of fungi changes area wise and depend upon climate under which seed are produced, storage condition and component of seed. Fungi must cause damage in storage or in field, if not controlled. Also, they reduced seed quality i.e., seed vigour and seed germination per centage of seed. Among the limiting factors of successful growing of paddy, seed mycoflora is one of the most important factors other than climate and crop management. So, it is necessary to study and understand these harmful fungi before they cause loss in viability, decrease in seed germination and seed quality.