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Rice diseases in the Camargue (France)

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Abstract. In the Camargue, rice diseases are caused by fungi. No bacterial disease is known, and the occurence of BYDV is suspected but is not yet proved. Seed born diseases, mainly due to *Alternaria* and *Dreschlera* sp., and soil fungi such as *Pythium* sp. and *Achlya* sp. are in part responsible of the poor rate of seed germination that is often observed. During rice growth the rice blast disease caused by *Magnaporthe grisea* is often observed but losses due to panicle blast are rare. The main problem is due to sclerotial diseases caused by *Magnaporthe salvinii* (Anamorph *Sclerotium oryzae*) and Sclerotium hydrophilum. In 1994, *M. salvinii* occured widespread in almost all rice fields. Last year, early lodging was observed in many rice fields causing bad grain quality and grain germination on the panicle. Due to the combination of this disease and heavy rains near harvest time, about 500 ha were abandoned by farmers. Artificial inoculation in a greenhouse, at an early stage corresponding to natural contamination stage, showed that *M. salvinii* may cause direct losses of 30% due to a reduction of the number of grains per panicle. This phenomenon is suspected to occur also in rice fields. Grain discolorations are common. They are mainly due to *Alternaria* sp. Seed treatments are under experimentation and gains of seed germination of 30% are obtained; yet they remain too low. Other control methods of rice diseases are studied but the increase of experiments since 1994 is too recent to provide awaited solutions.

I – Introduction

Rice is grown in France, in the Rhone river delta, named Camargue, since the middle of the XIXth century, but this crop was really established since 1947. In Camargue, variations of areas cultivated with rice were observed in relation with the economic competitivity of this crop. The cultivated area was around 32,000 ha in the sixties but had decreased to 5,000 ha during the seventies; it is now stabilised around 25 000 ha for the last 3 years. Camargue is one of the northern regions where rice is grown, so early *japonica* varieties as Cigalon and Ariete are used. Most of them have short round or medium grain. Since the last five years, long grain varieties such as Thaïbonnet are also cutivated. Many new varieties with different grain types were obtained by the rice breeders and are tested to allow farmers to grow new rice varieties with a grain type coresponding to the market demand.

Rice diseases in Camargue are similar to those observed in similar ecological regions in the Mediterrannean region or in the USA. Grain rot during germination, then stem rot (due to *Magnaporthe salvinii* Catt. and to *Sclerotium Hydrophilum* Sacc.), and rice blast (due to *Magnaporthe grisea* (Hebert) Barr) are the most common diseases. No bacterial and viral diseases were so far described in Camargue, but symptoms similar to those caused by the barley yellow dwarf virus (BYDV) were observed.

Rice diseases in Camargue were described by Bernaux (1966, 1977, 1974, 1981) who observed the first epidemy of rice blast (Bernaux, 1959) in this region.

II – Seedling damping off

In Camargue, as in many regions of the North Mediterrannean area, the germination is crucial for the establishment of the rice crop. In Camargue, rice is sown between the middle of April to the end of May, as soon as temperatures are appropriate. However during this period, climate variations are important and low temperatures are often observed. Fungi responsible for grain rot at germination stage are often observed. They have two origins, seed borne fungi, and fungi originating from rice field, soil and water.

Among various fungi which can contaminate the grain in the fields before harvest, *Alternaria* sp. is the most common. It was observed on 20% to 100% of grains of all analysed samples. It is probably not a true rice pathogen because no lesion is observed after spray of conidia on rice plants at the vegetative stage. Most of the time *Alternaria* sp. is localised on glumes but it may cause black spots on the endosperm and may contribute to decrease grain quality. During germination it may cause grain decay or reduce seedling vigor.

The causal agents of grain rot appear very similar to those described in other areas of the northern Mediterranean regions. During the year 1987, we collected diseased grains and plants in 9 rice fields and isolated one species of *Pythium* sp. and one of *Phytophthora dreschleri* Tucker (close to *Phytophthora cryptogea*) from most samples. Since that time, we observed these 2 fungi in many rice fields where germination was low. In 1993, we identified another water mold, caused by *Achlya* sp. which also participates significantly to grain rot. *Achlya* sp. was sometimes observed when temperatures were sufficient to ensure normal rice germination. These three fungi are the most frequent soil/water pathogens which cause seedling damping off in Camargue.

Surface sterilised grains placed in sterile water at 12°C, had survived more then 4 weeks, and had grown normally as soon as the temperature was higher. However when one of these 4 fungi was added in the water they had colonized the grains and destroyed them. The *Alternaria* sp. does not usually cause grain rot but at low temperatures, around 15°C, this fungus had grown on the endosperm and finally killed the plantlet. This occurs in fields where these fungi are often observed. As a result, high variability of plant density occur. Variability of environmental conditions, seeds quality, and the level of fungal population are responsible for the variability of seedling germination. Very low germination is often noticed and almost every year seeds have to be resown in 10% of rice fields.

The traditional control method is to sow a very large amount of seeds, 200 kg to 250 kg/ha, when about 80 kg/ha could be enough. The consequence is a high variability of plant density. Many experiments were carried out to examine if seed treatments with various fungicides could reduce the losses caused by the fungi. Many fungicides were tested in the laboratory, by placing treated seeds in small boxes on sterile sand covered by sterile water, at controlled temperatures. Each fungus was applied separately in these boxes. It appears that the fungi may cause high damage at 15°C as well as at 25°C. In the laboratory, different fungicides allowed to control the disease. However, when applied in rice fields these chemical products did not improve germination. The reasons could be the dilution of chemical fungicides in the water of the rice field, because farmers used to seed directly in flooded fields. The modification of the sowing method appear necessary to improve seed germination.

In Asia, the use of F1 rice hybrid is a method to improve yields but rice hybrid seeds are expensive, so they are used at rates between 25 and 50 kg/ha. This is not possible in Camargue with usual sowing methods. Present knowledge, and technics so far tested, do not make it possible to propose an improved sowing method using low amounts of seeds.

III – Foliage diseases

There are no important foliage diseases in Camargue excepting rice blast. Brown spot, usually caused by *Dreschlera oryzae,* is sometimes observed but it is not common and no special control measures are required.

The rice blast disease caused by *Magnaporthe grisea* (Hebert) Barr (anamorph *Pyricularia oryzae Cav.*) is known in Camargue since 1959 (Bernaux, 1959). It can be observed each year, on very susceptible cultivars, in breeding fields. It also occurs in spots where very large amounts of nitrogen applications cause an abnormal development of rice plants. It can also be observed on "wild red rice" which is often very susceptible to blast. Each year epidemics causing about 1% losses are noticed. More important losses occured in a few rice fields every 4 or 5 years: an epidemic caused 27% losses in a field cultivated with the cultivar Onda in 1990; the epidemic observed in 1996 on the cultivar Carillon, and the very severe outbreak observed on the cultivars Taïnato, Lido and Koral in 1997, also caused severe yield losses. The main causes are the excess of nitrogen and the choice of too susceptible cultivars. For example, the epidemic observed on the cultivar Carillon was due to the accumulation of organic soil in one half of the field during levelling. The climate is often favorable to the development of epidemics, rain is not frequent in summer, but long dew periods are very often observed.

Even if losses are very low most of the time, the risk of more important epidemics exists and it is necessary to maintain different control measures. Avoiding excess of nitrogen applications is necessary.

The resistance of varieties must be hig enough. Very susceptible varieties such as Sariceltik, Maratirlatirlatan, and Maratelli are highly diseased each year in breeding fields when most of commercially grown varieties (which are almost all compatible with the local population of the blast pathogen) appear resistant. Cultivars used in Camargue such as Ariete have a good level of partial resistance. This partial resistance plays a major role in the disease control. Because many resistant genes efficient against the European population of blast are available (Roumen et al., 1997), the introgression of these resistance genes into commercial cultivars could be a useful complementary strategy. The screening of new cultivars must include the evaluation of partial resistance, and no variety more susceptible than varieties presently cultivated should be released to farmers.

No fungicides are officially recorded and authorized for treatment of blast in France. The seed treaments may not be very efficient because the epidemics appear after tillering stage. The origin of the inoculum is not known, but the seeds of the “wild red rice” may play a major role in maintaining the inoculum.

IV – Stem rot

Stem rot is common after the milky stage, it often causes lodging. If the weather is very rainy at harvest, stem rot may cause heavy losses such as in 1994 when about 5% of the cultivated areas could not be harvested because of lodging due to a very severe epidemic. This disease is caused by two different fungi. One of these, *Magnaporthe salvinii* (anamorph *Sclerotium oryzae*) is an Ascomycete. The other *one Sclerotium hydrophilum,* is a Basidiomycete. Both of them make slerotia in senescent diseased stems. The two fungi can easily be recognized by the differences in the size and shape of the sclerotia. *Magnaporthe salvinii* is very frequent in most of the rice fields while *Sclerotium hydrophilum* is less frequent. The contamination occurs soon in the season. Slerotia remaining from the previous season in the rice fields remain floating until they are in contact with young plants (3-to-5 leaf stage). The sclerotia germinate and the fungus penetrates into the rice sheath producing a small lesion. During some weeks a latent period occurs and the fungus stays in sheath tissue during a biotrophic phase. Black necrotic spots (about 4 to 12 cm long) appear later, at the end of the tillering stage, but they mostly remain on the external sheaths of each tiller. It is very common to observe 50% to 80% of diseased tillers. The fungus invades the stems late in the season after heading.

No improved control method is available. In a field cultivated for the first time with rice the inoculum may arrive with irrigation water. However, we demonstrated that for fields cultivated with rice during several years, the main part of the inoculum originates from the rice field itself. Rotation with dry cultures is probably efficient to reduce the inoculum level. The disease is severe in lowlands which are difficult to drain and to keep dry during the off season. These wetlands can only be cultivated with rice, and crop rotations are not a useful method for such areas. A severe epidemy is not necessarily followed by a more severe one, because sclerotia survival is probably low during the off season. Attempts to spray fungicides on rice plants were not successful. The identification of cultivars with a better level of resistance is probably the only solution, and screening is under progress.

V – Conclusions

In Camargue, rice diseases significantly contribute to yield limitations. Losses due to fungal diseases occur each year but it is difficult to evaluate their impact. The main problem is probably due to water molds at germination stage: it is therefore necessary to use enormous seed amounts, and very important variations of plant density occur. Due to this problem the future development of rice hybrids in this region is unlikely to take place. Rice blast is not very severe when cultivars with appropriate level of partial resistance are used without excess of nitrogen. However very important epidemics occur when suceptible cultivars are used. The evaluation of resistance to blast is necessary before the release of new cultivars. Control of stem rot is desirable but no appropriate solution is so far available, yet screening for resistant cultivars may provide more resistant material in the future. Annual variations of northern and southern winds which are respectively very dry and very wet probably play a major role. Epidemiological analyses are necessary to understand which environmental events have some effects on the interannual variations of epidemics of each disease.

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