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Rice Notes

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Early Season Rice Diseases

Chris Greer, UCCE

Microorganisms are known to cause plant diseases and limit the health, quality and production potential of crop plants. There are many factors that determine the incidence and severity of a specific disease in the field. There are three principal elements that must be present for the occurrence of a plant disease: a susceptible host, a pathogen, and favorable environmental conditions for disease development. It is essential that you make informed disease management decisions based on biology. Remember that the best tools you have are your eyes so be sure to scout your fields regularly so you may make the most educated decision regarding your livelihood.

Seed Rot and Seedling Disease. Seed rot and rice seedling diseases may be caused by *Achlya klebsiana* and *Pythium* species. These diseases are widespread throughout the rice growing areas of California and may occur wherever rice is water seeded. Seed rot and seedling disease often result in poor establishment of uniform stands.

Symptoms of seed rot and seedling disease appear shortly after seeding. The most common sign of the pathogen is whitish fungal hyphae growing over the surface of the seed and young seedling. Algae often colonize the mycelium, turning it green. A dark circular spot may also occur on the soil surface around infected seed due to the growth of algae and bacteria on the fungal hyphae and infected seed. Seed that are infected shortly after seeding often don't germinate because the endosperm or embryo is rapidly destroyed. Growth of seedlings may be greatly impeded when seeds are infected following germination. Symptoms of seedling disease may include stunting, yellowing or rotting of the seedlings.

Unfavorable conditions for seed germination and seedling growth favor the development of these diseases. Cool weather at planting is the most common factor that predisposes seed and seedlings to these diseases because of decreased germination and seedling development rates. Once seedlings are established, seedlings will often outgrow the disease under environmental conditions favorable for seedling growth with little effect on plant growth and survival.

The seed rot and seedling disease fungi survive in the soil and produce zoospores (swimming spores) in response to flooding of the soil. Zoospores are attracted to cracks in the seed coat where the endosperm is exposed or to the germinating seedlings. Feeding by midge or tadpole shrimp may predispose seed or seedlings to seed rot and seedling disease.

Laser leveling and maintaining a flood of 4 inches promotes rapid germination and stand establishment without the loss of weed control often associated with draining for stand establishment. Planting high quality seed with 85% germination or more when water temperatures are favorable for seed germination and growth (> 70^{o}F) is an important cultural management practice for these diseases. Continuous scouting throughout the seed germination and seedling establishment stages is essential for managing these diseases. Under favorable disease conditions, these pathogens may significantly reduce stands and require reseeding. Early recognition of these diseases followed by field drainage to promote seedling development and remove the aquatic condition favored by these pathogens is the only option available for disease management once signs and symptoms appear. If acted upon early enough, there is a chance to salvage a reasonable stand and prevent the need for costly and usually unsuccessful reseeding.

Bakanae. Bakanae disease of rice is widely distributed in Asia and was first recognized in Japan in 1828. The word bakanae is a Japanese word that means "foolish seedling" and describes the excessive elongation often seen in infected plants. Symptoms of elongated seedlings led to the identification of bakanae in California rice fields in 1999. The disease has now become widespread throughout the rice growing areas of California and some infested fields suffered significant yield losses in the first few years the disease was present.

Bakanae is caused by the fungus *Gibberella fujikuroi*. The fungus infects plants through the roots or crowns and grows systemically within the plant where it produces the growth hormones gibberellin, which causes plant elongation, and fusaric acid, which causes stunting. The types of symptoms produced by an infected plant may be dependent upon the strain of the fungus and nutritional conditions. The most visually striking symptoms of the disease are chlorotic, elongated, thin seedlings that are often several inches taller than healthy seedlings. Infected seedling may also be stunted and chlorotic, exhibiting a root and crown rot. Infected seedlings usually die. Older plants infected with the fungus may exhibit abnormal elongation, stunting or normal growth and if they survive to maturity produce no panicles or empty panicles. As death approaches infected plants, leaf sheaths are usually covered with a mass of white or pinkish growth and sporulation of the fungus near the waterline. Leaf sheaths of infected plants may also turn a blue-black color with the production of sexual reproduction structures called perithecia.

Bakanae is primarily a seedborne disease and may be moved from one location to another on infested seed. Airborne spores of the fungus may contaminate seed after heading or during harvest. The fungus does not appear to infect the seed internally but rather contaminate the outside of the seed coat. Survival of the fungus in crop residue or the soil is thought to play only a minor role in the disease cycle of bakanae.

Planting clean seed is the most effective management method for Bakanae. Field trials in 2002 indicated that a sodium hypochlorite seed soak solution is the most effective method of reducing bakanae incidence in the field. An amendment to an existing agricultural use label for seed treatment was obtained in 2003 to allow the use of Ultra Clorox Germicidal Bleach for bakanae control. Bakanae disease hasn't been a big issue since instituting standardized seed treatments with Ultra Clorox. The recommended treatment replaces water with a 2.5% Ultra Clorox solution during the seed soaking period (~24 hours) followed by draining and seeding within 12-24 hours of draining. This treatment is not perfect but reduces bakanae disease incidence by about 90% at a very reasonable cost.

Planting within 12-24 hours of draining seed is essential as fungal inoculum may increase on seed being held in trailers starting about 24 hours after draining. Even treated seed may suffer from increased disease incidence if drained seed is held for prolonged periods. If you choose to use a registered seed treatment, use only in accordance with the product label. Low levels of bakanae disease are still found in most fields during the seedling stage and also in plants exhibiting late season symptoms. Most growers are not concerned with these low levels of disease and I have only received complaints in recent years from growers who have chosen not to treat their seed with Ultra Clorox. I recommend all California rice seed be treated for bakanae disease management unless there are extenuating circumstances such as drill seeding or organic production.

Managing Late Planted Rice

Cass Mutters, UCCE

Once again we are facing a difficult planting season. Stand establishment, weed control, and nitrogen are particularly problematic in wet springs like this one. Below are a few points that you might want to keep in mind.

Seed Bed Preparation

Well prepared, dry soil improves seedling vigor and stand establishment. Unless there are other overriding constraints, take the time to let the soil dry rather than rush planting into a wet seedbed.

Weeds

In wet years, another important objective of groundwork is to dry the soil to kill germinated weeds. Working wet soil may just transplant them although it may be unavoidable should spring rains persist this year. Consider taking the extra time to work the soil to allow it to dry, at least in the top 1-2" where most of the weeds arise.

Herbicide program tradeoffs are likely because it is hard to achieve optimum weed control when weeds germinate before planting and get a head start on the rice. For example, timing of water applied materials is more critical. To avoid crop injury with Bolero, it should be applied at the two leaf stage of rice, but watergrass should be less than two leaf. This narrow timing window may be lost because the weeds are ahead of the rice. The same idea is also true with Cerano, which can be applied at day of seeding. Consider reserving it for those fields which have had an opportunity to dry out thoroughly; Cerano in a wet field with pregerminated seeds may result in poor grass control. All these early applied materials still have a role, but may not work as well unless the seed bed gets dried out first.

A backup program involving foliar materials such as Abolish, propanil, Clincher or Regiment in sequences or combinations is an option. Timing and possibly rate will be affected if weeds pregerminate. Foliar applications provide a greater degree of flexibility.

Fertilizer

Switching to dry fertilizer and using lower N rates are useful strategies. What are the consequences of dry vs. aqua? Both urea and ammonium sulfate are viable alternatives but differ in their form and concentration. Urea is about 46% N and is a neutral salt so will move with the water until it converts to the ammonium form (about two days), after which it adsorbs on soil colloids. Urea is subject to volatile loss when applied to bare, moist soil so it should be incorporated promptly after application. In contrast, ammonium sulfate is 21% N, does not require conversion, adsorbs on soil colloids as soon as it dissolves and is much less subject to volatilization. The higher concentration of urea can lead to streaked applications, but may be cheaper to apply because less material is used. Plant response should not differ between these two materials, but experience suggests that broadcast N is generally less efficient than N which is banded into the soil.

As we move through the month of May and into June, N rates should come down to accommodate a shorter growing season and to offset the gain in soil N from more complete mineralization of organic N. In very late fields consider using only starter at planting and top dress later, based on crop need and leaf analysis.

In extreme circumstances some rice may get planted without any preplant N. In such a case consider 20% to 30% of the total N rate be applied within the first 20 days after planting (probably as ammonium phosphate or blend), and the balance split equally between early tillering (about 6 leaf stage) and the mid-tillering (8 leaf stage) to panicle initiation (10 leaf stage). An important point is to not apply too much early on plants that are under water. This is a recipe for algae. Wait for emergence or drop the water to make sure the plants are emerged.

Variety Choice/Planting Dates

Guidelines for preferred planting dates for optimum performance are given in Table 1. Keep in mind the dates given in Table 1 are conservative and for risk avoidance. Planting later than what is given is certainly possible, but risk increases with lateness.

Shrimp/Midge/Algae

With wet seedbeds and warm temperatures, shrimp eggs may be primed and ready to go, so be on the alert. Although midges are very difficult to predict, they seem to be associated with slow flooding and warm temperatures. With the potential for water competition because everyone will flood at the same time, this combination could occur, especially if it suddenly gets warm. With late planting and wet soils, the chances are good we will see some hot weather on young stands that are not yet emerged. This is ripe for algae to bloom. If you cannot incorporate P fertilizer prior to flooding consider waiting until 20 to 25 days after planting and apply it into the water to avoid algae problems

Tillage and Seedbed Preparation

Is crusting a problem? This is uncertain and probably varies with the soil, but some field observations suggest that crusts can affect stand establishment. It may be a good idea to do a light tillage to break the crust. A crust will soften under water so that roots can penetrate. But, if it is smooth and slick, seed may move and won’t have a chance to root.

Land planes don’t work very well in moist soil so you may have to use some sort of float or skip this step completely if the ground is reasonably smooth. Rollers may have less appeal this year if you can’t get the seedbed dry.

The objectives of seedbed preparation remain the same, with emphasis on drying to kill weeds and to prepare a surface that will provide a seedbed appropriate for maximum stand establishment.

Alternative Stand Establishment Methods

This will be the second year we are extending the UC Alternative Stand Establishment Methods to the farm level. The original intent of this experiment was to develop alternative cropping systems for combating herbicide resistant watergrass in fields where other options have not been successful. This spring several growers and pest control advisors expressed interest in trying minimum tillage systems for a variety of reasons including herbicide resistant watergrass management, fuel savings from reduced tillage, or problems with preparing fields due to late spring rains. Although this is a work in progress, the results thus far are encouraging.

If you are considering an alternative seeding technique and would like to know more about our project results, call or e-mail Cass Mutters (530-538-7201, rgmutters@ucdavis.edu), Chris Greer (530-822-7515, cagreer@ucdavis.edu) or Luis Espino (530-458-0578, laespino@ucdavis.edu).

Table 1. Suggested planting date ranges for public varieties

Variety by maturity group	Preferred date range	Optimum	Comment
Very Early			
S-102	May 1 – May 25	May 10	Avoid early planting in warm areas with all very early varieties. Advance all dates 5-10 days in cool areas.
M-103	May 1 – May 25	May 10	
M-104	May 1 – May 25	May 10	
CM-101	May 1 – May 20	May 5	
Early			
M-201	April 25 – May 20	May 5	Avoid cool areas
M-202	April 20 – May 25	May 5 –10	Avoid cold areas
M-204	April 25 – May 20	May 5	For warm areas
M-205	April 25 – May 20	May 5	For warm areas
M-206	April 20 – May 25	May 5 – 10	Adapted to most areas
L-204	April 25 – May 20	May 5	For warm areas
L-205	April 20 – May 20	May 5 - 10	Suited to all but cold areas
Calhikari 201	April 25 – May 20	May 5	Avoid cool areas
A-201	April 25 – May 20	May 5	For warm areas
Calmati-201	April 25 – May 20	May 5	For warm areas
Akitakomachi	April 20 – May 20	May 5	For most areas
Koshihikari	April 20 – May 20	May 5	For most areas
Late			
M-401	April 20 – May 5	May 1	For warm areas
M-402	April 20 – May 10	May 1	For warm areas

Nitrogen and Early Drains; Phosphorus and Potassium fertilization

Cass Mutters, UCCE

Managing herbicide-resistant weeds has led to changes in irrigation management to accommodate new herbicide chemistry. Farmers increasingly use foliar-active rather than herbicides applied into the water. Consequently, water levels must be lowered or fields completely drained before application of some herbicides.

What happens to the fertilizer N and plant growth when a field is drained for an extended period? Under flooded conditions, the fertilizer N is a reduced form (NH_3). Once the field is drained, it oxidizes to nitrate (NO_3). Upon reflooding, the nitrate is converted to N gas (N_2), which is lost from the soil. Nitrogen loss is about 2 lb/A per day in a drained field.

If the field is drained for 10 days awaiting herbicide application with a ground-rig, which is not unusual, then the N loss compares to the amount of "starter" typically applied.
Moreover, such drain periods can reduce biomass and penalize yields of popular California varieties. In a 2009 study, an extended drain reduced biomass and yield of M206 by eight percent and 13 percent, respectively. Also, keep in mind that drained fields allow other weeds to germinate, such as sprangletop, which can then become a problem later in the season. If you must drop the water, get the flood back on as soon as possible.

Here is a final note on phosphorus and potassium to keep in mind. The liquid “starter” is an N-P-K blend. Phosphorus left on the surface is ideal for algae growth. Add warm water temperatures, and you’ve the makings of a big problem. Fields are increasingly infested with blue-green algae (Nostoc), sometimes called “black” algae.

Blue-green algae, because of a gelatinous coating on its filaments, is very difficult to control with copper sulfate. Incorporate the phosphorus into the soil. Research has shown that in fields where P fertilizer was not incorporated into soil, the P levels in the outgoing water were five times greater than the levels in the incoming water soon after planting.

An adequate level of soil P, based on the Olson extraction method, is between 10 to 15 ppm for most rice soils in the Sacramento Valley. The rice soils in California contain high levels of native potassium. Some rice farmers have never applied K fertilizers. In recent years, K deficiencies are increasingly common, especially late-season deficiencies. A potassium-deficient field in the late season has a slight rusty red appearance.

There is about 40 lb/A of K in the rice grain and about 85 lb/A in the straw. If you incorporate your straw, replace the K removed in the grain when you fertilize. If you bale the straw, add an extra 45 lb/A to your annual K application rate. An adequate level of soil K, based on sodium acetate extraction, is between 70 to 80 ppm.

Pre-Plant Nitrogen Starter Application – Is It Needed?

Luis Espino, UCCE, and Bruce Linquist, UC Davis

In water seeded rice, pre-plant N fertilizer is applied in two forms: most (70-80%) is injected into the soil 3-4 inches as aqua ammonia (aqua) and the rest (20-30%) is applied to the surface of the soil as starter, usually a blend of N, P and K. The reason behind the application of starter N is the thought that seedlings will use the starter N while their roots grow long enough to reach the aqua under the soil. Recently, changes in water and straw management have prompted University of California scientists to evaluate the validity of this practice.

Small plot research and large scale comparisons conducted on commercial rice fields from 2005 to 2009 have shown that if the pre-plant starter N application is eliminated, and instead the rate of aqua N increased by the same amount, N use efficiency and grain yields increase. Following is a summary of key findings based on published reports*.

Rice seedlings can start taking up aqua N as early as 2 weeks after seeding. Growers and scientists thought that rice seedlings roots did not reach the aqua until approximately 30 days after seeding. This does not seem to be the case. Experiments showed that aqua does not move upwards in the soil profile and that rice seedlings begin taking up aqua N as early as 2 weeks after seeding. Therefore, it seems that rice seedlings roots grow deep enough to reach the level of the aqua fertilizer much earlier than originally thought.

The N recovery efficiency of aqua N applied into the soil is higher than that of surface applied starter N. Nitrogen recovery efficiency is the proportion of N applied that is actually taken up by the plant. Averaging across all experiments, the recovery efficiency of starter N was only 38%, while the recovery efficiency of N applied as aqua into the soil was 53%. The smaller recovery of starter N may be due to denitrificacion losses. Aqua is injected 3-4 inches below the soil surface where it is protected from losses.

Higher yields are obtained when all pre-plant N is applied as aqua than when it is applied as a combination of aqua and starter N. In the experiments, the production of above ground biomass (foliage) 30-40 days after seeding was higher when starter N was applied than when all N was applied as aqua. It seems that surface N can be easily taken up by the plants. In the field, this translated into bigger plants early in the season. However, higher above ground biomass early did not produce higher grain yields at the end of the season. For the same amount of N, grain yields were higher when all N was applied as aqua than when N was applied as a combination of starter and aqua. This has been confirmed in large scale trials (Table 1).

These findings indicate that all pre-plant N should be applied as aqua. Additionally, if we consider that N in starter fertilizers, usually ammonium or urea based, is more expensive than N in aqua, and that the application of starter N requires an additional field operation, the case for application of all pre-plant N as aqua is even more compelling.

The case of P and K. If P and K are yield-limiting nutrients and need to be applied, a P and K fertilizer blend may be used. To avoid algal problems, blends containing P need to be incorporated if applied pre-plant, or applied once rice plants have emerged through the water, 20-30 days after seeding.

- If applied pre-plant, use a blend with the lowest possible N content and adjust your aqua rate accordingly. Incorporate the blend into the top few inches of soil
- If the blend is applied 20-30 days after seeding, apply it when water is going to be held for at least 2 weeks after the application to avoid off-site movement.

In fields that have an adequate supply of P and K and their application is only to maintain adequate levels, blends can be applied in the fall, before incorporating the straw. In this case, the source of P and K applied should not contain N. Any N applied during the fall will be lost and will not be available the next spring.

** Linquist, B., Hill, J., Mutters, R., Greer, C. A., Hartley, C., Ruark, M. D., and C. van Kessel. 2009. Assessing the necessity of surface-applied preplant nitrogen fertilizer in rice systems. Agronomy Journal 101: 906-915; Linquist, B., van Kessel, C., and J. Hill. 2009. Improving fertilizer guidelines for California's changing rice climate. Annual Report to the California Rice Research Board*

Table 1. Rice yields as affected by N management in field scale studies from 2007-2009. Total N rates for both treatments were similar. Taken from Linquist, B., van Kessel, C., and J. Hill. 2009. Improving fertilizer guidelines for California's changing rice climate. Annual Report to the California Rice Research Board.

Year	Field	Rice grain yield (lbs/A)		
		All N applied as aqua	Aqua + starter (conventional)	Yield difference (lbs/A)
2007	1	10,001	9,531	+470
2008	2	10,040	9,710	+330
2008	3	9,419	8,529	+890
2008	4	10,570	10,275	+295
2009	5	10,200	10,350	-150
Mean	-	10,046	9,679	+367