Pest Management Strategic Plan for Midsouth Rice (Arkansas, Louisiana, Mississippi)

August 30, 2004

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Mr. Steve Prather, Producer, Stoneville, MS
Mr. Don Repress, County Agent-Bolivar County
Mr. Dan Roach, Consulant, Greenville, MS
Mr. Michael Rochelle, Farm Bureau, Greenville, MS
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Attendees of Rice PMSP meeting held in Vicksburg, MS on March 24-25, 2004

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Executive Summary

The rice acreage of Arkansas, Louisiana, and Mississippi accounted for approximately 78% of the total U.S. rice acreage (average of 3.2 million acres) from 1999 to 2003 (NASS). The estimated value of rice production for the three states averaged $738,891,000 per year from 1999 to 2003 (NASS). Rice is grown primarily in the delta regions of the three states, but significant acreage is also grown in other areas of the states.

Rice is a unique crop in that it is grown in an aquatic environment (i.e., more or less continuous flooded field conditions are maintained throughout the growing season). Therefore, abundant, high quality water sources are required to produce rice efficiently. Water management is a critical key to managing rice production. Because of the aquatic environment and the proximity of rice to other crops there are occasionally regulatory issues that must be addressed to maintain water quality and quantity and to protect broadleaf crops from the broadleaf herbicides applied to rice. In addition, there are occasional export issues associated with seed-borne pathogens of rice because of APHIS regulations and quarantines.

There are seven essential steps for successful rice production. They are:

1. Choosing the most profitable variety with the least risks.
2. Establishing a uniform stand.
3. Controlling weeds early.
4. Applying the correct nitrogen rate for each variety.
5. Managing water efficiently.
6. Controlling diseases and insects if necessary.
7. Harvesting on time.

- Weed control is a primary area of concern for rice producers. Crop production estimates from the Cooperative Extension Service, University of Arkansas indicate rice producers spend more per acre for weed control than for insect or disease control. These estimates indicate that typically 10-15% of the per acre expenses for rice production are for weed control and do not include irrigation costs which can be considered as part of the weed control strategy.

- The key to weed management in rice is providing the seedling rice plant with conditions that allow rice to outgrow weeds. While pre-plant and pre-emergence herbicides must be used to control or suppress weed growth, the application of timely post-directed herbicides is often required to maintain a successful weed control program. Cultural practices that promote rapid germination and vigorous rice seedling growth are very important in allowing timely post-emergence applications. The weed species composition of the rice crop is important in selection of the best weed control program. The proper identification of the weed complex will determine the best program to use.

- Losses from diseases include direct reduction of the plant population, direct yield loss through reduced grain filling and/or kernel weight and direct loss of head rice and/or total milled rice. Indirect losses to disease include additional research costs, need for use of resistant varieties, restrictions on crop rotation, cost of fungicide control and need for use of specialized cultural practices.

- Losses to rice in the Midsouth from disease are estimated at 10-12% of production in Louisiana and 8-10% in Arkansas and Mississippi. Currently, sheath blight is the most important disease, affecting a majority of rice production acreage in each state. Sheath blight has been shown to cause up to 50% yield losses in plots and 15-20 Bu/A or more yield losses in large scale replicated field trials. Head rice losses to sheath blight have been measured in the 1-4 percent range. Rice blast is considered the next most important, but is much more sporadic from year to year. Nevertheless, under the right environmental conditions, neck blast can cause total loss in specific fields. The seedling disease complex in drilled rice and water molds in water-seeded rice can cause partial or total stand failures, requiring expensive replanting. Kernel smut in Arkansas has caused up to 10% yield loss in severely affected fields and up to 6% head rice losses under the right conditions. In addition, heavily smutted rice is discounted as it cannot be parboiled. Straighthead has resulted in total losses where a susceptible rice cultivar was planted on a straighthead-affected soil and not drained properly.
- While rice yield potential in the Midsouth has advanced significantly in the past 20 years, disease potential has also increased. With the advent of better fungicides and increasing disease problems, fungicide use has risen to record levels in all three states.

- Insects can be a major factor limiting rice production in the south. The rice water weevil and the rice stink bug are key pests. They cause significant reduction in the quantity and quality of rice produced each year. Other insects attacking rice, though not key pests, can occasionally reduce rice yield and quality significantly. These include the grape colaspis, rice seed midge, rice leaf miner, fall armyworm, chinch bug, rice stalk borer, sugarcane borer, and other stink bug species.

Top Priorities for Rice Pest Management in the Midsouth

1. Impacts of Water, EPA, FIFRA, Clean Water Act, point source contamination, etc., on rice pest management.
2. Public education on rice pest management (need for it, practices used, safety, etc.).
3. Application technology issues.
4. More and better chemistries (must be economical) available in a timely manner to reduce development of resistance.
5. Remote sensing of pest populations/infestations (scouting is very time intensive)
6. More environmentally friendly pesticides.
7. Rice falls between “major” and “minor” crop definitions. We need a better classification to encourage development of new pesticides and pest management practices.
8. Application of pesticides to water needs to be addressed to insure availability.

9. Involve rice associations on setting priorities.
10. Limited choice of pesticides may lead to increased pesticide use, especially to counter pest resistance.
11. Quarantine issues related to seed borne diseases have to be resolved based on scientific data.
12. Education on West Nile virus (WNV) and the fact that rice culture is not the source of the implicated mosquito species.
13. Interagency relationships as they impact rice production. More coordination needed.
14. Need to be proactive (via education) on the lack of impacts on groundwater from rice pest management.
15. Hydrogen sulfide toxicity.

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2003

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PEST MANAGEMENT STRATEGIC PLAN FOR RICE IN THE MIDSOUTH
(ARKANSAS, LOUISIANA, MISSISSIPPI)

Production Facts

- The rice acreage of Arkansas, Louisiana, and Mississippi accounted for approximately 78% of the total U.S. rice acreage from 1999 to 2003 (NASS).
- The estimated value of rice production for the three states averaged $738,891,000 per year from 1999 to 2003 (NASS).

Production Regions

Rice is grown primarily in the delta regions of the three states, but significant acreage is also grown in other areas of the states.

Cultural Practices

There are seven essential steps for successful rice production. They are:

1. Choosing the most profitable variety with the least risks.
2. Establishing a uniform stand.
3. Controlling weeds early.
4. Applying the correct nitrogen rate for each variety.
5. Managing water efficiently.
6. Controlling diseases and insects if necessary.
7. Harvesting on time.

Rice can be grown on any soil type provided it has a slow permeability to reduce infiltration. A delayed flood culture is preferred provided red rice is not a major problem in the field. Continuous flood culture will provide the greatest suppression of red rice, but also requires the greatest managerial skills while pinpoint flood water management represents a compromise between delayed and continuous flood culture. Rice fields require approximately 2 to 4 acre feet of water during the growing season (data from Louisiana over the past two years indicates 2 to 3 acre feet with an average of approximately 26 acre inches) in addition to water normally received by rainfall. Ample water is basic to a good water management program in rice production.

Reasonably flat fields are required for rice production. This is so that levees constructed at 0.2 foot intervals in elevation can be accomplished with sufficient distance between levees for efficient harvesting. Properly constructed, water-tight levees are necessary for flushing and to simplify water management, weed control and drainage prior to harvest.

Crop rotation in a rice production program helps maintain high rice yields. A good rotation program assists in controlling weeds, particularly red rice, and has beneficial effect in controlling some diseases. The ideal program is rice grown once in every three years, but once in two years can be satisfactory, provided a good red rice control program is used on the rotation crop.

It is recommended that dry seeded rice be planted on level, firm weed-free seedbeds with no large clods. After disking, either in the fall or spring, the land is usually landplaned to remove row profiles, shallow depressions and ridges. If the seedbed is suitable for planting, a burndown herbicide may be used in place of tillage. When possible, levee construction is usually completed the same day as planting in drill seeded rice. Levee construction in water seeded rice can take place anytime from the fall of the year until seeding. It is recommended that levees be established and seeded prior to heavy rainfall on clay soils to achieve a stand on levees as well as establishing a stronger levee.

Levees are generally surveyed (vertical interval of 0.1 to 0.2 foot between levees) and marked prior to or just after seeding. Accurate surveying insures that a flood between any two levees will establish a uniform 2 to 4 inch depth. Levees are constructed over surveyed contour lines by means of a levee disk. Floodgates averaging from 3 to 7 feet in length are needed in each levee to control water depth when the field is flooded and to serve as a spillway when heavy rains occur. One to two floodgates are usually required per levee.

Under favorable conditions, 20 - 40 (state recommendations vary) clean, viable seeds per square foot drilled are sufficient for obtaining the desired stand of 15 to 20 plants per square foot. Seeding when the air temperature averages 70 degrees F (60 degrees in Louisiana) into a well-prepared, moist seedbed increases the probability of quick, uniform emergence and rapid seedling growth. Flushing to either provide moisture or to soften a crust will enhance stand establishment. Treating rice seed with plant growth regulators containing gibberellic acid also enhances rice stand establishment by promoting the growth of underground shoots.

Generally, seeding rates should be increased by 10 percent if seeded early, plus 20 percent for broadcast seeding, clay soil or poor seedbed preparation, or plus 30 percent for water seeding (dry or presprouted seed dropped into a flooded field). Excessive stands of 30 plants or more per square foot can enhance disease damage. Thin stands of 6 to 8 plants per square foot can thickened somewhat by applying sufficient nitrogen early to stimulate tillering and by shallow flooding.

Under certain conditions, such as extremely dry weather during and/or after seeding or when a crust may develop following excessive rains and rapidly drying conditions, a flush of water may be necessary for proper seed germination and/or emergence of seedlings.

The land should be leveled enough to permit timely removal of water as the soil is soaked. A flush should be complete and the water removed in two or three days. Water remaining for an extended period of time will cause poor germination and, consequently, stand reduction.

Drill or broadcast seeded rice is normally flooded when rice seedlings are 5 to 6 inches tall. Depending on planting date and emergence, this may be 3 to 4 weeks after seeding.

Herbicides and nitrogen are applied prior to flooding. It is recommended that flooding be started 24 hours after herbicide treatment and immediately after early season nitrogen application. Ideally, a flood should be established within 3 to 5 days after herbicide and nitrogen application to prevent weed re-infestation and nitrogen loss. The depth of flood should be maintained between 1 to 4 inches throughout the growing season. Flooding should be continuous except where soil conditions require drainage for straighthead control. The flood may be lowered to treat with herbicides for mid-season broadleaf control.

Timely drainage before harvest is important to rice maturity and harvesting efficiency. Proper timing of drainage depends on soil type, drainage facilities and time of season. Generally, rice fields are drained when rice heads are turned down and ripened in the upper half of the heads on heavy soils and when three fourths of the panicle is ripened on silt loam soils. This stage is approximately 2 -3 weeks before harvest.

Overall Concerns and Priorities for Rice Pest Management

1. Impacts of Water, EPA, FIFRA, Clean Water Act, point source contamination, etc., on rice pest management.
2. Public education on rice pest management (need for it, practices used, safety, etc.).
3. Application technology issues.
4. More and better chemistries (must be economical) available in a timely manner to reduce development of resistance.
5. Remote sensing of pest populations/infestations (scouting is very time intensive)
6. More environmentally friendly pesticides.
7. Rice falls between “major” and “minor” crop definitions. We need a better classification to encourage development of new pesticides and pest management practices.
8. Application of pesticides to water needs to be addressed to insure availability.
9. Involve rice associations on setting priorities.
10. Limited choice of pesticides may lead to increased pesticide use, especially to counter pest resistance.
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12. Education on WNV and the fact that rice culture is not the source of the implicated mosquito species.
13. Interagency relationships as they impact rice production. More coordination needed.
14. Need to be proactive (via education) on the lack of impacts on groundwater from rice pest management.
15. Hydrogen sulfide toxicity.

WEED CONTROL

Weed control is a primary area of concern for rice producers. Crop production estimates from the Cooperative Extension Service, University of Arkansas indicate rice producers spend more per acre for weed control than for insect or disease control. These estimates indicate that typically 10-15% of the per acre expenses for rice production are for weed control and do not include irrigation costs which can be considered as part of the weed control strategy.

Weeds compete with rice for light, nutrients, water, and other growth requirements. There are three primary ways that weeds cause losses in rice: 1) yield reduction due to competition, 2) losses in quality due to weed seeds in the milled rice, and 3) increased costs due to losses in efficiency and the costs of control measures.

Besides competing with the rice plant for nutrients and water, weeds can also impact rice quality by contributing weed seeds to the harvested rice. A loss in quality due to weed seeds in the milled rice is a significant problem for rice growers especially in the Midsouth. Rice contaminated with weed seeds receives a discounted price at the elevator. Hemp sesbania, northern jointvetch, morningglories, and red rice all have seeds which are similar in size to rice. Removing the weed seeds after harvesting is a difficult and costly process. Therefore, weed control strategies aimed at these weeds is critical to prevent them from reaching maturity and producing seed.

The economics of weed management can also negatively impact the profit potential for rice production. The use of certain relatively inexpensive herbicides, such as 2,4-D, has been restricted in some states due to drift problems on susceptible crops. The use restrictions often require that more expensive herbicides must be substituted to obtain the necessary weed control. Because of the aquatic environment and the fact that rice is either broadcast seeded or planted in narrow drilled rows, there is no opportunity for mechanical methods of weed control after the crop is planted.

Since mechanical cultivation is not an option, water and herbicides are the primary management tools for controlling weeds in rice. Maintaining flood water on the rice field during the growing season helps prevent the germination and development of many weed species. Sowing rice directly into a flooded field (i.e., water seeding), also takes advantage of the weed control provided by flooding. Water seeding can help eliminate or reduce some early season herbicide applications which can be important if herbicide sensitive crops are grown near the rice (i.e., cotton and certain horticultural crops). Water seeding is also a useful practice in suppressing red rice infestations.

Water seeding can have its drawbacks though. State Extension Service recommendations call for higher seeding rates (30% or more) when water seeding. Water seeding can result in reduced or uneven stands if the rice seed "drifts" or is "buried" by wind and wave action. Besides the higher initial seed cost, maintaining the flood water for a longer period in water seeded rice can also result in higher irrigation costs. Continuous water seeding has also resulted in the development of herbicide resistant aquatic weeds, such as ducksalad.

Drill seeding into a dry seed bed is generally more conducive to establishing a good stand of rice at seeding rates lower than those required for water seeding, but herbicides are critical for controlling early weed infestations which can have a major impact on the yield potential for a given field.

The key to weed management in rice is providing the seedling rice plant with conditions that allow rice to outgrow weeds. While pre-plant and pre-emergence herbicides must be used to control or suppress weed growth, the application of timely post-directed herbicides is often required to maintain a successful weed control program. Cultural practices that promote rapid germination and vigorous rice seedling growth are very important in allowing timely post-emergence applications. The weed species composition of the rice crop is important in selection of the best weed control program. The proper identification of the weed complex will determine the best program to use.

The herbicides used, percentage of acres treated by state, and average number of applications per growing season are listed in Table 1. The percentage of infested acres for each weed by state and the estimated minimum yield loss if the weed is not controlled is listed in Table 2.

Overall Concerns for Weed Management in Rice:

Research Priorities:

1. Shifts in weed species (in general) as new herbicides are being used.
2. Delayed phytotoxicity syndrome associated with biodegradation of certain herbicides.

Educational Priorities:

1. Resistant grasses – first to propanil and then Facet (quinclorac). We need multiple herbicides to avoid resistance and the educational efforts to use the alternative chemistries effectively (i.e., stewardship).

Regulatory Priorities:

1. We need multiple herbicides to avoid resistance and the educational efforts to use the alternative chemistries effectively (i.e., stewardship).

COMMON WEEDS IN MID-SOUTH RICE

ANNUAL GRASSES: Barnyardgrass (*Echinochloa crus-galli* as well as other *Echinochloa* species), Crabgrass (*Digitaria* spp.) (rare in Louisiana), Broadleaf signalgrass (*Brachiaria platyphylla*), Fall panicum (*Panicum dichotomiflorum*), Sprangletop (tighthead) (*Leptochola panicoides*), Sprangletop (bearded sprangletop) (*Leptochloa fascicularis*), Red rice (*Oryza sativa*), Johnsongrass (seedling) (*Sorghum halepense*).

Annual Grass Priorities for the Midsouth

Research Priorities:

1. Red rice resistance and outcrossing. We have Newpath (requires > 1 yr plant back to varieties other than Clearfield) but need others. Beyond herbicide (shorter residual than Newpath) is in the pipeline. (High Priority – especially the outcrossing issue).
2. Fall panicum and sprangletop may become more of a problem because of Newpath use. More research needed.
3. Rice cut grass (perennial) control in water-seeded rice. Conventional herbicides don't work.
4. Perennial grasses primarily in south Louisiana (several, including: *Echinochloa polystachya*) are a problem. 3-4 Paspalum species as well.

Educational Priorities:

1. Identification of the various annual grasses.
2. Stewardship of various herbicide resistant rice varieties and new technologies. If universities (should lead the effort) and individuals don't do it, it is not going to happen.
3. Educate clientele that drift symptoms from Command will not necessarily kill the non-target plant.

Regulatory Priorities:

1. Roundup Ready rice.
2. Liberty Link (transgenic) varieties.
3. Reexamine buffer zones for Command (probably safer around towns, etc., but buffer zones prevent it from being used).

BROADLEAVES: Ammania (red stem) (*Ammannia coccinea*), Cocklebur (*Xanthium strumarium*), Palmleaf morningglory (*Ipomea wrightii*), Morningglory (*Ipomoea* spp.), Smartweed (*Polygonum* spp.), Dayflower (*Commelina diffusa*), Ducksalad (*Heteranthera limosa*), Eclipta (*Eclipta prostrata*), False pimpernel (*Lindernia dubia*), Gooseweed (*Sphenoclea zeylandica*), Northern jointvetch (curly indigo) (*Aeschynomene virginica*), Indian jointvetch (*Aeschynomene indica*), Hemp sesbania (coffeebean) (*Sesbania exaltata*), Water hyssop (*Bacopa rotundifolia*), Cut-leaf Groundcherry (*Physalis angulata*), Purslane (*Portulaca oleracea*), Texasweed (*Caperonia palustrus*), Alligatorweed (*Alternanthera philoxeroides*).

Broadleaf Priorities for the Midsouth

Research Priorities:

1. Giant salvinia control (primarily Louisiana). What is the spread, distribution, and what are the control options?
2. Broadleaves are generally a bigger issue than grasses. Less propanil use has created a shift in the weed species (ex. pigweed, smartweed have become more of a problem)
3. Research needed on new broadleaf chemistries.

Educational Priorities:

1. Scouting broadleaf weeds (early scouting and identification). Early control is essential for broadleaves.

Regulatory Priorities:

1. Maintain registrations for propanil and Ordram (molinate). There is not a lot of new chemistry coming so we need to keep these “old” standbys.
2. Damage potential to treelines and other non-target areas. Is EPA doing anything about this? Is it a concern for them?

SEDGES: Rice flatsedge (*Cyperus iria*), Nutsedge (*Cyperus* spp.)

Sedge Priorities for the Midsouth

Research Priorities:

1. Research needed on Permit (halosulfuron-methyl) into a flooded field (label prevents it now).

Educational Priorities: None

Regulatory Priorities:

1. Regulatory aspects of Permit (halosulfuron-methyl) applied to flooded fields.

Frequency of occurrence: Every year.

The damage done by the pests: Competition with the rice crop for sunlight, nutrients, water, and other growth requirements. Need to control nutsedge in rice so that it is not a problem in next years soybeans (the usual rotation crop), when control options are limited.

Life cycle: Summer annuals except for certain species of nutsedge (*Cyperus esculentus* and *Cyperus rotundus*)

Critical timing of control measures: To best prevent rice yield losses, weeds should be controlled as early as possible. Preplant incorporated and preemergence applications (delayed preemergence applications are those made 2-4 days after planting to allow the rice seed to imbibe moisture and begin germination) of herbicides provide good early season control of the annual grasses and broadleaves. Post emergence applications of certain herbicides will also control the annual grasses, broadleaves, and sedges that escape early season applications.

PRE PLANT, PREPLANT INCORPORATED, AND PREEMERGE TREATMENTS

Molinate

Trade names are Ordram 15G and Ordram 8E. Recommended application rates range from 3.0 – 4.0 lb a.i. per acre for preplant incorporated applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours and the preharvest interval is 60 days.

Imazethapyr

Trade name is Newpath 2AS. For use on Clearfield™ varieties only. Recommended application rate is 0.063 lb a.i. per acre for preplant incorporated or preemerge applications, followed by 0.063 lb a.i. per acre postemerge. The label also allows for sequential post applications of 0.063 lb a.i. per acre. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 4 hours and the preharvest interval is 45 days.

Thiobencarb

Trade names are Bolero and Bolero 10G. Recommended application rates range from 3.0 - 4.0 lb a.i. per acre for preplant or delayed preemergence applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 4 hours for Bolero 8EC and 12 hours for Bolero 10G. The preharvest interval is not listed on the label.

Glyphosate

Trade names are Roundup Ultra, Roundup WeatherMax, Touchdown, Glyphomax, and various others. Recommended application rates range from 0.37 – 2.0 lb a.i. per acre for preplant burndown, preplant, preemerge, or delayed preemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 4 hours (12 hours for Touchdown and Glyphomax). The preharvest interval is not listed on the Roundup WeatherMax label. The preharvest interval for Touchdown is 7 days.

Paraquat

Trade name is Gramoxone Max 3SL. Recommended application rates range from 0.48 – 1.0 lb a.i. per acre for preplant burndown or preemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours. The preharvest interval is not listed on the label.

Clomazone

Trade name is Command 3 ME. Recommended application rates range from 0.3 – 0.6 lb a.i. per acre for preemerge or delayed preemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours. The preharvest interval is not listed on the label.

Quinclorac

Trade name is Facet 75DF. Recommended application rates range from 0.188 – 0.75 lb a.i. per acre for preemerge or delayed preemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours and the preharvest interval is 40 days.

Pendimethalin

Trade names are Prowl 3.3EC and Pendimax 3.3EC. Recommended application rate is 1.0 lb a.i. per acre for delayed preemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 24 hours. The preharvest interval is not listed on the label.

Triclopyr

Trade name Grandstand 3SL. Recommended application rates are 0.375 lb a.i. per acre for preplant burndown applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 48 hours and the preharvest interval is 60 days.

Halosulfuron

Trade name is Permit 75WSG. Recommended application rates are 0.031lb a.i. per acre for preplant burndown applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours and the preharvest interval is 48 days.

2,4-D

There are various formulations and trade names. Recommended application rates range from 0.47 – 2.0 lb a.i. per acre for preplant burndown applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 48 hours. The preharvest interval is not listed on the label.

POSTEMERGENCE TREATMENTS

Propanil

Trade names are Stam M-4, SuperWham, Propanil 4E and various others. There are premixes of propanil + molinate (Arrosolo 3+3E) and propanil + bensulfuron (Duet). Recommended application rates range from 2.25 to 6.0 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 24 hours. The preharvest interval is not listed on the label.

Bentazon

Trade names are Basagran and Storm (acifluorfen + bentazon). Recommended application rates range from 0.5 – 1.0 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 48 hours. The preharvest interval is not listed on the Basagran label, but it is 50 days for Storm.

Acifluorfen

Trade names are Ultra Blazer and Storm (acifluorfen + bentazon). Recommended application rates range from 0.125 – 0.5 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 48 hours and the preharvest interval is 50 days.

Molinate

Trade names are Ordram 15G, Ordram 8E, and Arrosolo 3+3E (molinate + propanil). Recommended application rates range from 1.5 – 5.0 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours and the preharvest interval is 60 days.

Triclopyr

Trade name Grandstand 3SL. Recommended application rates range from 0.19 - 0.375 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 48 hours and the preharvest interval is 60 days.

Halosulfuron

Trade name is Permit 75WSG. Recommended application rates range from 0.012 – 0.063 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours and the preharvest interval is 48 days.

Thiobencarb

Trade names are Bolero and Bolero 10G. Recommended application rates range from 2.0 - 4.0 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 4 hours for Bolero 8EC and 12 hours for Bolero 10G. The preharvest interval is not listed on the label.

2,4-D

There are various formulations and trade names. Recommended application rates range from 0.47 – 1.5 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 48 hours. The preharvest interval is not listed on the label.

Bensulfuron

Trade names are Londax 60DF and Duet (propanil + bensulfuron). Recommended application rates range from 0.028 – 0.063 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 24 hours and the preharvest interval is 60 days (80 days for Duet).

Quinclorac

Trade name is Facet 75DF. Recommended application rates range from 0.125 – 0.375 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours and the preharvest interval is 40 days.

Cyhalofop

Trade name is Clincher 2.38 EC. Recommended application rates range from 0.25 – 0.28 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours and the preharvest interval is 60 days.

Fenoxaprop

Trade names are RiceStar 0.58EC (includes safener), RiceStar HT (includes safener), and Whip 360. Recommended application rates range from 0.059 – 0.08 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 24 hours and the preharvest interval is 65 days.

Bispyribac-sodium

Trade name is Regiment 80WP. Recommended application rates range from 0.02 – 0.04 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours. The preharvest interval is not listed on the label.

Carfentrazone

Trade name is Aim 2EC. Recommended application rates range from 0.025 – 0.05 lb a.i. per acre for postemerge applications. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours and the preharvest interval is 60 days.

Clomazone

Trade name is Command 3 ME. Recommended application rates range from 0.3 – 0.6 lb a.i. per acre for postemerge applications. A postemergence grass herbicide must be added if grass is emerged at application. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 12 hours. The preharvest interval is not listed on the label.

Colletotrichum gloeosporoides

Trade name for this bioherbicide is Collego. The recommended application rate is 1 pkg spores + 1 quart rehydrating solution per 10 acres. See individual state's recommendations for specific rates and precautions.

Imazethapyr

Trade name is Newpath 2AS. Can only be used on Clearfield™ rice varieties. Recommended application rates are 0.063 lb a.i. per acre for preplant incorporated or preemerge applications followed by 0.063 lb a.i. per acre as a postemerge application. The label also allows for sequential post applications of 0.063 lb a.i. per acre. See individual state's recommendations for specific rates and precautions. The restricted-entry interval is 4 hours and the preharvest interval is 45 days.

Alternatives for weed control: Other weed control strategies are crop rotation, hand weeding, water (includes water seeding) and minimum/no-till. Crop rotation is also used to help control red rice. A rotational crop of soybeans allows the use of herbicides for controlling red rice that are not registered for use on rice. Another recommended alternative control method for red rice is flooding the harvested rice field during the winter, when possible, to encourage the presence of waterfowl which feed on the red rice seed that is at the soil surface, thereby reducing the seed numbers. Crayfish also feed on red rice seeds and sprouts during the winter.

Pipeline materials for weed control:

Roundup (glyphosate)
Beyond (imazamox), possibly available in 2004 with 24C in AR and LA
Liberty (glufosinate)
Grasp (penoxulam) maybe 2005

Table 1. Herbicides Used, Percentage of Acres Treated by State, and Average Number of Applications per Growing Season (2003).

Herbicides	Control Spectrum (Grasses, Broadleaves)	Percentage of Acres Treated by State for the Specified Herbicides and the Average Number of Applications (in parentheses).		
		Arkansas	Louisiana	Mississippi
2,4-D	Broadleaves	30 (1)	30 (1)	10 (1)
Acifluorfen	Broadleaves	5 (1)	5 (1)	15 (1)
Bensulfuron	Broadleaves	9 (1)	50 (1)	10 (1)
Bentazon	Broadleaves	5 (1)	10 (1)	
Bispyribac-sodium	Both	<5 (1)	15 (1)	10 (1)
Carfentrazone	Broadleaves	15 (1)	15 (1)	30 (1)
Clomazone	Both	60 (1)	35 (1)	75 (1)
Colletotrichum gloeosporoides	Northern jointvetch only	1 (1)	0	0
Cyhalofop	Grasses	10 (1)	20 (1)	20 (1)
Fenoxaprop	Grasses	<10 (1)	5 (1)	5 (1)
Glyphosate	Both	40 (1)	30 (1)	33 (1)
Halosulfuron	Broadleaves/Sedges	35 (1)	25 (1)	15 (1)
Imazethapyr	Both	5 (2)	8 (2)	10 (2)
Molinate	Both	<5 (1)	10 (1)	5 (1)
Paraquat	Both	<5 (1)	5 (1)	4 (1)
Pendimethalin	Grasses	10 (1)	10 (1)	5 (1)
Propanil	Both	65 (1)	40 (2)	60 (1)
Quinclorac	Both	60 (1.2)	20 (1)	30 (1)
Thifensulfuron + Tribenuron (premix)	Broadleaves	2 (1)	N/A	1 (1)
Thiobencarb	Both	5 (1)	1 (1)	2 (1)
Triclopyr	Broadleaves	12 (1)	20 (1)	35 (1)

Table 2. Percentage of Weed Infested Acres for Each State and the Estimated Minimum Yield Loss (%) Using Current Control Methods (2003).

Weed	Percentage of Infested Acres (2003)			Estimated Minimum Yield Loss Using Current Control Methods		
	AR	LA	MS	AR	LA	MS
Alligatorweed	5	70	0.5	5	10	0
Ammania (red stem	50	30	95	0	5	0.5
Barnyardgrass	90	95	100	0	20	1.0
Broadleaf signalgrass	50	20	60	0	5	0.5
Cocklebur	5	1	40	0	0	0.1
Crabgrass	15	1	60	0	0	0.1
Dayflower	20	25	80	0	5	0
Ducksalad	90	60	99	0	5	0.5
Eclipta	60	20	90	0	5	0.5
Fall panicum	15	30	20	5	10	0
False pimpernel	10	1	20	0	<1	0
Gooseweed	10	2	10	0	<1	0
Groundcherry	15	<1	10	0	<1	0
Hemp sesbania (coffeebean)	40	80	100	5	5	1.0
Indian jointvetch	15	1	10	5	<1	0
Johnsongrass (rhizome)	5	2	50	5	1	0.5
Morningglory	70	20	95	0	5	0.5
Northern jointvetch (curly indigo)	40	60	10	5	5	0
Nutsedge	40	60	90	5	2	0.5
Palmleaf morningglory	5	10	95	0	5	0.5
Purslane	20	1	15	0	<1	0
Red rice	75	70	20	30	20	1.0
Rice flatsedge	30	60	60	5	2	0
Smartweed	35	25	45	5	5	0.5
Sprangletop (bearded sprangletop)	40	2	40	0	2	0.5
Sprangletop (tighthead)	40	30	40	0	10	0.5
Texas weed	5	15	10	3	3	0.5
Water hyssop	35	2	60	5	<1	0

DISEASE CONTROL

There are numerous rice diseases in the Midsouth. Most are caused by plant pathogenic fungi although bacterial and nematode pathogens are present to a lesser extent. Major biotic diseases include sheath blight, rice blast disease, seedling disease complex, kernel smut, stem rot and bacterial panicle blight. Biotic diseases that are more minor or sporadic in nature but commonly encountered include false smut, leaf smut, brown spot, narrow brown leaf spot, aggregate sheath spot, bordered sheath spot, crown or black sheath rot and sheath rot. Biotic diseases rarely encountered but confirmed from the Midsouth include downy mildew, white leaf streak, bacterial foot rot, scab, white tip nematode, root knot nematode, stackburn and feeder root necrosis. Biotic diseases reported in the Midsouth but that are poorly understood include black kernel, minute leaf and grain spot, grain discoloration and ear blight. A biotic disease that has been reported but not confirmed in recent years includes sheath blotch. Also, eyespot has possibly been observed by modern researchers but never confirmed in the Midsouth – but has been confirmed on rice growing in an experimental nursery in North Carolina in the past two years. And in the past, a weakly virulent strain of bacterial blight was reported in Texas and Louisiana – however – additional research has shown the bacterium originally reported in the U.S. was not the bacterial blight pathogen reported in Asia and other parts of the world. Additional research is being conducted to characterize this unknown bacterium. Regardless, this strain was weakly pathogenic to U.S. rice at best and has largely disappeared from literature reports in the Midsouth in recent years. Plant pathogenic viruses, which cause important rice diseases in the tropics and other rice growing regions of the world, are not present in the United States. There are several important abiotic diseases including straighthead, glyphosate and other herbicide injuries, cold injury, salt injury, high pH problems and nutrient deficiencies.

Losses from diseases include direct reduction of the plant population, direct yield loss through reduced grain filling and/or kernel weight and direct loss of head rice and/or total milled rice. Indirect losses to disease include additional research costs, need for use of resistant varieties, restrictions on crop rotation, cost of fungicide control and need for use of specialized cultural practices.

Losses to rice in the Midsouth from disease are estimated at 10-12% of production in Louisiana and 8-10% in Arkansas and Mississippi. Currently, sheath blight is the most important disease, affecting a majority of rice production acreage in each state. Sheath blight has been shown to cause up to 50% yield losses in plots and 15-20 Bu/A or more yield losses in large scale replicated field trials. Head rice losses to sheath blight have been measured in the 1-4 percent range. Rice blast is considered the next most important, but is much more sporadic from year to year. Nevertheless, under the right environmental conditions, neck blast can cause total loss in specific fields. The seedling disease complex in drilled rice and water molds in water-seeded rice can cause partial or total stand failures, requiring expensive replanting. Kernel smut in Arkansas has caused up to 10% yield loss in severely affected fields and up to 6% head rice losses under the right conditions. In addition, heavily smutted rice is discounted as it cannot be parboiled. Straighthead has resulted in total losses where a susceptible rice cultivar was planted on a straighthead-affected soil and not drained properly.

While rice yield potential in the Midsouth has advanced significantly in the past 20 years, disease potential has also increased. With the advent of better fungicides and increasing disease problems, fungicide use has risen to record levels in all three states. In Arkansas, more than 600,000 acres were treated in 2003, approximately 45% of the total crop.

Overall Priorities for Disease Management in Midsouth Rice:

Research Priorities:

1. Regional pest survey (2004 for at least 3 years) with APHIS to identify the current spectrum of diseases.
2. More information on basic biology of rice diseases.
3. Detection (quantifying levels of infestation) and eradication of pathogens on seed.
4. Develop resistant varieties to more diseases and with higher yields and better quality.

Educational Priorities:

1. Local and regional rice newsletters – need funding.
2. State-specific publication on rice pests, diseases, injuries. This is under development.

Regulatory Priorities:

1. Seed-borne rice diseases. Detection, eradication, control and prevention.
2. Trade barriers associated with seed-borne pathogens (APHIS regulations). Education of U.S. and foreign regulatory personnel about seed-borne diseases – what is real; what is important.

BIOTIC DISEASES

Weakly Virulent Bacterial Leaf Disease

This problem was originally reported as bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae* and first reported in Texas and Louisiana in 1987. However, more recent research has shown the bacterium was not *X. oryzae* pv *oryzae* but an unidentified *Xanthomonas* species (Jan Leach, KSU, personal communication). Regardless, the bacterium reported in Texas and Louisiana caused very limited disease and no yield loss unlike true bacterial leaf blight in the Tropics. Further research is being conducted to determine the identity of the weakly virulent bacterial pathogen of rice in Texas and Southwestern Louisiana. The disease has not been noticed in recent years and never reported outside of Texas and the southern part of Louisiana.

Blast (*Magnaporthe grisea)* (anamorph = *Pyricularia grisea* or *Pyricularia oryzae*)

All above-ground parts of the rice plant can be infected resulting in different phases of the disease including leaf blast, nodal blast, leaf collar blast, neck or rotten neck blast and panicle blast. Although erratic in recent years, neck blast can be a devastating disease on susceptible rice cultivars growing under weather conditions favorable for the pathogen. The pathogen can survive on seed, overwinter in residue or survive in southern Louisiana on volunteer rice plants. While seedlings can be infected, leaf blast symptoms are usually the first indication of the disease in a field with the development of oval, irregular or diamond-shaped leaf lesions with pale centers and a reddish brown border usually noticed during the late tillering to early reproductive stages.

Characteristic conidia are produced on both sides of leaf lesions and dispersed to other plants by wind and rain. As leaves grow older, they become more resistant to infection and often the leaf blast phase appears to diminish from panicle differentiation to early heading. Occasionally, stem nodes become infected as the plant elongates resulting in black or gray nodes that gradually rot and break during grain fill, resulting in lodging. Leaf collars also become infected during stem elongation on some cultivars and there is a relationship between the number of infected flag leaf collars and neck blast. Neck blast occurs when the pathogen infects the node below the panicle, often resulting in the death of the entire panicle. When the panicle neck breaks at this node, rotten neck blast is the result. Neck blast can result in the loss of an entire field under favorable conditions.

Late planting, heavy nitrogen use and shallow flood irrigation can increase blast severity. Recent research has shown irrigation flood depth of 4 inches and deeper results in a more anaerobic root zone which induces field resistance not observed in rice plants growing in a more upland (aerobic root zone) environment. Both duration and depth of flood water impacts blast susceptible rice cultivars in this manner. Weather conditions that favor blast include mild temperatures, frequent light rainfall or long dew periods. Hot, dry weather minimizes blast.

Resistant cultivars, deeper flood depth and fungicides are the primary means of control for blast. Several sources of resistance genes are available in U.S. rice but the Pi-ta gene remains very important. The pathogen is very variable and a pathotype able to infect rice cultivars with Pi-ta genes has been documented. Over time, the pathogen is capable of overcoming most single resistance genes in widely grown resistant cultivars.

Fungicides are applied preventatively, with the first application of either azoxystrobin (Quadris) or trifloxystrobin (GEM) made just before the panicles start to emerge (5% heading) and the second recommended when 70-90% of the panicle length has emerged on the primary tillers (Chemical Control Section). Quadris and GEM have the same mode of action but so far no strains of the blast pathogen resistant to these fungicides have been noted. This could change as fungicide use increases and currently certain growers are consistently applying 2-3 applications of the strobilurin fungicides to rice fields in the Mid-South as well as an additional application to the soybean crop in rotation in alternate years in the same field. Strains of *Pyricularia grisea* in turf (grey leaf spot disease) have been discovered with resistance to azoxystrobin already in various parts of the U.S.

Priorities for Blast

Research Priorities:

1. Development of improved, resistant varieties with high yield and quality potential.
2. Discovery of new sources of resistance.
3. New fungicide chemistry with different mode of action.
4. Timing and economic use of fungicides.

5. Scouting and decision making systems.
6. Control of seed-borne blast inoculum.
7. Scientific basis for how cultural practices influence blast management.

Educational Priorities:

1. Economic use of fungicides and decision making.
2. Adoption of cultural practices to control the disease.
3. Management recommendations for individual rice cultivars.

Regulatory Priorities:

1. Movement of infected/infested seed or rice plant parts. (Prevent introduction of new pathotypes of *P. grisea*)

Brown Spot *(Cochiobolus miyabeanus)* (anamorph *Bipolaris oryzae*)

Brown spot is very common in the Midsouth. All modern rice cultivars have some resistance to the disease but conditions of nitrogen deficiency, potassium deficiency or other stresses can result in increased severity. The pathogen is often seed-borne and can cause seedling blight under warm, moist conditions. Leaf lesions on healthy plants appear as small, solid brown spots up to 1/8" across while on stressed plants they may expand to 3/8" long oval spots with grey centers and a dark border. This latter symptom may be confused with leaf blast on some cultivars. *B. oryzae* can infect the panicle branches and floret glumes, and has been associated with pecky rice when it penetrates the kernel.

Brown spot can be managed by maintaining proper soil fertility through routine soil testing and fertilization, using the appropriate rate of nitrogen fertilizer and minimizing cold water injury through the use of multiple-inlet irrigation methods. Seedling blight can be minimized by the use of seed protectant fungicides.

Priorities for Brown Spot

Research Priorities:

1. Maintain resistance in all cultivars developed in the Mid-South.
2. Understanding of rice soil fertility, nutrient imbalances and brown spot disease.

Educational Priorities:

1. Education on importance of soil sampling and fertilization.
2. Identification of brown spot and separation from leaf blast.

Regulatory Priorities: None

Crown Sheath Rot or Black Sheath Rot *(Gaeumannomyces graminis* var *graminis)*

The disease is not usually important in the Midsouth, although it has caused yield loss in specific fields. It is usually most severe in fields that have not been planted to rice recently. The pathogen infects many wild grass species and these alternative hosts likely provide the primary inoculum for infection of rice. The pathogen likely invades the lower parts of the plant first but may not be noticed until symptoms form just above the water line on the lower leaf sheaths. Initial sheath lesions are irregular to oval, dull black but often with a light-colored or off-white center. The underside of the lesion will often have a mycelial mat of the pathogen that appears as dark brown, fan-shaped masses of fungal hyphae. Under favorable conditions, the pathogen grows upwards underneath the sheaths, causing a progressive leaf death. Eventually, infected sheaths will begin to rot and small, spherical, black perithecia will be observed in the sheath surface cells. Perithecial beaks protrude to the outside of infected sheath cells and exude ascospores under moist conditions. On susceptible cultivars, crown sheath rot can be confused with sheath blight or stem rot. The pathogen also can invade stems and nodes, causing lodging even in semidwarf rice cultivars. Disease symptoms are often first noticed at panicle differentiation and increase through grain fill. The pathogen probably survives in infected crop debris and on alternative grass hosts. The pathogen has been isolated from seed occasionally and from dying seedlings. The disease is favored by thick plantings, excess nitrogen, the use of semidwarf long-grain rice cultivars and long rotations out of rice. The use of proper seeding and nitrogen rates minimize the disease and foliar fungicides like azoxystrobin and propiconazole applied early in the disease cycle suppress it but are not economical in most fields.

Priorities for Black Sheath Rot/Crown Sheath Rot

Research Priorities:

1. Pathogen biology and disease epidemiology.
2. Discovery of resistant germplasm.
3. Cultural practices and disease control.
4. Loss due to disease and decision thresholds.
5. Economics and efficacy of fungicide use.

Educational Priorities:

1. Use of cultural practices and cultivar selection for control.
2. Appropriate use of fungicides.
3. Correct identification of the stem diseases of rice.

Regulatory Priorities: None

False Smut *(Ustilaginoidea virens)*

False smut is usually a minor disease in the Midsouth. It infects developing flowers of rice, initially producing a silvery white gall that later grows into a large, orange ball (1/2" diam) which eventually turns brown to black at maturity. The dark galls are harvested along with rice grain, resulting in unsightly lots of paddy rice that have to be cleaned prior to use.

In 1997, the disease was first noticed in Arkansas on the cultivar 'Drew' and since then has become a persistent problem in Northeast Arkansas and parts of Mississippi and Louisiana. False smut has been a curiosity in other rice-producing states for many years. The galls are covered with secondary conidia of the pathogen that can rapidly spread the disease to nearby panicles. The conidia are believed to be windborne, splash-dispersed and possibly moved around by grain feeding insects like rice stinkbugs. Most cultivars are susceptible to the disease in the U.S. but some are more susceptible than others. Excessive nitrogen appears to favor the disease as does late planting or any condition that delays maturity of the crop. Early planting, uniform crop development and recommended nitrogen rates minimize the disease. Propiconazole fungicides applied during the booting stage will suppress the disease and result in a 50-80% reduction in galls in the harvested grain.

Priorities for False Smut

Research Priorities:

1. Discovery of resistant germplasm.
2. New and better fungicide chemistry.
3. Scouting and decision-making systems.
4. Epidemiology of the disease and biology of the pathogen.
5. Influence of fertility and other practices on the disease.

Educational Priorities:

1. Appropriate use of fungicides.
2. Management of the disease without sole dependence on fungicides.

Regulatory Priorities:

1. Phytosanitary restrictions and trade implications of false smut contaminated rice.

Kernel Smut *(Neovossia horrida (= Tilletia barclayana))*

The pathogen infects developing flowers of the rice plant, growing within the embryo "milk" until the kernel enters the soft dough stage. At this time, the vegetative hyphae of the pathogen turn into dark black teliospores that replace the internal rice kernel contents. The teliospores absorb moisture during the night and early morning hours and the black spore mass often exudes from the rice flower during the morning. As the spores dry, they are blown around the field and contaminate other plant parts, the soil and harvesting equipment. The pathogen is ubiquitous in Midsouth rice soils where the teliospores can survive for more than 2 years. When the field is planted to rice again, teliospores float to the surface of the irrigation water and eventually germinate, producing primary sporidia. The primary sporidia have not been observed to fuse, as is the case in *Tilletia*, but do produce two types of secondary sporidia. The allantoid-shaped secondary sporidia are easily airborne and probably are responsible for most infections. Only a few florets per panicle are infected in most fields, but the disease has caused up to 10% yield loss and reduced head rice yield by 6% in certain highly susceptible cultivars under favorable conditions. The cultivars 'LaGrue', 'Francis', 'Banks', 'Cocodrie', 'Priscilla' and 'Cypress' are considered susceptible to very susceptible, especially under conditions where excessive rates of nitrogen fertilizer have been applied. Heavily "smutted" rice cannot be parboiled since it results in a grey product so mills routinely discount for "smutty" rice. While teliospores contaminate rice seed and are moved geographically with them, seed treatments do not affect the disease since it is primarily soilborne once established. Kernel smut is favored by extended periods of cloudy weather during heading, high humidity, long dew periods and frequent but very light rainfall. Excessive nitrogen use at preflood and late planting strongly favor kernel smut development. Heavy rainfall during heading can reduce the disease. Kernel smut can be minimized by early planting, use of recommended nitrogen rates and propiconazole fungicide applied preventatively during the booting stage.

Priorities for Kernel Smut

Research Priorities:

1. Discovery of resistant germplasm.
2. New and more effective fungicide chemistry.
3. Better decision-making systems for fungicide use.
4. Epidemiology of the disease and biology of the pathogen in the U.S.

Educational Priorities:

1. Appropriate use of fungicides.
2. Appropriate use of cultural practices, cultivar selection and other factors in management of kernel smut.

Regulatory Priorities:

1. Phytosanitary restrictions and trade issues associated with kernel smut contaminated export rice.

Narrow Brown Leaf Spot *(Cercospora oryzae)*

Narrow brown leaf spot is a very common, though minor disease of rice in the Midsouth. Disease symptoms are usually noticed late in the growing season and increase during grain filling. Leaf symptoms include pencil-thin, reddish brown streaks up to ½" long that run lengthwise on the leaf blade. It is likely that white leaf streak (*Mycovellosiella oryzae*) is part of the narrow brown leaf spot disease in the southern U.S. The pathogen may invade the collar portion of the leaf and cause large, irregular, netted brown blotches on infected sheaths late in the season. The latter may be confused with sheath blight or bacterial panicle blight symptoms on some cultivars. The pathogen can infect the sub-panicle node and the panicle rachis, sometimes being confused with neck or panicle blast. The panicle phase of the disease can cause yield loss in certain years but has not been studied extensively. Cultivars vary in reaction to the disease but most southern rice cultivars appear to have some resistance. It is likely that the pathogen varies in the southern U.S. and various pathotypes may exist. Control measures are not recommended but foliar fungicides used for other diseases late in the growing season probably minimize narrow brown leaf spot as well. At present, propiconazole fungicides have been shown to be the most effective.

Priorities for Narrow Brown Leaf Spot

Research Priorities:
1. Discovery of resistant germplasm.
2. Epidemiology of the disease and biology of the pathogen in the U.S.
3. Assessment and identification of narrow brown leaf spot and white leaf streak.
4. Crop loss when associated with the leaf sheath and panicle.

Educational Priorities:

1. Identification of rice leaf diseases.

Regulatory Priorities: None

Seed rots and Seedling Disease Complex

Several opportunistic bacteria and fungi likely contribute to rotting of planting seed in the field. In water-seeded rice, *Achyla* and *Pythium* fungi have been identified as major seed rotters and pathogens under cool temperature conditions. In dry-seeded rice, seedborne and soilborne pathogens include *Pythium, Cochiobolus, Curvularia, Sarocladium, Fusarium, Rhizoctonia,* and *Sclerotium* among others. Cold, wet weather usually results in the most stand loss from these pathogens although warm, wet weather and no-till or minimum tillage may favor certain *Rhizoctonia* spp. and *Sclerotium rolfsii*. Planting very early in the season will result in the highest risk for these problems and deep planting also favors stand loss in rice. Optimum planting date, properly prepared seedbeds, uniform and shallow planting depth, high-quality seed and the use of seed protectants can minimize seed rot and the seedling disease complex and resulting stand loss.

Priorities for Seedling disease complex in drill seeded rice.

Research Priorities:

1. Economic use and efficacy of seed treatments.
2. Discovery and assessment of resistant germplasm.
3. Epidemiology, biology and identification of seed/seedling pathogens.
4. Correct field diagnosis of seed/seedling problems in rice.

Educational Priorities:

1. Economic use of fungicide seed treatments for rice.
2. Prevention of stand loss.

Regulatory Priorities: None

Sheath Blight *(Rhizoctonia solani* AG1-1A)

Sheath blight is the most important rice disease in the Midsouth, affecting more than 50% of planted acreage each year. The pathogen has a broad host range including rice and soybeans. A rice-soybean alternate year rotation appears to be most favorable for long-term development of sheath blight in rice and aerial blight in soybean. And this is the most common crop rotation in the Midsouth. Other factors that favor sheath blight include the use of semidwarf long grain rice cultivars, thick plantings, early planting and excessive use of nitrogen fertilizer. It has been shown that the preflood nitrogen application has the most effect on sheath blight if excessive rates are used. Summer weather conditions in the Mid-South favor the disease each year.

Sheath blight symptoms begin as elongated oval lesions on the leaf sheath above the water line and are usually first noticed about panicle differentiation. The lesion often has a light green to gray center surrounded by a purplish border. After the rice leaf canopy closes together during early reproductive stages, the pathogen rapidly grows upwards under sheath and leaf tissue and across touching leaves to nearby plants. Primary infections result from overwintered sclerotia that float on the water surface or from infected crop debris floating on the water. During stem elongation, the rice plant extends the upper leaves away from sheath blight for a time but eventually the disease will "catch up" late in the season. Shorter, leafier long grain rice cultivars such as Cypress, Cocodrie, Clearfield CL161 or Lemont suffer more damage from sheath blight than taller cultivars, although the latter may still be damaged under conditions of high fertility and thick stands. Medium grain cultivars are usually less susceptible to sheath blight regardless of stature. In very susceptible cultivars, the pathogen may invade the stem resulting in lodging or plant death.

Over time, sheath blight becomes aggregately distributed in rice fields as a result of the accumulation of sclerotia or infected crop debris in the lower ends or along the edges of fields. However, growers spread infected debris and sclerotia around the field during preparation for planting, resulting in more uniformly distributed disease. Lower seeding rates, recommended preflood N rates and the foliar fungicides azoxystrobin, flutolanil and trifloxystrobin can all be used to minimize sheath blight. Wider drill row spacings and burning of infected crop debris have also been cited as potentially useful in reducing sheath blight over time. Rotations including rice followed by two years of soybeans, rice rotated with cotton or other crops, or even continuous rice have all been observed to reduce sheath blight compared to the traditional rice-soybean rotation. Minor Rhizoctonia diseases including aggregate sheath spot and bordered sheath spot may be confused with sheath blight and both occur in parts of the Midsouth.

Priorities for Sheath Blight

Research Priorities:

1. Discovery and utilization of resistant germplasm, including partial resistance.
2. New fungicide chemistry.
3. Better understanding of cultural practices and sheath blight.
4. Biology and diversity of the pathogen.

5. Precision agriculture technology – remote scouting for sheath blight.
6. Economics and efficacy of fungicide use.
7. Identification and characterization of other *Rhizoctonia* spp. on rice in the U.S.

Educational Priorities:

1. Appropriate use of fungicides for control.
2. Correct identification of sheath and stem diseases.
3. Appropriate use of cultural practices and cultivar selection for sheath blight control.

Regulatory Priorities: None

Stem Rot *(Magnaporthe salvinii (= Sclerotium oryzae))*

Stem rot has been a major historical disease in the Midsouth. The pathogen survives as long-lived, spherical, black, tiny sclerotia in the soil that float to the water surface and infect the rice sheath at the water line. The pathogen gradually invades the stem and may result in premature death of infected tillers under certain circumstances. Initial symptoms include black, blocky sheath lesions that expand up to 6 inches in length during the reproductive stages of infected rice plants. Symptoms may be confused with those of crown sheath rot. At the end of the season, infected tissues often have abundant sclerotia formed within and sclerotia continue to form after harvest in infected stubble. In recent years, the disease has been most damaging on lighter soils inherently low in potassium. However, rice production systems that feature continuous rice production and the use of high levels of nitrogen fertilizer may also have problems. Most southern U.S. rice cultivars are susceptible to stem rot so management focuses on frequent soil testing and the appropriate use of potassium and nitrogen fertilizers and burning infected stubble where possible. Azoxystrobin fungicide applied early in the disease cycle has been reported to suppress the disease but results have been inconsistent.

Priorities for Stem Rot

Research Priorities:

1. Discovery of resistant germplasm.
2. Fertility and cultural practices and stem rot.
3. New fungicide chemistry.
4. Scouting and decision-making systems for short and long-term control.
5. Economics and efficacy of fungicides.

Educational Priorities:

1. Appropriate use of fungicides.
2. Correct identification of the stem diseases of rice.

Regulatory Priorities: None

Bacterial Panicle Blight *(Burkholderia glumae)*

The pathogen is believed to be primarily seedborne and may cause seedling blight in addition to panicle blighting later in the season. The pathogen probably establishes itself as an epiphyte on seedlings and grows along with the plant until later reproductive stages. It infects developing panicles resulting in aborted or partially developed grains, blanked grains and sometimes rotted flag leaf sheaths that may be confused with sheath blight. Cultivars vary in susceptibility in commercial production but most are susceptible under inoculated test conditions. The medium grain cultivar 'Bengal' has been most affected in commercial fields of the Midsouth although 'Cocodrie' and 'Cypress' cultivars have also been damaged in certain years. The disease appears to be strongly favored by hotter summer temperatures, especially at night, so intensity varies greatly from year to year. Yield losses up to 50% have been measured for this disease under certain conditions. Management of the disease on affected cultivars is not possible at present. Reliable detection and quantification of the pathogen in seed lots is not practical and seed treatments have not proven useful to date. Resistant germplasm has been identified by LSU scientists but resistant cultivars are several years away. Chemical control using oxolinic acid would be possible but registration of this material does not appear promising.

Priorities for Bacterial Panicle Blight

Research:

1. Discovery of resistant germplasm.
2. Detection and quantification is planting seed.
3. Methodology to eradicate the pathogen from planting seed.
4. Epidemiology of the disease and biology of the pathogen.
5. New bactericide chemistry – seed and foliar applied.

Educational:

1. Correct diagnosis of the disease in the field.

Regulatory:

1. Seed borne aspects of the disease and potential impact on seed exchange.

ABIOTIC DISEASES

Straighthead

Straighthead is a disorder usually associated with lighter soils, fields with arsenic residues or fields having large amounts of plant residue incorporated into the soil before flooding. Panicles are upright at maturity because the grain does not fill or panicles do not emerge from the flag leaf sheath. Hulls (palea and lemma) may be distorted and discolored, with portions missing or reduced in size. Distorted florets with a hook on the end are called "parrot beak" and once were considered diagnostic for straighthead. However, "parrot-beaked" florets can also be induced by glyphosate injury to rice if drift from this herbicide occurs during panicle initiation to panicle differentiation growth stages. In addition, some modern rice varieties do not "parrot-beak" unless straighthead conditions are extreme but yield loss will still be evident in these fields. Straighthead-affected plants tend to be darker green and may produce new shoots and adventitious roots from the lower nodes where the disorder is severe. These symptoms can be mimicked by injury due to "grass" herbicide drift later in the growing season when the heads may be injured or killed during emergence. Management is by use of resistant varieties and draining at proper time to dry the soil until it cracks if possible. Use of the DD50 program is helpful in timing straighthead drainage.

Priorities for Straighthead

Research:

1. Discovery of the physiological basis of straighthead in nature.
2. Discovery of resistant germplasm and development of improved resistant cultivars.
3. Improvement of straighthead screening in the field.
4. Genetic basis of straighthead resistance.
5. Correct diagnosis of straighthead compared to similar appearing conditions.

Educational:

1. Correct identification of straighthead compared to glyphosate injury.
2. Prevention of straighthead through good planning.

Regulatory: None

Herbicide Injury

Injury from herbicide carryover and drift has become more frequent in recent years with the advent of new herbicide technology for rice and rotation crops. One of the most common drift injury problems is glyphosate injury to rice, both at the seedling stage coming from nearby "burn down" applications to minimum tillage fields being prepared for planting. Seedling rice is very sensitive to glyphosate and symptoms are similar to seedling disease, salt injury and other problems. Rice in the early reproductive stages is also very sensitive to glyphosate drift and panicles emerging later in the season on drift-affected plants can be distorted, blanked and very similar to straighthead in appearance. The flag and other upper leaves may also be shortened and stiff on these plants. Rice affected by glyphosate will have distorted panicles on levees as well as in paddies compared to straighthead where affected panicles do not occur on levees. Another common drift problem that has recently emerged has been from NewPath herbicide applied to nearby Clearfield rice fields. While Clearfield rice varieties are resistant to NewPath herbicide to allow for in-season control of red rice, non-Clearfield rice varieties are very sensitive to the product. Symptoms on non-Clearfield rice include cessation of growth, severe stunting, discoloration of the leaves and gradual death over a 2-4 week period after injury. "Grass" herbicide injury to rice later in the growing season has been a diminishing problem with the growing dominance of glyphosate in soybeans and other crops for weed control. Common grass herbicides like Select, Poast and others will cause death of the main growing point if drifted onto rice. In late summer, this main growing point is often the base of the panicle resulted in a dead panicle that can be easily pulled from the stem. The base of the panicle neck will be rotted and discolored. Adventitious tillers will be common growing from lower stem nodes as affected rice plants try to compensate for the death of the main panicle. Diagnosis of herbicide injury problems can be difficult and a competent weed scientist should be enlisted for help. Drift patterns are usually a primary key in diagnosing herbicide injury and good application records by all involved can be helpful in sorting out the exact cause of the problem.

Priorities for Herbicide Injury

Research:

1. Development of "non-drift" herbicide systems for row-crop production.
2. Crop loss from drift injury at various levels.
3. Correct diagnosis of herbicide injury symptoms to rice.

Educational:

1. Correct identification of herbicide injury symptoms.
2. Prevention of herbicide injury through good planning and applications.

Regulatory: None

Salinity

Soil alkalinity, or salinity, and water salinity injure rice and are characterized by areas of stunted, chlorotic plants in the field. Under severe conditions, leaves turn from yellow to white, and plants die. Root systems of salt-affected plants may have a "bottle-brush" appearance with many short, stubby roots. Affected areas usually have dead or dying plants in the center or on high spots or on tops of levees, with stunted yellow or white plants surrounding that area and green, less affected plants in lower areas. Salt deposits may be seen on the edges of leaves, on clods of soil and other high areas of the field. Flushing with water low in salt reduces damage. On some saline soils, the use of phosphate fertilizer may reduce salt problems over time.

Priorities for Salinity

Research:

1. Discovery of resistant germplasm.
2. Better characterization of saline soils and irrigation sources.
3. Remediation of saline soils for rice production.
4. Management options for saline problems in rice.
5. Fertilizer options and saline problems.

Educational:

1. Management options for salinity in rice.
2. Correct diagnosis of salt-affected rice and saline soils.

Regulatory: None

High pH and Zinc Deficiency

Soils high in pH (> 7.0) may have persistent problems with rice production, often revolving around zinc deficiency that can occur on these soils after the permanent flood is established and if the soils are very low in zinc. Zinc deficiency symptoms include rapid color change of leaves after flooding, usually yellow or bronze colors, with severely affected leaves developing a yellow midrib especially at the base. Roots may deteriorate and plants become "limp" and float on the water surface. There may be a complex of problems associated with high pH and the causes of all problems have not been identified. Zinc deficiency can be managed by soil testing and applying zinc fertilizer. In mild cases, zinc seed treatment has been shown to help manage the problem and "rescue" treatments that involve draining the field and applying foliar chelated zinc may still be used in some cases.

Priorities for Zinc Deficiency and high pH soils

Research:

1. Discovery of resistant germplasm.
2. Development of improved management options for high pH soils.
3. Prevention of high pH in rice soils.
4. Correct diagnosis of high pH related symptoms in rice and their cause.

Educational:

1. Correct identification of high pH problems and zinc deficiency.
2. Overall management of high pH soils in rice production.

Regulatory: None

Other Nutrient Deficiencies

Rice soils in the Midsouth that have been leveled, have inherently weak soil fertility and thin top-soil, or that have been cropped to death without a good soil fertility program may result in various nutrient deficiencies in rice. Phosphorus, potassium and sulfur deficiency in rice have been more commonly reported in recent years. Phosphorus deficient plants are stunted, dark green to blue green in color, have few tillers and have a poor root system. Potassium deficient plants may be stunted and poorly tillered as well but often have a lighter green color. Brown spot and stem rot can be very severe on potassium deficient plants. Sulfur deficiency in rice appears as yellowish upper leaves with brown spots forming between the veins near the leaf tips. These gradually spread down the leaf and may coalesce into streaks. Sulfur deficiency often is not noticed until late in the season and is usually associated with lighter soils and those soils that do not have a shallow hardpan. These nutrient deficiencies are preventable using a good soil testing and soil fertilization program. In the case of sulfur deficiency, the routine use of ammonium sulfate has become part of the nitrogen fertilization program.

Priorities for Other Nutrient Deficiencies

Research:

1. Understanding and characterization of nutrient deficiencies in rice and their causes.
2. Development of appropriate management options to prevent nutrient deficiencies.

Educational:

1. Prevention of nutrient problems in rice.
2. Identification of nutrient problems in rice.

Regulatory: None

Hydrogen Sulfide Toxicity (and decaying organic matter toxicity)

In water-seeded systems and in fields with soils high in sulfates, a problem known as hydrogen sulfide toxicity may occur. The formation of hydrogen sulfide occurs under the flood where oxygen content is low and organic matter being decomposed is high. Hydrogen sulfide is very toxic to rice roots and may result in root death over time. Rice plants stop growing and seedling rice plants die relatively quickly. Larger plants are stunted and turn light green or yellowish over time. Root systems of severely affected plants rot off and the odor of "rotten-egg" gas may be evident when plants are pulled from affected paddies. Decomposing organic matter under the rice flood water may also result in other toxic products to rice plants, most poorly understood. Management of these problems involves rotating out of rice, destruction of crop residue by burning or thorough tillage, aeration of soil prior to planting or draining and aeration of fields once symptoms are noticed.

Priorities for Hydrogen Sulfide and related problems

Research:

1. Discovery and characterization of the causes of hydrogen sulfide toxicity.
2. Field diagnosis of these problems.
3. Discovery of resistant germplasm.
4. Development of management options to control toxic soil problems.

Educational:

1. Prevention of hydrogen sulfide and related problems.
2. Correct identification of these problems.

Regulatory: None

Cold Injury

Cold weather affects rice development most at the seedling or reproductive stages of growth. Seedling damage is expressed as a general yellowing of the plants or as yellow or white bands across the leaves where a combination of wind and low temperature damaged the plants at the soil line. Cold weather (less than 60 F) present during the reproductive stages causes panicle blanking or blighting. Individual florets or the whole panicle may be white when emerging. To eliminate this problem, adjust planting date to avoid low temperatures. Stand loss due to early planting and cold soil temperatures may result from the seed/seedling disease complex (previous sections).

Priorities for Cold Injury

Research:

1. Discovery of resistant germplasm (cold tolerant rices).
2. Understanding the basis for cold sensitivity.
3. Characterization of the causes of stand loss due to early planting.

Educational:

1. Correct identification and management of early season rice planting problems.

Regulatory: None

FUNGICIDES

Seed Treatments (Dry-Planted Rice)

Pythium seed rot and seedling blight

Metalaxyl

Trade name = Allegiance FL. Application rates range from 0.75 – 1.5 fl oz/cwt (applied as seed treatment). See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 24 hours.

Mefenoxam

Trade name = Apron XL. Application rates range from 0.32 – 0.64 fl oz/cwt. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 48 hours.

Rhizoctonia seedling blight and general seed rots

Carboxin + Thiram

Trade names are RTU-Vitavax-Thiram and Vitavax 200. Application rates average 6.8 oz/cwt for RTU-Vitavax-Thiram and 4 fl oz/cwt for Vitavax 200. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 24 hours.

Fludioxonil

Trade name is Maxim 4FS. Application rates range from 0.08 – 0.16 fl oz/cwt. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 12 hours.

Azoxystrobin

Trade name is Dynasty 100FL. Application rates range from 0.153 – 1.53 fl oz/cwt. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 4 hours.

Pythium + Rhizoctonia + general seed rots (broad spectrum)

Carboxin + Thiram + Metalaxyl

Trade names are Vitavax 200 (carboxin + thiram), Allegiance (metalaxyl), and Stiletto (carboxin + thiram + metalaxyl). Application rates average 4 fl oz/cwt Vitavax 200 plus 0.375 fl oz/cwt Allegiance, or 6.8 fl oz/cwt Stiletto. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 24 hours.

Mefenoxam + Fludioxonil

Trade names are Apron XL and Maxim. Application rates average 0.32 – 0.64 fl oz/cwt Apron XL and 0.08 – 0.16 fl oz/cwt Maxim. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 48 hours.

Azoxystrobin + Mefenoxam + Fludioxonil

Trade names are Dynasty (azoxystrobin), Apron XL (mefenoxam), and Maxim (fludioxonil). Application rates average 0.153 – 1.53 fl oz/cwt Dynasty, 0.32 – 0.64 fl oz/cwt Apron XL, and 0.08 – 0.16 fl oz/cwt Maxim. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 48 hours.

Foliar Fungicides

Sheath Blight

Foliar fungicides should be applied by air in 5 - 10 gpa from shortly after panicle differentiation (1/2 inch internode elongation) to early heading depending on environment and disease intensity. When scouting, applications should be considered when sheath blight is noted on rice in at least 35% of stops (5-10% infected tillers) throughout the main part of a field for highly susceptible varieties and 50% of stops (10-15% infected tillers) for moderately susceptible varieties – and/or when the disease begins to move into the upper canopy (top three to four leaves).

There are a number of important restrictions on the use of these foliar fungicides in rice, most involving use around crayfish, catfish or baitfish operations. Propiconazole fungicides cannot be used in certain areas where endangered mussel species are believed to exist. Propiconazole fungicides must be used prior to head emergence in rice. The current Federal labels for each fungicide should be referenced for detailed information on restrictions.

Trifloxystrobin

Trade name is GEM 25 WDG. Application rates range from 8 – 9.8 oz/A. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 12 hours.

Azoxystrobin

Trade name is Quadris 250 SC. Application rates range from 9.2 – 12.3 fl oz/A. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 4 hours.

Flutolanil

Trade name is Moncut 70 DF. Application rates range from 1.0 – 1.4 lb/A. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 12 hours.

Trifloxystrobin + Propiconazole

Trade name is Stratego 250 EC. Application rates average 16 oz/A. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 24 hours.

Azoxystrobin + Propiconazole

Trade name is Quilt 200 SC. Application rates range from 28 – 34.5 fl oz/A or tank-mix a lower rate of Quilt (14 fl oz or above) with Quadris. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 24 hours.

Kernel Smut (prevention)
False Smut (suppression)

Apply fungicides by air in 5 – 10 gallons water. The best overall timing for prevention (or suppression) of the smut diseases is the booting stage. Low rates of propiconazole applied prior to booting may not be effective. Do not apply propiconazole fungicides after rice head emergence and follow all label restrictions for protection of crayfish, catfish and endangered mussel species.

Propiconazole

Trade names are Tilt 3.6 EC and Propimax 3.6 EC. Application rates range from 4-6 oz/A. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 24 hours.

Trifloxystrobin + Propiconazole

Trade name is Stratego 250 EC. Application rates average 16 - 19 fl oz/A. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 24 hours.

Azoxystrobin + Propiconazole

Trade name is Quilt 200 SC. Application rates range from 28 – 34.5 fl oz/A or tank-mix a lower rate of Quilt (14 fl oz or above) with Quadris. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 24 hours.

Rice Blast

Apply fungicides by air in 5-10 gallons water per acre to susceptible varieties where leaf blast has been detected or as a preventative in fields with a strong history of neck blast. The first application should be made from late boot to when the first panicles have just started to emerge from the flag leaf sheath (5% heading). A second application should be considered if weather conditions continue to favor blast development and should be made when panicles on the main tillers have emerged from the flag leaf sheath about 60 – 90 percent of the way out but before the base of the main panicles (necks) have emerged. Refer to current product label for restrictions on use and advice on resistance management.

Trifloxystrobin

Trade name is GEM 25 WDG. Application rates range from 6.4 – 9.8 oz/A. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 12 hours.

Azoxystrobin

Trade name is Quadris 250 SC. Application rates average 12.3 fl oz/A. See individual states' recommendations for specific rates and precautions. The restricted-entry interval is 4 hours.

Crown (black) sheath rot
Stem rot
Minor leaf and sheath diseases

There are no specific recommendations for the use of foliar fungicides for these diseases. Follow fungicide label directions for use on specific diseases where they have become a persistent problem.

New Rice Fungicides Under Development (Name, use, and date of availability):

1. Quilt 200 SC (azoxystrobin + propiconazole) will be labeled for use on rice in 2004.

Non-Chemical Control of Rice Diseases:

1. Resistant cultivars with higher yield and quality potential are needed.
2. More practical cultural practices need to be developed.
3. Biological or Biorational control products are being developed but have not been effective.

Table 3. Fungicides Used, Percentage of Acres Treated by State, and Average Number of Applications per Growing Season (2003)

Fungicides	Percentage of Acres Treated by State for the Specified Fungicides and the Average Number of Applications (in parentheses).		
	Arkansas	Louisiana	Mississippi
Metalaxyl (Allegiance FL)	10 (1)	5 (1)	0
Mefenoxam (Apron XL)	45 (1)	25 (1)	85 (1)
Mancozeb (Manzate 200 DF, Dithane F-45, Dithane M-45, Dithane DF, Dithane DF Rainshield NT, Dithane ST	1 (1)	10 (1)	0
Thiram (42-S Thiram)	1 (1)	0	10 (1)
Carboxin + Thiram (Vitavax 200)	10 (1)	5 (1)	0
Fludioxonil (Maxim 4FS)	45 (1)	25 (1)	85 (1)
Mancozeb + Copper + Hydroxide (Mankocide DF)	0	0	0
Carboxin + Thiram + Metalaxyl (Stiletto)	2 (1)	0	0
Azoxystrobin (Quadris 2.08 SC)	35 (1)	25 (1)	15 (1)
Trifloxystrobin (GEM)	1 (1)	5 (1)	1 (1)
Trifloxystrobin + Propiconazole (Stratego 2.08 EC)	10 (1)	15 (1)	30 (1)
Flutolanil (Moncut 70 DF)	1 (1)	10 (1)	1 (1)
Propiconazole (Tilt 428C	35(1)*	5 (1)	12 (1)
Propicnazole 1.04lb EC (Propimax)	5 (1)*	0	18 (1)

* May be applied to same acres with Quadris, GEM, Moncut etc.

INSECT CONTROL

Insects can be a major factor limiting rice production in the south. The rice water weevil and the rice stink bug are key pests. They cause significant reduction in the quantity and quality of rice produced each year. Other insects attacking rice, though not key pests, can occasionally reduce rice yield and quality significantly. These include the grape colaspis, rice seed midge, rice leaf miner, fall armyworm, chinch bug, rice stalk borer, sugarcane borer, and other stink bug species.

The insecticides used, percentage of acres treated by state, and average number of applications per growing season are listed in Table 3. The percentage of infested acres for each insect by state is listed in Table 4.

Overall Concerns for Insect Management in Rice:

Research Priorities:

1. Pest surveys, chemical usage.
2. Alternatives to organophosphates and carbamates.
3. Need something to replace Icon (fipronil).
4. Utilize host/plant resistance to the maximum.
5. Precision application technology.

Educational Priorities:

1. Investigate a regional newsletter
2. Rice problems publication (disease, insects, fertility, herbicide injury, etc.) – will be state specific.
3. Insect identification (including beneficials) emphasis for growers (publications, field demonstrations, grower meetings, etc.)

Regulatory Priorities:

1. Icon replacements
2. Need organophosphate and carbamate replacements.
3. Managing imported and/or invasive pests (quarantines)

Rice Water Weevil, *Lissorhoptrus oryzophilus* (Kuschel)

Research Priorities:

1. Need pheromone research for trapping, etc.
2. Research on overwintering sites.
3. Need more/newer chemistry (mode of action and applications)
4. Larvacides needed.
5. Varietal tolerance evaluations to rice water weevil needs to be continued.

6. Evaluate thresholds.
7. Effects/influence (insect and yield) of delayed flooding
8. Effects of pesticides on crawfish culture (general concern for rice pest management)
9. Need to look at biorationals for rice water weevil control.
10. Effects of draining on weevil control.
11. Potential for development of resistance to present chemistry
12. More research on the biology and ecology of the insect.

Educational Priorities:

1. Continue to emphasize proper use of adulticides.
2. Proper monitoring.

Regulatory Priorities:

1. Need more chemical options.
2. Reinstate use of Icon (fipronil), via IR-4, or a substitute.

Description and Life Cycle: The rice water weevil is one of the most injurious insect pests in rice production. Yield losses of more than 1,000 pounds per acre can occur from severe infestations. Rice water weevil adults are grayish brown beetles about $^1/_8$ -inch long with a dark brown V-shaped area on their backs. They overwinter as adults in grass clumps and ground debris near rice fields. Wing muscles of overwintering adults degenerate so these insects cannot fly. When spring temperatures rise to 65° F, wing muscles begin to regenerate and adults begin moving out of overwintering sites. Adults fly in the early evening, with little flight occurring when night temperatures fall below 60° F or if high winds persist into the evening.

Adults will invade either unflooded or flooded rice fields and begin feeding on the leaves of rice plants. The flight muscles degenerate again as the weevils become established, and the adults cannot fly. Females begin egg laying in flooded fields or in areas of unflooded fields that contain water, such as low spots, potholes or tractor tire tracks. Females deposit white, elongate eggs in the leaf sheath at or below the waterline. White, legless larvae with small brown head capsules emerge from the eggs in five to seven days.

First instar larvae are about $^1/_{32}$ inch long and feed in the leaf sheath for a short time before exiting the stem and falling through the water to the soil. Afterwards, they burrow into the mud and begin feeding in or on the roots of rice plants. The larvae continue to feed on the roots of rice plants developing through four instars in about 27 days. Larvae increase in size with each succeeding molt. Fourth instar larvae are about $^3/_{16}$ inch long. Larvae pupate in oval, watertight cocoons attached to the roots of rice plants. The cocoons are covered with a compacted layer of mud and resemble small mud balls.

Adults emerge from the cocoons in 5 - 7 days, are able to fly a short time after emerging and may attack rice in the same or a different field. The life cycle from egg to adult takes about 35 days. The length of the life cycle is temperature-dependent, however, and can vary from 25 - 45 days in warm and cool weather, respectively. The number of generations per year varies with latitude. Two and a partial third generation can occur in the southern rice-growing areas of the region. One and a partial second generation occur in the northern rice growing areas. Most adult weevils emerging in late July to early August fly to overwintering sites and remain inactive until the next spring.

Injury: Adult rice water weevils feed on the upper surface of rice leaves, leaving narrow longitudinal scars that parallel the midrib. Adult feeding injury can kill plants when large numbers of weevils attack very young rice, but this is rare and is usually localized along the field borders. Larvae feeding in or on rice roots cause most economic injury. This feeding or root pruning reduces root surface area, resulting in decreased nutrient uptake by the plant. Plants with severely pruned root systems turn yellow and appear to be nitrogen deficient. At harvest, plants from heavily infested fields will be shorter than normal, will have fewer tillers and have lower yields.

Management of the Rice Water Weevil using Cultural Control: Fields may be drained to reduce rice water weevil larval numbers. Draining fields is the only rice water weevil control method available for rice grown in rotation with crawfish. This procedure requires careful planning so conflicts with weed, disease and fertilizer management programs can be avoided or minimized

The Stem Borers

Rice Stalk Borer, *Chilo plejedellus* (Zink)

Research Priorities: None (minor problem in Midsouth)

Educational Priorities: None

Regulatory Priorities: None

Description and Life Cycle: The rice stalk borer is a sporadic pest of rice in the south. These borers overwinter as last instar larvae in the stalks of rice and other host plants. Larvae pupate in the spring, and adult moths emerge in early to late May, mate and possibly live on various hosts until large rice is available. Adults are about 1 inch long with tan fore wings and lighter hind wings tinged on the edges with metallic gold scales. Front wings are peppered with small black dots. Although egg laying may begin in late May, injurious infestations usually occur from August through September. Flat, oval cream-colored eggs are laid in clusters of 20 - 30 on the upper and lower leaf surfaces. Eggs are laid at night over 1 - 6 days. Larvae emerge in four to nine days and crawl down the leaf toward the plant stem. Larvae may feed for a short time on the inside of the leaf sheath before boring into the stem. They are pale yellow-white with two pairs of stripes running the entire length of the body. These stripes distinguish rice stalk borer larvae from sugarcane borer larvae, which have no stripes. Mature larvae are about 1 inch long. Larvae move up and down the stem feeding for 24 - 30 days before moving to the first joint above the waterline, chewing an exit hole in the stem and constructing a silken web in which to pupate. Pupae are about 1 inch long, brown and smoothly tapered. There are two to three generations per year in rice.

The Sugarcane Borer, *Diatrea saccharalis* (F.)

Research Priorities:

1. Conduct surveys of prevalence.
2. Plant characteristics that lead to susceptibility.
3. Research on effects of early planting
4. Economic thresholds, scouting procedures need to be developed.
5. More research on ecology and biology of insect in rice
6. Research on B.t. rice
7. Identify alternate hosts of the borer.

Educational Priorities:

1. Identification of borer species.
2. Scouting techniques (even though no thresholds at this time)

Regulatory Priorities:

1. Research on B.t. rice
2. New chemistries for controlling the pest.
3. Biological controls would be nice.

Description and Life Cycle: The sugarcane borer is also a sporadic pest of rice in the south. Like the stalk borer, sugarcane borers overwinter as last instar larvae in the stalks of rice and other plants. These larvae pupate in the spring, and adult moths emerge as early as May. They mate and live on various hosts until rice stem diameter is large enough to support larval feeding. Adults are straw-colored moths about 1 inch long with a series of black dots, arranged in a V-shaped pattern, on the front wings. Egg laying on rice can begin as early as May, but economically damaging infestations generally do not occur until August or September. The flat, oval, cream-colored eggs are laid at night in clusters of 2 - 100 on the upper and lower leaf surfaces over 1 - 6 days. Larvae emerge in 3 - 5 days, crawl down the leaf and bore into the plant stem. They move up and down the stem, feeding for 15 - 20 days before chewing an exit hole in the stem and pupating. Larvae are pale yellow-white in the summer, with a series of brown spots visible on the back. Overwintering larvae are a deeper yellow and lack the brown spots. The lack of stripes distinguishes sugarcane borer larvae from rice stalk borer larvae, which have stripes in winter and summer. Mature larvae are about 1 inch long and do not enclose themselves in a silken web before pupation. The pupae are brown, about 1 inch long and roughly cylindrical in shape, not smoothly tapered, as are rice stalk borer pupae. Over-wintering sugarcane borer larvae are usually found closer to the plant crown than rice stalk borer larvae. The pupal stage lasts 7 - 10 days. There are 3 generations per year.

Injury: Injury to rice results from stalk and sugarcane borer larvae feeding on plant tissue as they tunnel inside the stem. Injury is often first noticed when the youngest partially unfurled leaf of the plant begins to wither and die, resulting in a condition called deadheart. Later in the growing season, these rice stems are weakened and may lodge before harvest. Stem feeding that occurs during panicle development causes partial or complete sterility and results in the whitehead condition. The white, empty panicles are light in weight and stand upright.

Mexican rice borer

Research Priorities:

1. Constant monitoring needed
2. Research needed on control measures.
3. Varietal preference/tolerance

Educational Priorities:

1. Identification of species (adult and larvae)
2. Increase awareness of potential risks

Regulatory Priorities:

1. Possible exclusionary or eradicatory measures (contingency plan)

Rice Stink Bug, *Oebalus pugnax* (F.)

Research Priorities:

1. New chemistries needed.
2. Thresholds
3. Monitor development of resistance
4. Differences in varietal responses
5. Alternate monitoring methods.

Educational Priorities:

1. Emphasize scouting for growers.
2. Impacts of parasites/beneficials.

Regulatory Priorities:

1. Keep methyl parathion for resistance management practices (due to limited alternatives).
2. Alternatives to organophosphates (Diamond (IGR) is one possibility).

Description and Life Cycle: Adult rice stink bugs are shield-shaped, tan insects about ½ inch long. Rice stink bugs overwinter as adults in grass clumps and ground cover. They emerge from overwintering sites in early spring and feed on grasses near rice fields before invading fields of heading rice. Adults live 30 - 60 days. Females lay masses of light-green cylindrical eggs on the leaves, stems, and panicles of rice plants. Eggs are laid in parallel rows with about 20 - 30 eggs per mass. As they mature, eggs become red with black markings. Immature stink bugs (nymphs) emerge from eggs in 4 - 5 days in warm weather or as long as 11 days in cool weather. Nymphs develop through 5 instars in 15 - 28 days. Newly emerged nymphs are about $^{1}/_{16}$ inch long, with a black head and antennae and a red abdomen with 2 black bars. Nymphs increase in size with successive molts and the color of later instars becomes tan with black and red markings. Four generations per year can occur in the south - 2 on weed hosts and 2 on rice. However, only 1 generation usually develops in a given field.

Injury: Rice stink bugs feed on the rice florets and developing rice kernels. Feeding on florets reduces rough rice yields, but most economic loss results from stink bugs feeding on developing kernels. Kernel feeding results in discolored or "pecky" rice kernels that have lower grade and poor milling quality. Both adult and nymph rice stink bugs feed on developing rice grains, but adults alone account for most economic losses in rice. Relationships between stink bugs and stink bug injury developed in Texas show a strong increase in percentage of pecky rice and a strong decrease in percentage of head yield with increasing numbers of adult stink bugs during the heading period. When numbers of immature stink bugs were included, this relationship did not change.

Southern Green Stinkbug (*Nezara viridula*)– Minor component of stinkbug complex (Green and Brown stinkbug are more of a problem although rice stinkbug is the primary one)

Research Priorities:

1. Alternatives to organophosphates
2. Sub threshold populations – when to treat, what is economic damage at these lower levels over time?

Educational Priorities: None

Regulatory Priorities:

1. Keep methyl parathion for resistance management practices (due to limited alternatives).
2. Alternatives to organophosphates (Diamond (IGR) is one possibility)

Rice Seed Midge, *Chironomus* spp.

Rice Seed Midge – minor problem primarily in water seeded rice

Research Priorities:

1. Alternatives to Icon

Educational Priorities:

1. Water management (plant and drain)

Regulatory Priorities:

1. Alternatives to Icon (fipronil)

Description and life cycle: Adult midges can be seen in swarms over rice fields, levees, roadside ditches, and other bodies of water. Adult midges resemble small mosquitoes but lack the needle-like mouthparts. They hold their forelegs up when resting. Eggs are elongate and laid in strings, usually on the surface of open water. A sticky material that forms a gelatinous coat around the eggs holds the strings together. After emerging, the larvae move to the soil surface, where they live in spaghetti-like tubes constructed from secreted silk, plant debris and algae. The larvae go through 4 instars before pupating under water in the tubes. The life cycle from egg to adult requires 10 - 15 days.

Injury: Midge larvae injure rice by feeding on the embryo of germinating seeds and on the developing root and shoot of young rice seedlings. Most economic injury to rice is the result of stand loss caused by larvae feeding on the embryo of germinating seeds. Reports of injury caused by rice seed midge have increased in recent years.

Chinch bug, *Blissus leucopterus leucopterus* (Say) – minor problem primarily in dry seeded rice (if corn is nearby it can be more of problem)

Research Priorities:

1. Research on seed treatments (both chinch bug and midge)

Educational Priorities:

1. Information on biology and life cycle.

Regulatory Priorities:

1. Alternatives to Icon (fipronil)

Description and life cycle: Chinch bugs overwinter as adults in grass clumps, leaf litter and other protected areas, emerging in early- to mid-spring to feed and mate on grass hosts including small grains such as wheat, rye, oats and barley. Adults are small, black insects about $^1/_8$ inch long, with white front wings. Each wing has a triangular black spot near the outer wing margin. Adults lay white, elongate eggs $^{1}/_{24}$ inch long behind the lower leaf sheaths or in the soil near the roots. Eggs turn red as they mature and larvae emerge in 7 - 10 days. There are 5 nymphal instars. Early instar nymphs are red with a yellow band on the front part of the abdomen. Last instar nymphs are black and gray with a conspicuous white spot on the back. The life cycle from egg to adult takes 30 - 40 days, and adults may live 2 - 3 weeks.

Injury: Chinch bugs are a sporadic pest of rice in the south. Economic injury to rice generally occurs when favorable weather conditions and production practices allow chinch bugs to build in corn, sorghum, and wheat fields. As these crops mature and are harvested, large numbers of chinch bugs may move to young plants in nearby rice fields. Serious economic losses can result from chinch bug infestations if thresholds are reached. The trend toward increasing acreage of small grains increases the potential for chinch bug problems. Chinch bug injury results when adults and nymphs feed on the leaves and stems of rice plants. Feeding on young seedlings causes leaves and stems to turn light brown. High numbers of chinch bugs can kill young plants, severely reducing plant stands.

The Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith)

Research Priorities:

1. Defoliation impacts (primarily yield) due to the pest
2. Investigate possibility of using Confirm

Educational Priorities:

1. Educating growers on identifying pest and damage caused

Regulatory Priorities: None

Description and Life Cycle: The fall armyworm feeds on most grasses found in and around rice fields. It is also a serious pest of corn and pasture grasses. Since rice is not its preferred host, the fall armyworm is only an occasional pest on rice. Adult moths are about 1 inch long with gray-brown sculptured front wings and whitish hind wings. The front wings of male moths have a white bar near the wing tip. This bar is absent in female moths. Females lay masses of 50 to several hundred whitish eggs on the leaves of rice and other grasses in and around rice fields. Egg masses are covered with moth scales and appear fuzzy.

The larvae emerge in 2 - 10 days, depending on temperature, and begin feeding on rice plants. They vary from light green to brown to black, but have distinctive white stripes along the side and back of the body. Larvae feed for two to three weeks, developing through 4 instars. Mature larvae are about 1 inch long and have a distinctive inverted “Y” on the head. Mature larvae prepare a cocoon and pupate in soil or decomposing plant material. Moths emerge in 10 - 15 days, mate and disperse widely before laying eggs on new plants.

Injury: Fall armyworm larvae feed on the leaves of rice plants, destroying large amounts of tissue. Leaf loss of 25 percent in the seedling stage can reduce rice yields by about 130 pounds per acre. When large numbers of armyworms are present, seedlings can be pruned to the ground, resulting in severe stand loss. Larvae feeding on the leaves of larger rice plants are not as harmful to yield except if feeding occurs on the flag leaf. Fall armyworm infestations generally occur along field borders, levees and in high areas of fields where larvae escape drowning. The most injurious infestations occur in fields of seedling rice that are too young to flood. Larvae from the first overwintering generation, occurring in early spring, are the most injurious. Infestations later in the season may cause feeding injury to rice panicles, although this is rare. In Arkansas the true armyworm, *Pseudaletia unipuncta* (Haworth), is more of a problem. It comes from wheat fields into seedling rice and often eats plants to the ground. Plants can recover if the growing point is not harmed, but will have slight delays in heading and small yield losses (5 bu or less).

The Rice Leaf Miner, *Hydrelia griseola (*Fallen*)*

Research Priorities:

1. Research on seed treatments (both chinch bug and midge)

Educational Priorities:

1. Information on biology and life cycle.

Regulatory Priorities:

1. Alternatives to Icon (fipronil)

Description and Life Cycle: Adults are dark flies with clear wings and a metallic blue-green to gray thorax. Less than $^1/_4$ inch long, they can be seen flying close to the water and lighting on rice leaves. White eggs are laid singly on rice leaves that float on the water. Transparent or cream-colored legless larvae emerge in 3 - 6 days and begin feeding between the layers of the rice leaf. Larvae become yellow to light green as they feed. Mature larvae are about $^1/_4$ inch long. The larvae feed for 5 - 12 days before pupating. Adults emerge after 5 to 9 days and live 2 - 4 months. Under ideal conditions the life cycle can be completed in as little as 15 days. In cool weather the life cycle can extend for more than 1 month.

Injury: The rice leaf miner is a sporadic problem. Problems are more severe in continuously flooded rice than in periodically flooded rice, and when water is more than 6 inches deep. Injury is usually greatest on the upper side of levees where water is deepest. The rice leaf miner attacks rice during the early spring. Larvae feeding between the layers of the rice leaf cause injury. Leaves closest to the water are attacked and killed. As larvae move up the plant, additional leaves die. When leaf miner numbers are high, entire plants can die, reducing stands severely. Data suggests the rice leaf miner seems to attack fields in the same vicinity year after year.

Other Insect Pests of Rice:

Several other insects may occasionally attack rice in the south. They include several short-horned grasshopper species, and the larvae of several species of skippers and tiger moths. The numbers of these insects in rice fields are usually below levels justifying treatment, but they may increase rapidly under favorable conditions and yield losses can occur.

Recently, severe problems with the lespedeza worm or grape colaspis [*Colaspis brunnea* (F.)] has begun to surface in parts of Arkansas. The preferred food for adults is legumes such as lespedeza and soybeans, but corn is also a host. Overwintered larvae will feed on almost any plant, including rice, when activity begins in the spring. The worms overwinter deep in the soil, and in the spring move upwards and feed on the roots and underground part of the rice stem, if rice has followed an adult host crop. Rice is not a host crop of adults. There are no insecticide treatments to control the larvae after the rice emerges since the worms are below ground. Lespedeza worms develop into beetles that feed on lespedeza and soybeans, but it's the worms that do most of the damage to rice. Icon as a seed treatment is the only effective insecticide treatment. Flushing the rice will kill some larvae, but mainly prevents injured plants from dying of water stress. Research in AR has shown that the lowest labeled rate of Icon (0.025 lb ai/acre, $11.00/acre) will give excellent control of grape colaspis.

Grape Colaspis (*Colaspis brunnea*) - primarily a problem in AR and some in MS (limited to silt loam/sandy loam soils)

Research Priorities:

1. Alternatives to Icon (it was very effective). Cultural and other practices provide limited control. Poncho (clothianidin) is one identified alternative, but more work needed.
2. Effectiveness of cultural practices.

Educational Priorities:

1. Distribution of pest and early season identification.

Regulatory Priorities:

1. Alternatives to Icon (fipronil)

Rice levee billbug (cattail billbug) (*Spenophorus* sp.) -minor problem in Midsouth

Research Priorities:

1. Furrow irrigated rice could be conducive to this pest. We need to be on the lookout for this and sugarcane beetle.

2. More of a problem when corn or grain sorghum is nearby

Sugarcane beetle (*Euetheola rugiceps*) - minor problem in Midsouth)

1. More of a problem when corn or grain sorghum is nearby

Potential for Golden Apple snail (*Pomacea canaliculata*) to be a problem. Need to keep an eye on it.

Research Priorities: None

Educational Priorities: None

Regulatory Priorities: None

INSECTICIDES

Lambda-cyhalothrin

Trade name is Karate Z. Recommended application rates range from 0.025-0.04 lb a.i. per acre. The restricted-entry interval is 24 hours and the pre-harvest interval is 21 days. See individual product labels for specific recommendations and precautions.

Zeta-cypermethrin

Trade names are Fury and Mustang Max. Recommended application rates range from 0.04-0.05 lb a.i. per acre for Fury and 0.020-0.025 lb a.i. for Mustang Max. The restricted-entry interval is 12 hours and the pre-harvest interval is 14 days. See individual product labels for specific recommendations and precautions.

Methyl parathion

There are various trade names and formulations. Recommended application rates range from 0.5-0.75 lb a.i. per acre. The restricted-entry interval is 5 days and the pre-harvest interval is 15 days. See individual product labels for specific recommendations and precautions.

Carbaryl

There are various trade names and formulations. Recommended application rates range from 1-1.5 lb a.i. per acre. The restricted-entry interval is 12 hours and the pre-harvest interval is 14 days. See individual product labels for specific recommendations and precautions.

Fipronil

The trade name is Icon. It is applied to seed at 0.025-0.05 a.i. per acre. See individual product labels for specific recommendations and precautions.

Diflubenzuron

The trade name is Dimilin. Recommended application rates range from 0.1875-0.25 lb a.i. per acre. A flood is required for application. The restricted-entry interval is 12 hours and the pre-harvest interval is 80 days. See individual product labels for specific recommendations and precautions.

Malathion

There are various trade names and formulations. Recommended application rates vary according to pest but usually range from 0.6-1.5 lb a.i. per acre. The restricted-entry interval is 12 hours and the pre-harvest interval is 7 days. See individual product labels for specific recommendations and precautions.

Bacillus thuringiensis

There are various trade names and strains. Formulations vary but application rates are usually around 0.5 lb a.i. per acre. The restricted-entry interval is 4-12 hours depending upon strain, and the pre-harvest interval is 0 days. See individual product labels for specific recommendations and precautions.

Rice Insecticides in the "Pipeline":

1. Dow's isomer of Karate Z (stinkbug, rice water weevil, other general pests) is called Prolex – gamma cyhalothrin was registered in 2004.

Non-Chemical Control of Rice Insects:

1. Water management (grape colaspis, armyworm complex).
2. Border treatments (chemical and mechanical, such as mowing grasses) for chinch bug and rice stink bug.
3. Drill seeding instead of water seeding can help with rice water weevil control.

Table 4. Insecticides Used, Percentage of Acres Treated by State, and Average Number of Applications per Growing Season (2003).

Insecticides	Percentage of Acres Treated by State for the Specified Insecticides and the Average Number of Applications (in parentheses) per growing season.		
	Arkansas	Louisiana	Mississippi
Lamba-cyhalothrin	5-7 (1)	60(1)	35(1)
Zeta-cypermethrin	2-3 (1)	60(1)	35(1)
Methyl parathion	5(1)	15(1)	5(1)
Carbaryl	0.3(1)	0	0
Fipronil	25-30 (1)	10(1)	9(1)
Diflubenzuron	<1 (1)	0	0
Malathion	3.5(1)	5(1)	0.5(1)
Bacillus thuringiensis	0	<1 (1)	<1 (1)

Table 5. Percentage of Insect Infested Acres for Each State (2003).

Insect	Percentage of Infested Acres		
	AR	LA	MS
Rice water weevil	95-100	90-100	90
Borers (general)	30-35	60-75	30
Rice stink bug	95-100	90-100	90-100
Rice seed midge	<1	<5	<1
Chinch bug	<1	<5	<1
Fall armyworm	<1	50	<1
Rice leaf miner	<1	<5	<1
Aphids	<1	<5	<1
Grasshopper	10	90-100	90-100
Grape colaspis	25-30	0	15

WORKER ACTIVITIES

Land Preparation – This information can be obtained from the ‘Crop Production’ section of this report. When operating mechanical equipment there is a very slight risk of operator injury when dealing with the manual adjustment of the plowing equipment - tightening of bolts, etc. With a wrench, an operator could bruise the knuckles if the wrench were to slip - only a minor injury.

Planting Methods –This information can be obtained from the 'Crop Production' section of this report. Only rare cuts, scrapes, and bruises would occur in the adjustment of planting equipment. It would be likened to the carpenter who occasionally hits his thumb with a hammer - only a minor injury.

Cultivation – Cultivation practices prior to planting are covered in the 'Crop Production' section of this report. Due to the growth habit and flood culture of rice, mechanical cultivation after planting does not exist.

Fertilization/Pesticide Application – Take necessary precautions in handling fertilizers, lime, etc.

At one time, flaggers were used to assist in aerial application of pesticides. However, with the advent of GPS (Global Positioning System) tracking systems, flaggers are rarely, if ever, used. The only time an operator would come in contact with pesticides is when loading the spray equipment, i.e., the spray tank of the equipment. Assuming proper PPE, risk is minimal.

Approximately 75-85% of all pesticides are applied by air. Roughly 20-25% is still applied by land. Pre-plant incorporated herbicides are applied with ground equipment.

Irrigation – Irrigation in rice is essentially managing or maintaining the floodwater. This is accomplished through pumping coupled with ditch, canal, and levee management.

Scouting – The only time workers are in the field and not on a piece of heavy machinery usually involves pest monitoring. ATV's (all terrain vehicles) are frequently used to assist with insect, weed, and disease monitoring as well as flood control. Conceivably a worker could have an injury involving an ATV. However, the speed at which one travels in a rice field is so slow, injury rarely if ever happens.

Harvesting – Premature harvesting of rice keeps the grain from reaching maturity, and can cause serious losses in the quality of the product. Furthermore, it is important to accomplish the harvest while the moisture content of the grain is acceptable. Using moisture sensors, the moisture content should be 17 - 22%. Too low a moisture content can cause the panicles to shatter at the time of cutting leading to serious losses of product.

Combine harvesters or simply 'combines' are machines that do the cutting, threshing and pre-cleaning of the rice in one operation. Self-propelled with an enclosed and often temperature regulated cab, combines have a cutting apparatus, a threshing chamber composed of a revolving threshing drum (with teeth), and a stationary counter-thresher. Two major types are used: a conventional setup and a stripper-header. There are variances among augers and feeding mechanisms among the two. Generally the stripper-header offers considerably faster harvesting, but it does have drawbacks. It is more expensive, heavier to operate, and is limited to small grains (rice, wheat, oats, etc.) This makes it difficult for a grower who wishes to use the same combine for another crop such as soybeans in rotation with rice.

Generally, a minimum of 4 - 5 people are involved in rice harvesting: one to operate the combine, one to drive a grain cart, and two or more to drive the trucks to the grain elevator for drying and storage in bins. Depending on equipment used and field conditions, 25 - 50 acres may be harvested in one day.

There are times when the combine will become clogged and require manual removal of debris from the header or cutter mechanism. Cuts, bruises, and abrasions can occur as a result. In rare cases, a fatality can occur when an operator, who does not properly shut off the header mechanism, attempts to remove debris from the header. This occurred more often in years past, but due to more safety features of the equipment, including automatic shutoff devices, fatalities are rare. Institutions that gather agricultural statistics such as the USDA and NIOSH (The National Institute for Occupational Safety and Health) do not carry data specific to rice combine injuries and fatalities. However, state rice specialists agree the occurrence of fatalities involving rice combines is declining.

RICE TIMELINE

Other factors associated with rice production can be found in the Rice Timeline developed and published in 2002 by Mr. Matt Shipp with the LSU AgCenter. The Rice Timeline can be accessed at the following site: http://pestdata.ncsu.edu/croptimelines/pdf/Rice.pdf

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