Soil Fertility

Nitrogen Management for Dry-Seeded, Delayed Flood Systems

The N fertilizer can be applied in the **standard two-way split** or as a **single optimum preflood application** (see recommended N rate and distribution table).

Early (Preflood) N Application and Management

Apply as an ammonium N source onto dry soil immediately prior to flooding near the 4- to 5-leaf growth stage.

No “exact time” but a two-week window. See the DD50 printout.

Maintain flood for a minimum of three weeks for maximum N uptake!

DO NOT apply the preflood N into the flood in a single application.

If wet/muddy conditions persist, apply NBPT-treated urea to muddy soil but wait until soil dries before flooding to minimize N loss.

If rainfall has flooded the field and prevents the large preflood N application, increase the early N rate and split-apply it every week in increments of 30-45 lb N/A per application until IE.

Preflood N application.

Midseason and Late Boot N Application

Apply the 45 lb N/A midseason N in one application to pureline cultivars.

Apply midseason N in one application a minimum of three weeks after the preflood N application AND internode elongation has started.

Midseason N is taken up in three to five days.

Hybrids require 30 lb N/A at the late boot stage to minimize lodging and maximize grain yield.

Rice stems showing internode elongation (IE).The stem on the far left is at the green ring stage (note the green band above the top node), the stem in the middle is at 1/2 inch and the stem on the far right is at 1 inch IE.

Nitrogen Fertilizer Rates

Recommended nitrogen rates and distribution for common rice cultivars grown in Arkansas

Cultivar	Optimum Preflood[1] N Rate	Rates and Distribution for Two-Way Split Application			
		Total N Rate (lb N/A)	Preflood N Rate[2] (lb N/A)	Midseason N Rate[3] (lb N/A)	Late Boot N Rate[4] (lb N/A)
Antonio	115	135	90	45	--
Bengal	130	150	105	45	--
Caffey	115	135	90	45	--
Cheniere	130	150	105	45	--
CL111	130	150	105	45	--
CL151*	100	120	75	45	--
CL152	130	150	105	45	--
CL261	115	135	90	45	--
Cocodrie	130	150	105	45	--
Colorado	115	135	90	45	--
Della	90	110	65	45	--
Della-2	115	135	90	45	--
Francis	130	150	105	45	--

Jazzman	115	135	90	45	--
Jazzman-2	115	135	90	45	--
Jupiter	130	150	105	45	--
Mermentau	130	150	105	45	--
Presidio	115	135	90	45	--
Rex	130	150	105	45	--
Roy J	115	135	90	45	--
Taggart	130	150	105	45	--
Wells	130	150	105	45	--
RT CL XL729	--	120	90	0	30
RT CL XL745	--	150	120	0	30
RT XL723	--	120	90	0	30
RT XL753	--	150	120	0	30

[1]Conditions for use of optimum preflood N rate: 1) flood field timely, 2) maintain 2-4 inch flood depth for 3 weeks after flood. Use NBPT or ammonium sulfate if can't flood silt loam in 2 days or clay in 7 days.
[2]N rate for rice on silt loam soils following soybean in rotation. Adjust rate for soil, stand, other crops.
[3]Midseason N applied in single application between internode elongation (IE) and 1/2-inch IE.
[4]Midseason N for hybrids should be made at boot rather than IE. Refer to DD50 for timing.
*Total of 120 but may split 75-45 or 90-30.

Early N Rate Adjustments

1. Increase early N rate by 30 lb/A if rice is grown on clay soils.
2. Increase early N rate by 20 lb/A if:
   a. Rice follows RICE in rotation.
   b. Stand density is < 10 plants per sq ft. for varieties.
3. Increase early N rate by 10 lb/A if rice follows GRAIN SORGHUM, WHEAT, CORN or COTTON.
4. Decrease early N rate by 10 lb/A if rice follows FALLOW that is not continuously tilled in rotation.
5. Omit early N rate if rice follows FISH, LONG-TERM PASTURE or FIRST YEAR AFTER CLEARING.

Nitrogen Source Conversions	
Urea needed (lb)	[lb N recommended × 100]/46
Ammonium Sulfate needed (lb)	[lb N recommended × 100]/21

N-STaR (Nitrogen Soil Test for Rice)*

Sample depth:
0-18 inches for silt loam soils
0-12 inches for clay soils

Advantage of N-STaR soil sample bucket:
- Use of a drill rather than manpower
- Entire sample taken in a single core
- Ability to sample in variety of soil conditions
- Ease of sampling and sample transfer

Conditions critical for use of N-STaR:
- Timely flooding of field
- Urea treated with NBPT or use ammonium sulfate (unless field can be flooded in two days for silt loam or in seven days for clay)

For additional information, contact the N-STaR lab at **479-575-6752** or **nstarlab@uark.edu**.

*Correct identification of soil texture and use of correct sampling depth critical to ensure proper N-STaR nitrogen rate recommendation.

Nitrogen Fertilizer Sources

N Source (in order of preference)	Remarks
Early Season (65% to 75% of total N requirement)	
Urea – 46% N	High N analysis, high N loss via ammonia volatilization if applied to silt loam soil and not incorporated by floodwater in two days or less on silt loam or seven days or less on clay.
NBPT-treated Urea – 46% N	High N analysis, cost slightly more than urea, minimal N loss via ammonia volatilization if applied to soil.
Ammonium Sulfate – 21% N, 24% S	Low N analysis, high cost, minimal N loss via ammonia volatilization if applied to soil. Good source on soils that also require sulfur (e.g., sandy soils).
Urea ammonium nitrate solution (UAN) – 32% N	Medium N analysis, cost similar to urea, high N loss via ammonia volatilization if applied to soil and not incorporated by floodwater in two days or less and high N loss via denitrification from nitrates in solution. Not recommended for preflood N fertilization.
Midseason (25% to 35% of total N requirement)	
Urea – 46% N	High N analysis, widely available, minimal loss at midseason.
UAN Solution – 32% N	Even distribution, cost similar to urea, ammonia volatilization loss greater than urea at midseason.

Rice Nitrogen Uptake

List of tested and recommended NBPT-containing urease inhibitors (based on product labels available in May 2014) and suggested application rates for urea

Product Name	Manufacturer	Weight per gallon lb/gallon	NBPT concentration %	Recommended volume qt/ton fertilizer
Agrotain Ultra	Koch Fertilizer, LLC	8.84	26.7	3.0
Arborite AG-NT	Weyerhauser NR Co.	9.15	24.0	3.0
Factor	Rosen's, Inc.	9.09	24.5	3.25
N-Fixx PF	Helena Chemical	8.50	unknown	3.0 - 4.0
NitroGain	Arclin, Inc.	8.92	20.0	4.0
NitroGain	Arclin, Inc.	9.00	26.7	3.0
N-Veil	Invictis Crop Care, LLC	8.92	26.7	3.0 - 5.0

*One ton of fertilizer approximates 181 gallons of 32% UAN and 187 gallons of 28% UAN.

N Management for Alternative Systems

Water Seeding – Pinpoint Flood System

Apply N preplant incorporated and flood field. Maintain soil saturation or N loss will occur.

Alternatives

Apply early N:

1. When field is drained for pegdown.
2. After draining at the 5-leaf to early tillering stage.

Water Seeding – Conventional or No-Till System

No-till dry-seeded, delayed-flood. Apply preflood N as in conventional-till fields. If high amount of plant residue, add 10 lb N/A.

No-Till Water-Seeded

Not an efficient N management system.

Options:

1. “Spoon-feed” with biweekly top-dress N applications.
2. Drain and dry field at 4- to 5-leaf stage, apply N onto dry soil, reflood.

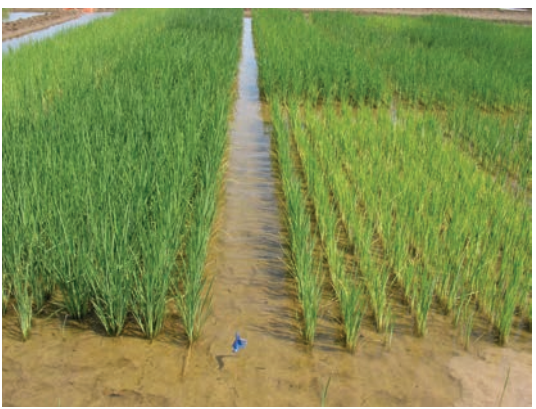
N Deficiency

Symptoms:

- Stunted plant with limited tiller number.
- Yellowish green upper leaves.
- Yellow older leaves.
- During reproductive growth, yellowish leaf canopy and subtle stunting.

Salvage:

- Vegetative growth: apply 30 lb N/A immediately.
- Reproductive growth: after flag leaf emergence, no need for additional N, yield is already set.



Rice with sufficient N fertilizer (left) compared to rice with no N applied (right).

Soil Sampling and Soil Analysis

Appropriate use of soil-test results requires that one understand that the soil test nutrient (e.g., P, K and Zn) values are simply an “availability index” and not an absolute value of soil nutrient content or plant-available nutrients.

- Soil sample from December to April.
- Soil sample to a 4-inch depth.
- Take enough soil samples to adequately represent the field, or collect samples based on “zone” or grid sampling methods.
- One composite soil sample should represent **no more than 20 acres**.
- Fields should be sampled in the direction of water movement across the field to detect pH gradients caused by the precipitation of Ca and Mg bicarbonates from well water.
- Obtain soil sample boxes, and submit samples through the nearest county Extension office.
- For additional information, call your local Extension office or the **Marianna Soil Test Laboratory (870-295-2851)**.

Guide for interpreting nutrient concentrations from plant tissue analysis

Nutrient	Plant Part	Growth Stage	Sufficient Concentration
Phosphorus	Whole Seedling	Mid-Tillering	> 0.20%
Potassium	Whole Plant	Midseason	> 1.80%
Potassium	Whole Plant	Late Boot	> 1.30%
Sulfur	Flag Leaf	Late Boot	> 0.15%
Zinc	Whole Seedling	Mid-Tillering	> 20 ppm

Sulfur (S) Management

Sulfur is most likely needed on sandy soils or sandy areas of the field and recently leveled clay soils.

- Apply 50-100 lb ammonium sulfate/A.
- Use ammonium sulfate as part of midseason N needs on fields with a history of late-season S deficiency.

S Deficiency

Symptoms:

- Initial yellowing of youngest leaves.
- Yellowing may progress to entire plant before midseason.
- Reduced tillering.
- Delayed maturity.
- Stunted growth.

Salvage:

- Plant tissue analysis to correctly identify.
- If early-season deficiency is verified, apply ammonium sulfate at 50-100 lb/A.
- If late-season deficiency is observed, corrective applications will not improve yield.

Symptoms on upper leaves due to late-season sulfur deficiency.

Sulfur deficiency occurring in sandy area of field.

Phosphorus (P) Management

Silt loam soils with a soil pH > 6.5 and very low soil test P levels are most likely to result in yield responses to P fertilizer.

- For precision-graded soils, 40 lb P_2O_5/A is recommended, unless the soil test calls for a higher amount.
- If a high rate (60 to 90 lb P_2O_5/A) of P is recommended, a split application may be useful on highly responsive soils (one-half to two-thirds applied preplant followed by one-third to one-half applied before flooding).

Phosphorus fertilizer recommendations for rice based on soil test P (Mehlich-3) and soil pH

Soil Test Level	Soil Test P Range	Soil pH	
		< 6.5	≥ 6.5
		lb P_2O_5/A	
Very Low	≤ 15 ppm	50	90
Low	16-25 ppm	30	60
Medium	26-35 ppm	0	50
Optimum	36-50 ppm	0	0
Above Optimum	≥ 51 ppm	0	0

P Deficiency

Symptoms:

- Seedling rice: severe stunting; small, very erect and dark green leaves; small stems; lack of tillering; delayed development.
- Leaf yellowing and bronzing in seedlings.

- Rapid deterioration of older leaves, especially after flood.
- Symptoms most common 7-14 days after permanent flood (mid-tillering).
- Can be confused with Zn deficiency.
- Plant tissue analysis (whole seedling) to correctly ID.
  - > 0.20% is sufficient.
  - 0.15%-0.20% is low.
  - < 0.15% is deficient.

Salvage:

- Plant tissue analysis to correctly identify.
- When seedling rice is P deficient, application of P fertilizer as late as panicle differentiation may improve growth and increase yield.
- Yield increase from midseason P fertilizer is usually less than that applied earlier in the growing season.

Phosphorus deficiency of rice. Notice dark green streak with stunted plants and reduced tillering.

Potassium (K) Management

Potassium is taken up by rice in amounts equal to or greater than N. Potassium-deficient plants may not show any visual deficiency symptoms, “hidden hunger,” and is well known for its important role in maintaining plant health. Potassium fertilizer recommendations are based on soil test K in the top 4 inches of soil.

Potassium fertilizer recommendations based on soil test K (Mehlich-3) in the top 4 inches of soil

Soil Test Level	Soil Test K Range	K Fertilizer Rate lb K_2O/A
Very Low	≤ 60 ppm	120
Low	61-90 ppm	90
Medium	91-130 ppm	60
Optimum	131-175 ppm	0
Above Optimum	≥ 175 ppm	0

K Deficiency

Symptoms:

- Seldom appear before midseason.
- Vegetative growth: normal color, no reduction in tillering, may lack vigorous growth with mild bronzing on lower, older leaves.
- Reproductive growth: stunted plants, yellowing of interveinal areas of lower leaves, leaf tips die and turn brown, development of brown spots on all leaves.
- Symptoms will often appear in and along barrow ditches first.

Salvage:

- Plant tissue anaysis to correctly identify.
- K fertilizer is recommended when rice shows deficiency symptoms during the season.
- Apply 60 lb K_2O per acre as soon as deficiency is positively identified.

Potassium-deficient leaf (top) compared to healthy leaf (bottom). Note severe brown spot and yellow/brown leaf margins of K-deficient leaf.

Potassium-deficient rice at heading. Note brown spot on leaves and panicles.

Poultry Litter

Contains appreciable amounts of many nutrients, including N, P and K, and may be used as an alternative to inorganic P and K fertilizers.

- Poultry litter, because of its low nutrient analysis, dictates it be applied with ground rigs prior to planting.
- When preplant incorporated about 25% of N in the poultry litter will be available to the rice crop. Reduce preflood N by 25% of the total N content of the poultry litter.
- Poultry litter should be applied to nongraded soil based on its P and K content and not on its N content.
- The P and K in poultry litter are as available as that in commercial fertilizers.
- Nutrient content of litter usually declines as its moisture content increases.
- Poultry litter should be analyzed for nutrient content since it is not a homogenous material.
- About one pint of a representative sample in a sealed plastic bag is needed for analysis.
- Send sample, completed form AGRI-429 (from county Extension Office) and the appropriate postage and analysis fee to **Agricultural Diagnostic Lab, 1366 West Altheimer Drive, Fayetteville, AR 72704**. Call 479-575-3908 for the analysis fee.

Poultry litter properties*

Property	Broiler Litter	Hen Manure	Turkey Litter
Observations	514	208	38
Moisture, %	30.2 (8.9)	39.7 (15.9)	29.5 (7.9)
pH	8.3	8.7	8.2
EC, µmhos cm^{-1}	11,400	7,734	8,545
Total C, %	25.5	19.4	26.6
Total N, %	3.08 (0.51)	2.06 (0.89)	3.53 (0.76)
C:N ratio	8.3	10.2	7.7
Organic N, %	85.2 (6.1)	82.7 (11.4)	85.0 (5.9)
NH_4-N, ppm	3,392	2,568	4,956
NO_3-N, ppm	420	365	227
Total P_2O_5, %	3.28 (0.66)	3.32 (0.94)	3.30 (0.60)
Total K_2O, %	2.96 (0.50)	2.29 (0.55)	2.66 (0.36)
Total Ca, %	2.38 (0.71)	5.66 (1.68)	2.40 (0.44)

*Mean and (standard deviations) of selected chemical and physical properties.

Zinc (Zn) Management

Zinc deficiency normally occurs on silt and sandy loam soils or on precision-graded fields. The availability of native soil Zn declines as pH increases. Zn availability is reduced when the soil pH is > 6.0. Zinc deficiency may be corrected by either acidifying the soil or applying a suitable Zn fertilizer source at the proper rate and timing. Granular zinc fertilizers with high water-soluble Zn content should be applied preplant to build soil test Zn when soil pH is > 6.0 and soil test Zn levels are Very Low. Highly water-soluble, granular Zn sources intended for soil application should be applied at 10 lb Zn/A and are the best sources for increasing soil test Zn.

Zinc

Soil-test Zn and soil pH based Zn fertilization recommendations for rice

Soil Texture	Soil pH	Soil-Test Zn Level and Concentration			
		Very Low	Low	Medium	Optimum
		≤ 1.5 ppm	1.6-2.5 ppm	2.6-4.0 ppm	≥ 4.1 ppm
		lb Zn/A			
Sandy Loam and Silt Loam	> 6.0	10	10	1-10	0
	≤ 6.0	5-10[1]	0	0	0
Clay Loam and Clay	> 6.0	10	0	0	0
	≤ 6.0	10[1]	0	0	0

[1]Recommended for general maintenance of soil-test Zn.

Suggested Zn fertilizer sources and rates

Fertilizer Source	Actual Zn lb/A
Organic chelates EDTA, DPTA, etc.	1.0
Organic complexes lingo-sulfonates, phenols, citrates mixtures, etc.	2.0-2.5
Inorganic sulfates, oxysulfates liquids such as nitrates and chlorides	10.0 2.0-2.5

Liquid Zn source conversion

Fertilizer Zn Concentration	Fertilizer Zn Content	Volume to Apply lb Zn
% Zn	lb Zn/gallon	quarts/A
4	0.40	10.0
6	0.62	6.5
8	0.62	6.5
8	0.80	5.0
10	1.00	4.0
12	1.14	3.5

As a seed treatment, apply Zn at 0.25-0.50 lb Zn per 100 lb of seed (cwt).

Zn Deficiency

Symptoms:

- Easily confused with P deficiency and salinity injury.
- Occurs after flushing or flooding (salinity problems occur under dry conditions).
- Basal leaf chlorosis – portion of leaf nearest stem is light green and tip is dark green.
- Bronzing – consists of brown "splotches" starting on oldest leaves. Midrib of lower leaves may be pale green or yellow and surrounded by bronzed leaf tissue.
- Short plants – stacking of leaf sheaths or joints.
- Floating leaves – lose turgidity and float on the water surface.

Salvage:

- Drain immediately after symptoms detected.
- Recovery takes 7-14 days.
- Correction with foliar Zn application NOT recommended when rice still flooded unless detected early, flood depth is shallow and Zn deficiency not severe.
- After draining and new root and shoot growth are observed, apply 1 lb Zn/A.
- Wait 3-5 days after Zn application, then apply 100 lb ammonium sulfate/A and reflood.

Mottled discoloration due to chlorosis and bronzing of lower rice leaves caused by prolonged zinc deficiency.

Stacked leaf collars of zinc-deficient rice plant.

Management of Saline Soils

Salinity damage occurs mainly on rice during the seedling stage and on larger rice located on levees both prior to and after flooding. Salinity injury may occur on soils having an EC1:2 > 400 micromhos/cm. Salt accumulation at the soil surface can reduce stands in areas of the paddy such as the breaks of ridges, stagnant water areas (low spots) and on the top or south and west sides of levees.

Symptoms:

- Plants are usually at the 2- to 5-leaf stage. Rice is relatively tolerant to salinity during germination; however, it becomes quite sensitive to salinity during early seedling development.
- Symptoms include leaf tip die-back, leaf rolling, stunting and rapid death, increased sensitivity to herbicides and reduced stand density. Salt-stressed plants may turn chlorotic (yellow), with the yellowing beginning in the youngest leaves.
- Plant analysis usually indicates an excessive level of chlorides and/or nitrates in the tissue.
- Tissue analysis (whole seedling) interpretation:
    - Normal
        < 10,000 ppm Chloride
        < 1,600 ppm Nitrate
    - Possible Toxicity
        10,000-12,000 ppm Chloride
        1,600-2,400 ppm Nitrate
    - Probable Toxicity
        > 12,000 ppm Chloride
        > 2,400 ppm Nitrate

Management:

- Flush the seedling rice frequently with good quality water that is low in salts to minimize accumulation of salts within the root zone.
- Flood the rice as soon as it can tolerate a flood.
- Have irrigation water tested for quality. When possible, minimize the use of poor quality water by substituting good quality surface water.

Liming

Generally for the benefit of the other crops in rotation because rice grows well in moderately acidic soil.

- Liming is beneficial to rice when soil pH is 5.0 or lower.
- It is best to apply lime in the fall after the rice crop to minimize the chance of inducing a Zn deficiency in rice.
- Uniform application is critical to avoid lime-related production problems.
- Lime rates can be halved and applied in separate years to gradually adjust pH.

Lime rates by soil texture for soils that have rice in rotation[1]

	Soil pH			
	< 5.0	5.0-5.3[2]	5.4-5.7[3]	5.8-6.2
Soil Texture	lb ag lime/A			
Sandy loam	2,000	2,000	0	0
Silt loam	3,000	2,000	0	0
Clay loam	4,000	3,000	0	0
Clay	5,000	4,000	0	0

[1]Lime upper half of field only when well water concentration is < 3 meq Ca/L and soil pH of water-inlet area < 5.5.
[2]Apply lime to crops grown in rotation with rice in this pH range.
[3]Consult soil-test recommendations to determine the lime recommendations for specific crops grown in rotation with rice.

Diagnostic Soil and Plant Tissue Sampling

Correct diagnosis of nutritional problems is not always easily performed through soil testing and visual identification of deficiency symptoms. Plant tissue analysis should be used to help identify the nutritional or salinity problem(s).

To submit for analysis:

For seedling rice samples:

- Send complete plants (without roots) of both healthy and unhealthy plants. About 30-40 seedlings are needed to provide enough tissue for analysis.
- Rinse fresh plant tissue with clean water to remove soil contamination.
- Place the healthy and unhealthy seedlings in separate paper sacks, and deliver to the county Extension office.

For older plants:

- Submit as whole plants or samples of the affected tissues (i.e., top or bottom leaves).

Send samples, completed AGRI-423 form and check for postage and analysis fee to **Agricultural Diagnostic Laboratory, 1366 West Altheimer Drive, Fayetteville, AR 72704**. Phone 479-575-3908.

Fertilization and Management of Precision-Graded Soils

Productivity often declines from precision grading of silt and sandy loam soils. Graded fields of silt loam soil that have the topsoil removed, stock-piled and replaced after the field is put to grade typically do not have as great a loss of productivity.

General:

- Observation of winter vegetative growth can identify the problem areas.
- The deeper the cut, the greater the decline in soil productivity.
- Clay soils do not generally exhibit reduced productivity following grading.
- Routine soil testing is often unable to identify the nutrient(s) that are limiting plant growth on the cut areas, but at least apply the nutrients the soil test recommends.
- Deeper cuts require poultry litter for reclamation.
- Cultivar selection is very important, so select one that has excellent seedling vigor. Use seed treatments that aid in quick, uniform stand establishment.
- Be careful with herbicide application, especially the residuals.
- Rice is usually the best crop to grow on a graded soil.

Management:

- Apply recommended rates of commercial fertilizer based on soil test results.
- For cuts < 6 inches, apply poultry litter at a rate of no less than 1,000 lb/A.
- If the cut is > 6 inches, apply 2,000 to 4,000 lb/A of poultry litter.
- For the best results, apply poultry litter in the spring rather than the fall.
- Poultry litter application can probably be ceased when two consecutive productive crops are produced on the graded soil.