

RICE FERTILIZER RECOMMENDATIONS

R. J. Hodges, C. D. Welch, Nathan S. Evatt, J. W. Stansel, D. G. Westfall and W. B. Anderson*

Wise use of fertilizer, along with other sound farming practices, is a practical way to increase rice yields and returns. To meet production requirements, fertilizers containing one or more of the three primary elements essential to plant growth — nitrogen, phosphorus and potassium — are added to supplement plant nutrients in the soil. For best results, the right kinds and amounts of fertilizer must be applied to assure nutrient balance.

Soil testing is an important tool in making fertilizer recommendations. Accurate fertilizer recommendations call for thorough knowledge of the soil, crop, area climatic conditions and past research related to the crop. To gain greatest benefit from a fertilizer, other factors affecting yield must be controlled. For example, weed competition will result in ineffective fertilizer response and also reduce the potential of new high-yielding varieties. Insects, improper flooding, poor stands and limited sunlight also affect response.

Of the three major fertilizer elements, nitrogen normally becomes deficient first. While a plant's nitrogen requirements are more difficult to determine, both nitrogen and phosphorus are the two plant nutrients needed most often to maintain high rice yields on heavier Texas soils. Potassium may be usefully applied under certain conditions and soil types.

Nutrients Removed by Crop

On the basis that 1 barrel (162 pounds) of rough rice will remove from the soil approximately 2.2 pounds of nitrogen (N), 1 pound of phosphorus (P_2O_5) and 0.6 pound of potassium (K_2O); a 30-barrel yield would remove 66 pounds of N, 30 pounds of P_2O_5 and 18 pounds of K_2O . Assuming that 3 tons of straw are produced with this rice yield, an additional 36 pounds of N, 12 pounds of P_2O_5 and 84 pounds of K_2O will be required. Total nutrient requirements do not have to be

*Respectively, Extension agronomist and Extension soil chemist, Texas A&M University; associate professor and assistant professors, Agricultural Research and Extension Center at Beaumont; and assistant professor, Department of Soil and Crop Sciences, Texas A&M University.

provided by additional commercial fertilizers. Weathering and chemical and microbiological changes are continuously occurring in the soil, releasing a substantial portion of required plant nutrients. Residual phosphorus adds to the soil's capacity to supply this nutrient.

Time of Application

Correct timing of fertilization is just as important as the total quantity of nitrogen, phosphorus and potassium applied. A knowledge of the rice plant's life history is essential to obtain maximum fertilizer efficiency.

The rice plant has two main stages of development — vegetative and reproductive. The vegetative stage involves periods of seedling development, early tillering, maximum tillering and late tillering. Tillering normally begins 13 to 19 days after seedling emergence. Number of panicles (heads) per acre depends upon the amount of tillering during the tillering period. Low fertility during this stage can seriously reduce the number of tillers produced, thus reducing yields.

The reproductive stage begins with panicle differentiation and involves formation of the young head, its development, flowering, filling and ripening. The first part of this growth period, called jointing or first joint, occurs shortly after the top internode has elongated and the second internode is beginning elongation. Observation of elongation gives only an approximate estimate of panicle differentiation because deep flooding, high nitrogen levels and high plant density may cause premature elongation. In addition, varieties vary considerably in amount of stem elongation at the panicle differentiation stage.

Panicle differentiation is that developmental stage when the main stem of three out of ten plants sampled has a panicle 2 millimeters long or about the size of a number 6 shotgun pellet. With most varieties, the reproductive period is rather constant, usually about 55 to 60 days after panicle differentiation to harvest. Studies show that rice needs large amounts of nitrogen during the tillering and panicle differentiation stages of growth.

Quantity of plant nutrients required by the plant varies according to variety, fertility level and environmental conditions. A major proportion of rice nutrient requirements is utilized before the grain is formed in the production of tillers and leaves. This provides the plant's basic architecture so that it may receive sunlight, conduct photosynthesis and produce carbohydrates translocated to grain during the reproductive period. During panicle development, the period from panicle differentiation until heading, panicle size and number of florets per panicle are determined. Low fertility at this time can reduce the number of florets per panicle, and if too few florets per panicle are produced, yield potential will be reduced seriously.

Application Methods

Fertilizer may be applied and incorporated into the soil or simply broadcast on the soil surface before seeding. It may be drilled or broadcast at seeding time, broadcast by plane or ground equipment after seeding or applied through irrigation water.

For greatest efficiency, adequate quantities of fertilizer nutrients correctly balanced with soil nutrients should be uniformly spread within the root zone. Best results usually are obtained by application of all phosphorus and potassium and a portion of the nitrogen as near seeding time as possible. Twenty to forty percent of total nitrogen needs, applied at planting, is adequate for normal growth until second application before flooding.

The first fertilizer application can be drilled below the seed. Good results also may be obtained by incorporating broadcast materials 2 to 6 inches into the soil by harrowing. Drill application or soil incorporation helps control algae growth. If fertilizer is applied to the surface or only lightly incorporated, the area should be flushed immediately and kept moist to prevent nitrogen loss.

Avoid preplant applications of nitrogen more than 7 to 10 days before seeding because high chemical losses through nitrification of ammonium and denitrification of nitrates may occur. Losses usually are related to temperature and soil aeration, and chances of significant losses are increased as seeding time is delayed after fertilization. Nitrogen fertilizer should be placed where most of it can be retained in ammoniacal form. High losses can occur if soil nitrogen is in nitrate form when flood water is applied. If ammonium nitrogen is applied on warm spring days to well-aerated soil, ammonium will be converted rapidly to nitrate. When these soils are flooded, nitrates

may be reduced to gaseous forms of nitrogen which may escape from the soil. This denitrification process is one reason why nitrogen applications too far ahead of seeding may have definite disadvantages.

Applying Anhydrous Ammonia

Application of anhydrous ammonia in water is generally unsatisfactory. When injected into the stream of water, hydrolysis (conversion of NH_3 to NH_4) results. Positively charged ammonium ions carried by water through the soil may be attracted and held by the negatively charged clay and organic particles. Therefore, soil over which water passes first and for the longest time may have higher nitrogen concentration, while the last area flooded may have little or no nitrogen.

Under certain soil conditions, this practice is satisfactory. Because of lower clay and/or organic matter content, sandy soils will not adsorb as many ammonium ions as will heavier soils, which results in better nitrogen distribution. If nitrogen solutions are used, distribution will be a lesser problem since most solutions contain a mixture of nitrate and ammonium nitrogen.

N and K_2O Affect Germination

Large amounts of nitrogen and potassium salts applied with seed are hazardous because they may reduce germination and delay seedling emergence. If soil has adequate moisture at seeding, usually no harmful effects are noted. If soils are dry, they should be flushed immediately because low soil moisture will increase concentration of salts in the soil solution and chances of injury to seedlings. A delay in seedling emergence of 5 to 10 days may occur if moisture is limited. This delay complicates the problem of controlling grassy weeds.

Nitrogen Efficiency

On heavy soils, nitrogen topdressed after seeding or stand establishment should coincide with proper soil moisture. Greatest efficiency is possible when nitrogen is applied to dry soil and followed immediately with floodwater. Water acts as a carrier, placing most of the nitrogen deep enough that losses to nitrification and denitrification are negligible. Research shows about 10 percent loss in efficiency when nitrogen is applied to wet soil, and another 5 to 10 percent loss when applied to flooded soil. Sometimes, loss of nitrogen is unavoidable when irrigation water is scarce or grass infestations make water removal unwise. Some of the initial nitrogen application may be lost by denitrification when soils are allowed to dry, particularly if the initial application was broadcast and not incorporated into the soil. Also, often there is insufficient time with very early

maturing varieties to allow soil to thoroughly dry for nitrogen applications since the vegetative phase in these varieties is short. In such cases, fertilizer should be applied in water.

Apply P₂O₅ and K₂O Early

Apply phosphorus as near seeding as possible because: (1) it is required for good survival of seedlings, (2) it aids in development of panicle-bearing tillers and (3) it improves root development. Young plants utilize phosphorus rapidly, but intake slows considerably as the plant matures. Other characteristics of phosphorus include: (1) flooding increases the pH of acid soils as much as 1/2 to 1 1/2 units and (2) phosphorus is more available under flooded conditions, so broadcast surface applications are as effective as those incorporated or banded. Phosphates normally do not move in soil; however, flooding aids in downward movement and enhances availability of both soil and applied phosphorus.

Potassium should be applied early because it, too, is essential to early root and seedling growth as well as grain formation and development. Potassium's role in reducing lodging or increasing milling yields has not been established fully.

Phosphorus (and potassium if needed) may be applied before or at seeding and should be applied before first flooding. Essentially, no problems occur from applications of more phosphorus and potassium than required for optimum yields. Thus, all phosphorus and potassium required by the first and stubble crops can be included in the first application.

Rate Recommendations

Research results indicate most Texas rice soils respond to 40 pounds of phosphorus per acre. Light soils usually respond best to 60 pounds of nitrogen, while heavy soils require about 80 pounds per acre. Economic rice yield increases on Katy fine sandy loam often are obtained from application of 20 pounds of potash per acre. On this basis, the following general fertilizer recommendations are suggested:

Beaumont clay	80-40-0*
Lake Charles clay	80-40-0*
Bernard clay loam	80-40-0*
Katy fine sandy loam	60-40-20*
Hockley fine sandy loam	60-40-0*
Edna fine sandy loam	60-40-0*

*Increase N level by 25 percent for Bluebelle

Increase N level by 25 percent for late March, early April seedings

Some decrease in N level may be required for late May and June seedings

Each producer will make adjustments upward or downward, and application of one or two different rates within a field can be valuable in determining future rates. Past results and experiences can also serve as important guides.

If the field has a history of severe lodging or has not been cropped recently to rice, suggested nitrogen rates should be reduced. Also, high nitrogen applications should be avoided in fields where blast has been a problem. If stubble crop production is planned, about 60 pounds of nitrogen should be applied immediately after harvest.

Nitrogen Symptoms

Observation of the growing crop before jointing may enable the producer to make upward adjustments in the nitrogen rate. Serious loss in green color and extremely slow growth usually indicate a need for additional nitrogen; thus, about 20 pounds per acre ordinarily provide economic yield increases. Proper timing of this last application is extremely important and should not be later than 55 to 60 days before harvest. While later applications under certain conditions have shown response, they usually produce diminishing economic returns. The panicle differentiation stage appears to be close to the ideal time for the last nitrogen application if the producer desires a late topdressing. Topdressing too far ahead of this stage may produce excessive vegetative growth, resulting in harmful mutual shading. If the plant shows symptoms of nitrogen deficiency before panicle differentiation, a nitrogen topdressing should be applied immediately.

Nitrogen-deficient rice fields are indicated by retarded growth, pale green to yellow plant color, poorly developed tillers, firing of leaf tips and lower leaves, increased susceptibility to brown spot or Helminthosporium leaf spot and reduced yields. Excess nitrogen produces rank succulent growth, increases height of rice plants which often results in lodging, makes plants more susceptible to diseases such as blast (*Piricularia oryzae*) and causes minor delays in maturity.

Split Nitrogen Applications

Data from small plots at the Beaumont research center have not shown consistent yield increases from late split applications of nitrogen. However, in no case have split applications reduced yields. Split applications may be desirable because: (1) it is difficult to determine nitrogen needs for any year at the season's beginning, (2) high single applications may increase susceptibility to blast, (3) high single applications may increase grass and weed infestations, (4) high single applications may increase losses to denitrification and (5) on

light sandy soil, split applications may increase nitrogen efficiency.

Nutrient Sources

Many different nitrogen sources are on the market, while phosphorus and potassium sources for fertilizer use are fewer but adequate.

Equivalent amounts of available phosphorus (P_2O_5) and potassium (K_2O) from different sources are approximately equal in efficiency. Polyphosphates as a new source of phosphorus are being evaluated. Currently, from the producer's standpoint, polyphosphates when applied at rates to supply equivalent amounts of phosphorus, have been equal to conventional phosphorus sources.

Fertilizers supplying nitrogen in ammoniacal form are best suited to rice. Mixed solid or liquid materials containing all or part of the nitrogen in nitrate form would be less desirable than if all nitrogen were in ammoniacal form. This is assuming that mixed materials would be applied near seeding as recommended.

Once rice plants have established extensive root systems, they can utilize at least a portion of the nitrogen in nitrate form. Ammonium sulfate, urea, ammonium nitrate, ammonium chloride and ammonium phosphates should give approximately the same results if topdressed at a rate to supply equivalent amounts of nitrogen.

Liming Rice Soils

Rice soils range from very acid to alkaline. No evidence indicates that calcium or magnesium limit rice production in Texas. Neither are there indications that application of lime to correct acidity of some soils will increase rice yields. This probably is related to normal pH increase in flooded soils. There is no research indicating that application of lime to pastures in the rice-pasture rotation system will have harmful or reducing effects on rice yields.

Application of lime can increase availability of other plant nutrients, especially phosphorus, and

increase growth of beneficial soil bacteria and other microorganisms. This will aid in decomposition of organic materials such as rice straw and stubble. Since most rice soils are utilized as pasture land when not planted to rice, liming is an important practice in this area. Many of these soils need lime to produce high forage or soybean yields.

Lime should be broadcast and mixed thoroughly with the soil 3 to 6 months before planting to allow sufficient time for lime to react and create a more desirable soil condition. Amount of lime needed and frequency of application should be determined by a soil analysis every 2 or 3 years.

Micronutrients

Chlorosis, yellowing of seedlings, results in unthrifty growth and partial to complete plant loss. This problem has occurred for several years in scattered spots throughout the western rice growing area. Soon after emergence, rice seedlings in isolated areas ranging from small spots to areas of 30 acres or more become unthrifty, chlorotic and soon die. This condition also occurs on "cut areas" where top soil has been removed by land leveling. In certain instances, the primary root system of the rice seedling dies. If affected seedlings survive during this growth stage, they partially regain their vigor and produce nearly normal heads. The main result is a greatly reduced stand which causes delayed maturity and reduced yields. Flooding seems to aggravate the symptom.

Limited research shows that rice grown on "cut areas" and on soils that historically have produced chlorotic seedlings responds to zinc and iron micronutrient fertilization. Based on data from several experiments in areas where this symptom occurs, if a producer anticipates this problem he may apply 10 pounds of zinc sulfate and up to 250 pounds of ferric (iron) sulfate per acre or equivalent quantities from other sources at seeding. Micronutrient fertilization *has not* increased rice yields except in those areas where seedling chlorosis exists.