

Fertilizer Placement for Rice

ammonium-form nitrogen drilled into seedbed before flooding increased rice yields 25% to 50% in placement experiments

D. S. Mikkelsen and D. C. Finrock

Ammonium-form fertilizers have special significance in the production of the California rice crop because ammonium nitrogen is the only inorganic form that can be maintained in continuously flooded soils. However, the maintenance of ammonium nitrogen is dependent upon proper fertilizer placement. When ammonium nitrogen is placed at a depth of 2"-4" in a rice seedbed prior to flooding, its maximum utilization for increased rice yields is realized. Nitrogen which is converted to nitrate nitrogen before or after flooding will be denitrified and lost from the soil as nitrogen gas.

Recognition that ammonium-form nitrogen is essential for California rice—grown on land continuously flooded during most of the growing season—was established in early fertilizer trials. Recent studies have shown the importance of maintaining the ammonium form of nitrogen in the soil after it has been applied.

Maintenance of ammonium nitrogen in the soil after flooding is possible because flooded soils develop two distinct and different zones in respect to nitrogen transformation. In a very thin layer of soil—not more than one-fourth inch deep—where broadcast fertilizer might accumulate, there exist conditions for chemical and biological oxidation. This layer contains oxygen supplied by the water and also that released by living aquatic plants. Oxidation products such as nitrates, sulfates, and ferric iron are found in this layer. Ammonium nitrogen which is adsorbed on colloidal particles, exists in this layer only temporarily because it is converted to nitrate nitrogen which moves with percolating water.

Immediately beneath the surface oxidizing layer and extending into the entire plow layer, is a zone where reducing con-

ditions prevail. This reduction layer develops after about three days of continuous submergence, and the soil remains reductive until the water is removed. The oxygen contained in the soil before flooding is used up by soil microorganisms and it is not replaced.

Nitrates are not found in the reduction layer, but ammonium nitrogen applied into that zone remains unchanged and is available as a source of nitrogen for rice. Nitrate nitrogen which exists in this zone, or which has moved from the surface layer in drainage water is denitrified. The nitrogen transformed by denitrification escapes from the soil as a gas without benefit to plants.

Different methods of applying ammonium fertilizers to rice—surface, combined surface and subsurface, and subsurface nitrogen applications—have been studied during the past four years. Ammonium sulfate—to supply 30 pounds of

actual nitrogen per acre—was applied by: 1, broadcast in the water after flooding; 2, broadcast on the dry seedbed, just prior to flooding; 3, broadcast on the dry seedbed before flooding but mixed by disking to a soil depth of 4"; 4, drilled to a depth of 2" in bands 12" apart; and 5, drilled in bands 12" apart to a depth of 4" just prior to flooding.

The growth, nitrogen uptake and yields of rice from the various treatments were studied. The rice yields were converted into index values with the unfertilized rice equal to 100. The yearly yield index values and the four-year average are shown in the accompanying table in the center column.

The highest yields of rice were produced where the ammonium sulfate was drilled into the seedbed to a depth of 2"-4" prior to flooding. This nitrogen, drilled into the reducing layer, maintained the nitrogen supply enabling better growth and yields of rice. Ammonium sulfate applied broadcast on the surface and mixed into the soil prior to flooding gave better yields than where it was allowed to remain on the surface. Surface applied nitrogen gave a little earlier growth stimulation to the rice, but this effect did not last longer than 14-21 days. Applications made into the water after flooding gave the lowest yields. Nitrogen was not lost in run-off water, but losses which occur after nitrification and subsequent denitrification were large.

California rice crops utilize ammonium nitrogen most efficiently when it is drilled into the seedbed prior to flooding. In a number of experiments ammonium-form nitrogen placement has increased yields from 25% to 50% over similar fertilizer treatments applied by broadcast methods. The necessity of us-

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Yields of Rice in Experiments at Biggs Field Station

Fertilization*	Rice yield index				
	1953	1954	1955	1956	Av.
Unfertilized	100	100	100	100	100
Broadcast in water	106	111	..	..	108
Broadcast on dry seedbed	122	118	118	126	121
Broadcast and disked . . . . .	..	132	118	130	126
Drilled 2" deep . . . . .	..	..	140	143	142
Drilled 4" deep	142	137	133	146	140

* Nitrogen applied as ammonium sulfate at rate of 150 pounds per acre equal to 30 pounds actual nitrogen per acre.

Lower left—Diagrammatic illustration of how nitrogen transformed by denitrification escapes from the soil as a gas without benefit to plants. Lower right—Subsurface—drilled—applications compared with surface—broadcast—applications of ammonium sulfate on California rice. Left front—60 pounds actual nitrogen broadcast. Center—60 pounds actual nitrogen drilled 4" deep.



