

Effect of soil moisture on the efficiency of pre-flood N applications in rice

Soil moisture at the time of fertilizer nitrogen (N) application can play a large role in N use efficiency (NUE) of pre-flood applications in rice production. Losses of N can occur from ammonia volatilization and from nitrification/denitrification. Field studies were conducted to: 1) evaluate NUE and grain yield response when pre-flood fertilizer N is applied on a dry, moist and flooded rice soil; and 2) quantify N volatilization losses of pre-flood fertilizer N when applications are made on a dry, moist and flooded rice soil. A subsequent laboratory trial was conducted to more accurately quantify ammonia volatilization and nitrification over 14-d period in an environmentally controlled environment.

Two field yield and two field volatilization trials were conducted at the H. Rouse Caffey Rice Research Station in Crowley, Louisiana, in 2014 and 2015. Field yield trials consisted of three soil moisture conditions at fertilization: 1) dry, 2) moist, and 3) flooded. Fertilizer N treatments included urea, Agrotain Ultra-treated urea (AU-U; 26.7% NBPT), manufactured Agrotain urea (MAU; NBPT concentration unknown), and SuperU (NBPT + DCD incorporated urea). Volatilization was measured in the field over a 15-d period of time after fertilization using semi-open volatilization chambers and an acid trap. A subsequent laboratory trial was conducted in 2016 which quantified ammonia volatilization, and soil and water N over a 14-d period in a temperature controlled enclosed cabinet. Two N sources included 1) NBPT treated urea and 2) urea. Soil moisture at time of fertilization included 1) dry surface (2/3 F.C.), 2) moist (F.C.), and flooded.

When urea was the fertilizer source, cumulative volatilization losses over the 15-day period of the field study were 23.6, 25.2, and 5.9% when applied on a dry, moist, or flooded soil, respectively, in 2015 and were 23.0, 19.8, and 4.5% when applied on a dry, moist, or flooded soil, respectively, in 2014. In both years, significantly higher volatile N losses were observed from urea when N was applied on a dry or moist soil as compared to applications into a standing flood, regardless of fertilizer source. When the fertilizer source was AU-U, MAU or SuperU, applications on a dry or moist soil were significantly reduced as compared to untreated urea; however, applications into a standing flood resulted in volatilization losses similar to untreated urea.

In 2015, when urea was the fertilizer N source, rice yield was highest when applied on a dry soil (7,992 kg ha⁻¹), was reduced when applied on a moist soil (4,353 kg ha⁻¹), and reduced further when applied into a standing flood (2,477 kg ha⁻¹). Rice grain yields, when enhanced efficiency fertilizer sources were used, were superior to urea when applied onto dry or moist soil. Rice yields were significantly less when N fertilizer was applied into a standing flood as compared to applications onto dry ground, regardless of N source. NUE of rice, when fertilizer N was applied into a standing flood, was 6% or less regardless of N fertilizer source used, highlighting the inefficiency of N applications that are applied into standing water when rice is at the 4- to 5-leaf stage of development.

Increased nitrification/denitrification and volatilization losses will occur when fertilizer applications are made onto moist soils or into flooded rice fields, as compared to applications on dry ground, when rice is at the 4- to 5-leaf stage of development. Pre-flood fertilizer applications should always be applied on a dry soil.