Nitrogen Source and Placement Effects on Soil Nitrous Oxide Emissions from No-Till Corn

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A nitrogen (N) source comparison study was conducted to further evaluate the effects of inorganic N source and placement on growing-season and non-crop period soil nitrous oxide (N₂O). Commercially available controlled-release N fertilizers were evaluated for their potential to reduce N₂O emissions from a clay loam soil compared with conventionally used granular urea and urea-ammonium nitrate (UAN) fertilizers in an irrigated no-till (NT) corn (Zea mays L.) production system. Controlled-release N fertilizers evaluated were: a polymer-coated urea (ESN), stabilized urea (SuperU), and UAN+AgrotainPlus (SuperU and AgrotainPlus contain nitrification and urease inhibitors). Each N source was surface band applied (202 kg N ha⁻¹) near the corn row at emergence and watered into the soil the next day. Subsurface banded ESN (ESNsub) and check (no N applied) treatments were included. Nitrous oxide fluxes were measured during two growing seasons and after harvest using static, vented chambers. All N sources had significantly lower growing-season N₂O emissions than granular urea (0.7% of applied N), with UAN+AgrotainPlus (0.2% of applied N) and ESN (0.3% of applied N) having lower emissions than UAN (0.4% of applied N). Similar trends were observed when expressing N₂O emissions on a grain yield and N uptake basis. Corn grain yields were not different among N sources but were greater than the check. Selection of N fertilizer source can be a mitigation practice for reducing N₂O emissions in NT, irrigated corn in semiarid areas. In our study, UAN+AgrotainPlus consistently had the lowest level of N₂O emissions with no yield loss.

Nitrous Oxide Emission from soils results from nitrification and denitrification processes, with agriculture contributing approximately 67% of the total U.S. N₂O emissions (USEPA, 2010). Although present in small quantities, N₂O has a global warming potential approximately 298 times greater than that of CO₂ (Solomon et al., 2007). Therefore, developing methods to reduce N₂O emissions from agricultural croplands is important. Optimizing crop yields and economic returns in irrigated corn production systems in the U.S. Central Great Plains requires the addition of an adequate amount of N fertilizer (Archer et al., 2008; Archer and Halvorson, 2010; Maddux and Halvorson, 2008). Numerous studies have shown that N fertilization increases N₂O emissions from cropping systems (Bouwman et al., 2002; Hao et al., 2001; Dusenbury et al., 2008; Mosier et al., 2006, Halvorson et al., 2008; Van Groenigen et al., 2010; Hoben et al., 2011).

Reviews of greenhouse gas emissions data from cropping systems in the semiarid western United States revealed that little information is available on the effects of commercially available controlled-release and stabilized N sources on N₂O emissions (Snyder et al., 2009; Halvorson et al., 2012). A worldwide meta-analysis by Akiyama et al. (2010) showed that N fertilizers containing a nitrification inhibitor reduced N₂O emissions by 38% and polymer-coated fertilizers by 35% on average compared with conventionally used N fertilizer, while N fertilizers containing urease inhibitor were not as effective in reducing N₂O emissions. Jumadi et al. (2008) also reported reduced N₂O emissions with the use of a nitrification inhibitor added to urea. Parkin and Hatfield (2010) found no benefit from using nitrapyrin with fall-applied anhydrous ammonia when N₂O emissions were evaluated over the entire growing season in Iowa. Halvorson et al. (2010a,b, 2011) reported reductions in N₂O emissions from N fertilizers containing both urease and nitrification inhibitors and with polymer-coated urea fertilizer compared with conventionally used granular urea in Colorado. Venterea et al. (2011b) reported lower N₂O emissions from a stabilized urea N source (contained urease and nitrification inhibitors) applied to corn compared with polymer-coated UAN+AP: UAN with AgrotainPlus added; WFPS, water-filled pore space.