NITROGEN SOURCE AND DRAIN TILE SPACING AFFECTS CORN YIELD RESPONSE IN A CLAYPAN SOIL

Kelly Nelson
Research Agronomist

Peter Motavalli
Professor

Research in corn has evaluated interactions between drainage and nitrogen management (Drury and Tan, 1995; Kladivko et al., 1999) as well as water quality (Fausey et al., 1995; Drury et al., 1996; Kladivko et al., 2004; Randall and Goss, 2001). Computer simulations of southern Illinois soils indicated the need for 20 ft drain tile lateral spacing for drainage and subirrigation (Mostaghimi et al., 1985). Limited research has evaluated how drainage affects corn response (Sipp et al. 1986; Rausch et al., 1990; Nelson et al., 2009). No research has evaluated the effects of drainage or drainage plus subirrigation drain tile spacings in a claypan soil. Enhanced efficiency N application rates have been evaluated in claypan soils (Nelson et al., 2009; Noellsch et al., 2009; Nash et al., 2012), but no studies have looked at the impact of N source selection and the interaction with different drain tile spacings and water management systems in a claypan soil. The objective of this research was to evaluate corn yield, plant population, grain protein, and grain N removal response to subsurface tile drainage or drainage plus subirrigation tile spacings and N sources.

Research in 2006 and 2007 evaluated the effects of nitrogen (N) sources [non-treated control, anhydrous ammonia, urea, polymer-coated urea (PCU), and 32% urea ammonium nitrate (UAN) at 150 lbs N/acre] and water management systems [drained, non-irrigated (DNI) at 20, 30, and 40 ft spacings; non-drained, non-irrigated (NDNI); non-drained, overhead irrigated (NDOHI); and drained plus subirrigated (DSI) at 20, 30, and 40 ft spacings] on corn (*Zea mays* L.) yield, plant population, grain protein, and grain N removal. DNI increased grain yield 15 to 30 bu/acre (10% to 22%) compared to NDNI (Table 1). DSI increased yields up to 70 bu/acre (24% to 38%) depending on N source and spacing. DSI increased yields 10% to 28% compared to DNI. Nitrogen sources in the NDOHI increased yields 42% to 45% compared to NDNI, and 10% to 20% compared to DSI at a 20 ft spacing. In irrigated and poorly drained claypan soil (NDOHI), PCU increased yield 14 bu/acre compared to NCU. PCU had the highest yields among N sources with DSI at 20 ft, DSI at 30 ft, DSI at 40 ft, and DNI at 40 ft. In a well drained soil (DNI at 20 ft), NCU had the highest yield (142 bu/acre) among N sources, while anhydrous ammonia had the highest yields in the NDNI control (125 bu/acre) and DNI at 30 ft (144 bu/acre). Grain N removal was greatest (226 to 227 lbs/acre) with anhydrous ammonia and PCU with NDOHI (data not presented). Nitrogen source selection is an important component of high-yielding corn production systems depending on water management system.

Table 1. Effects of water management and N source applied at 150 lbs N/acre on corn grain yield. Data were combined over years 2006 and 2007.

Water management system	NTC[†]	AA	NCU	PCU	UAN
	---------- bu/acre ----------				
Non-drained, non-irrigated (NDNI)	79	125	117	120	110
Drained, non-irrigated at 20 ft (DNI 20)	101	140	142	138	139
Drained, non-irrigated at 30 ft (DNI 30)	93	144	144	139	136
Drained, non-irrigated at 40 ft (DNI 40)	96	144	138	148	140
Drained plus subirrigated at 20 ft (DSI 20)	106	173	187	190	166
Drained plus subirrigated at 30 ft (DSI 30)	92	169	170	171	151
Drained plus subirrigated at 40 ft (DSI 40)	92	165	172	174	157
Non-drained, overhead irrigated (NDOHI)	110	216	207	221	197
LSD (P = 0.05)	---------- 13 ----------				

[†]Abbreviations: AA, anhydrous ammonia; NCU, non-coated urea; NTC, non-treated control; PCU, polymer-coated urea; and UAN, 32% urea ammonium nitrate.

References

Drury, C. F., and C. S. Tan. 1995 Long-term (35 years) effects of fertilization, rotation, and weather on corn yields *Can. J. Plant Sci.,* 75(2):355-362. doi: 10.4141/cjps95-060

Drury, C. F., C. S. Tan, J. D. Gaynor, T. O. Oloya, and T. W. Welacky. 1996. Influence of controlled drainage-subirrigation on surface and tile drainage nitrate loss. *J. Environ. Qual.,* 25(2) 317-324. doi:10.2134/jeq1996.00472425002500020016x

Fausey, N. R., L. C. Brown, H. W. Belcher, and R. S. Kanwar. 1995. Drainage and water quality in Great Lakes and cornbelt states. *J. Irrig. Drain. Eng.,* 121:283–288.

Kladivko, E. J., J. R. Frankenberger, D. B. Jaynes, D. W. Meek, B. J. Jenkinson, and N. R. Fausey. 2004. Nitrate leaching to subsurface drains as affected by drain spacing and changes in crop production system. *J. Environ. Qual.,* 33(5):1803-1813 doi:10.2134/jeq2004.1803

Kladivko, E. J., J. Grochulska, R. F. Turco, G. E. Van Scoyoc, and J. E. Eigel. 1999. Pesticide and nitrate transport into subsurface tile drains of different spacings *J. Environ. Qual.,* 28(3):997-1004. doi:10.2134/jeq1999.00472425002800030033x

Mostaghimi, S., W. D. Lembke, and C. W. Boast. 1985. Controlled-drainage/subirrigation simulation for a claypan soil. *Trans. ASAE,* 28(5):1557-1563.

Nash, P. R., P. P. Motavalli, and K. A. Nelson. 2012. Nitrous oxide emissions from claypan soils due to nitrogen fertilizer source and tillage/fertilizer placement practices. *Soil Sci. Soc. Am. J.,* 76:983-993.

Nelson, K. A., S. M. Paniagua, and P. P. Motavalli. 2009. Effect of polymer coated urea, irrigation, and drainage on nitrogen utilization and yield of corn in a claypan soil. *Agron. J.,* 101(3):681-687. doi:10.2134/agronj2008.0201

Noellsch, A. J., P. P. Motavalli, K. A. Nelson, and N. R. Kitchen. 2009. Corn response to conventional and slow-release nitrogen fertilizers across a claypan landscape. *Agron. J.,* 101(3):607-614. doi:10.2134/agronj2008.0067x

Randall, G. W., and M. J. Goss. 2001. *Nitrate losses to surface water through subsurface, tile drainage*. pp. 95–122. In R.F. Follett and J.L. Hatfield (ed.) Nitrogen in the environment: Sources, problems, and management, Elsevier Science B.V, the Netherlands.

Rausch, D. L., C. J. Nelson, and J. H. Coutts. 1990. Water management of a claypan soil. *Trans. ASAE*, 33:111–117.

Sipp, S. K., W. D. Lembke, C. W. Boast, J. H. Peverly, M. D. Thorne, and P. N. Walker. 1986. Water management of corn and soybeans on a claypan soil. *Trans. ASAE*, 29: 780–784.