

Table S1. Soil classification, texture, and initial soil-test levels (0-15 cm depth) at 19 field research locations in Minnesota, USA.

Site	County in Minnesota, USA	Dominant soil series (classification)	Texture	pH	Phosphorus†		Potassium	Organic matter
					Bray-1	Olsen		
					-----mg kg ⁻¹ -----		g kg ⁻¹	
1	Rice	Angus (fine-loamy, mixed, superactive, mesic Mollic Hapludalfs)	loam	7.3	48		172	45
2	Stearns	Dakota (fine-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Typic Argiudolls)	loam	6.6	89		304	48
3	Stevens	Forman-Aastad Complex (fine-loamy, mixed, superactive, frigid Calcic Argiudolls and frigid Pachic Argiudolls)	clay loam	7.7	17	10	222	52
4	Morrison	Brainerd (coarse-loamy, mixed, superactive, frigid Aquic Hapludalfs)	sandy loam	6.9	58		81	30
5	Pipestone	Vienna (fine-loamy, mixed, superactive, frigid Calcic Hapludolls)	silty clay loam	5.6	83		391	54
6	LeSueur	LeSueur (fine-loamy, mixed, superactive, mesic Aquic Argiudolls)	loam	6.4	149		497	58
7	Martin	Clarion-Swanlake Complex (fine-loamy, mixed, superactive, mesic Typic Hapludolls and mesic Typic Calcicudolls)	loam	7.7	40	24	259	42
8	Stevens	Forman-Aastad Complex (fine-loamy, mixed, superactive, frigid Calcic Argiudolls and frigid Pachic Argiudolls)	clay loam	7.2	26		176	51
9	Rice	Marquis (fine-loamy, mixed, superactive, mesic Oxyaquic Hapludolls)	silt loam	6.0	136		274	28
10	Goodhue	Mt. Carroll-Hersey complex (fine-silty, mixed, superactive, mesic Mollic Hapludalfs)	silt loam	7.2		23	128	32
11	Stearns	Arvilla (sandy, mixed, frigid Calcic Hapludolls)	sandy loam	6.2		63	235	27
12	Stearns	Osakis (sandy, mixed, frigid Oxyaquic Hapludolls)	loam	7.6		18	218	83
13	Stevens	McIntosh (fine-silty, mixed, superactive, frigid Aquic Calcicudolls)	silt loam	7.9		38	305	53
14	Todd	Gonvick (fine-loamy, mixed, superactive, frigid Aquic Argiudolls)	loam	6.8		57	402	58
15	Morrison	Brainerd (coarse-loamy, mixed, superactive, frigid Aquic Hapludalfs)	sandy loam	7.7		10	222	52
16	Stearns	Arvilla (sandy, mixed, frigid Calcic Hapludolls)	sandy loam	5.7		7	96	44
17	Rice	Marquis (fine-loamy, mixed, superactive, mesic Oxyaquic Hapludolls)	silt loam	6.3		16	166	44
18	Murray	Clarion (fine-loamy, mixed, superactive, mesic Typic Hapludolls)	loam	6.7		12	179	45
19	Stevens	McIntosh (fine-silty, mixed, superactive, frigid Aquic Calcicudolls)	silt loam	7.9		59	349	47

†Phosphorus test in 2015 (sites 1-9) was Bray-1 at all sites and Olsen where pH>7.4. Phosphorus test in 2016 was Olsen on all sites (10-19).

Table S2. Forms, rates, and dates of fertilizer nitrogen (N) application at the 10 sites where applied.

Site	Urea	Date	Urea-ammonium nitrate	Date	Ammonium sulfate	Date	Ammonium phosphate†	Date	Anhydrous ammonia	Date	Total N
	kg N ha ⁻¹		kg N ha ⁻¹		kg N ha ⁻¹		kg N ha ⁻¹		kg N ha ⁻¹		kg N ha ⁻¹
2016 maize growing season											
3	157	2 May									157
4	4	9 May			24	7 May					28
5			34	15 May			2	13 May			36
8	112	2 May									112
2017 maize growing season											
12	13	6 May							55	20 May	68
13	135	14 May									135
14			66	10 May			2	10 May			68
15	11	11 May			24	9 April					35
16	81	9 May					5	9 May			86
18			67	11 May							67

†Mono-, di-, or poly-ammonium phosphate applied as starter fertilizer.