Starter Fertilizer Nutrient Component Effects on Corn Yield

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Summary of Previous Work:

Predicting when starter fertilizer will result in a positive corn growth response on soils testing high or excessively high for P and/or K is uncertain in Wisconsin. Several factors appear to increase the probability of a significant corn yield response to starter fertilizer in these situations. These factors may include soils which are slow to warm in the spring; starter fertilizer rate, placement, and composition; planting date; soil compaction; and growing-season climatic conditions. Cold and wet soil conditions may reduce the mineralization rates of N and S from organic matter resulting in inadequate availability of these nutrients to the plant early in the growing season; and usually result in slow root growth and nutrient uptake, particularly for immobile nutrients. Cold and wet soil conditions may be the result of indigenous soil physical characteristics (finer texture, high clay content, poor drainage, etc.), high surface residue levels, no-tillage, and/or site-specific climatic conditions.

Several published studies evaluating the effect of starter fertilizer on corn yield have been conducted in Wisconsin in the past 30 years. Ghodrati (1983) reported that for several the major crop production soils in Wisconsin where a significant corn yield response to 2 x 2 placed starter fertilizer occurred (as individual nutrient components), there was no yield increase to rates greater than 10 lb N/acre, 20 lb P_2O_5/acre, and 20 lb K_2O/acre. Wolkowski and Kelling (1985) reported similar corn grain yields where 100 and 200 lb/a of a 6-24-24 granular or liquid starter fertilizer was 2 x 2 applied and both of these rates and sources resulted in significantly greater yields than seed placed liquid starter fertilizers including 36 lb/a of 9-18-9 and 46 lb/a of 7-14-7. The authors attributed the lower corn yields to inadequate fertilizer rates (3 lb N/a, 6 lb P_2O_5/a, and 3 lb K_2O/a) with the seed placed liquid fertilizers, which were applied at lower rates to minimize the risk of salt injury. Bundy and Widen (1991) reported the addition of starter fertilizer was profitable in 19 of 24 comparison across a range of planting dates (late April to late May) for both moldboard plow and no-till systems. In addition, the authors indicated that starter fertilizer treatments, which contained both P and K in addition to N, produced the highest yields where soil test P and K levels were in the optimum category. Bundy and Andraski (1999) evaluated corn yield response to starter fertilizer at 100 on-farm sites where soil test P and K levels were generally in the excessively high category over a three-year period. The major findings of this study were that yield increases were likely if soil test K level was <140 ppm and/or the combined effect of corn hybrid relative maturity (RM) and planting date (PD) in Julian days (PDRM) resulted in an inadequate growth period for the crop to achieve its full yield potential. Yield responses were more likely to occur at later planting dates using longer RM hybrids (PDRM >235). For example, if a 105-day RM hybrid was planted in Wisconsin on 25 April (115 Julian days) the PDRM would be 220 and the probability of obtaining a positive economic return would be about 25%. If the same hybrid was planted on 20 May (140 Julian days) the PDRM would be 245 and the probability of obtaining a positive economic return would increase to about 50%. More recently on high testing no till soils, Mallarino (2009) reported a

larger increase in early season corn growth when 23-30 lb N/a was applied as 2x2 starter compared to a lower amount of N-P or N-P-K starter, suggesting that N may be the most important component of starter fertilizer on these soils.

There has not been any Wisconsin research published evaluating individual and interactive effects of nutrient components in starter fertilizer on high testing P and K soils. In addition, there is no reported work on the effect of sulfur (S) and/or micronutrient amended starter fertilizer on corn yield. Atmospheric deposition of S in Wisconsin is reported to have declined by 42% from 1970 to the mid 1980's, and approximately an additional 50% from 1987 to 2009 (Hoeft et al., 1972; Andraski and Bundy, 1990; NADP, 2009). These reductions in available S for crop production indicate a real need for evaluating crop response to fertilizer S additions to minimize potential yield reductions due to crop S deficiencies. The potential for lower S availability, coupled with the marked increase in corn yield potential, justifies the need for a current evaluation of the individual and interactive effects of nutrient components in starter fertilizer to maximize corn yield potential in a profitable manner.

Objectives:

Objective 1: Understand the individual and interactive effects of nutrient components in 2 x 2 placed starter fertilizer when corn is grown in a high yield environment with high soil test P and K levels.

Objective 2: Understand the effects of nutrient components in pop-up (with seed) placed starter fertilizer when corn is grown in a high yield environment with high soil test P and K levels.

Objective 3: Evaluate the efficacy of pop-up (with seed) fertilizer containing lower rates of nutrients to increase yield and decrease grain moisture compared to 2 x 2 placed starter fertilizer.

Objective 4: Evaluate the effect of cultural practices to "bump" yield levels.

Objective 5: Collect new data on plant nutrient concentrations at various growth stages to improve our plant analysis interpretation database to more adequately reflect current high yield corn hybrids.

Progress to Date:

A field study was conducted at the University of Wisconsin Agricultural Research Station at Lancaster (43^{o} 18' 12.6" N; 89^{o} 23' 2.4" W) on a Fayette silt loam soil in southwestern Wisconsin in 2012. Other funding was obtained to conduct an additional study in 2012 at the University of Wisconsin Agricultural Research Station at Arlington (43^{o} 18' 12.6" N; 89^{o} 23' 2.4" W) on a Plano silt loam soil in southern Wisconsin. A complete list of soil nutrient levels, cropping history, and growing season activities at Arlington and Lancaster are shown in Tables 1 and 2, respectively. Soil test P and K levels were in the high to excessively high category (Laboski et. al., 2006), where corn yield response to added fertilizer P and K is unlikely, allowing us to determine a "starter effect" where fertilizer is placed near the seed potentially increasing plant availability during the early-season growth period when corn has limited rooting area.

Sixteen treatments were established at planting and included several starter fertilizer nutrient components, seeding rate, sidedress N rate, and foliar fungicide arranged in a randomized complete block design with six replications for treatment numbers 1 and 10, and four replications for the remaining treatments (Table 3). Commercially available liquid fertilizer solutions were used to obtain the various nutrient components and rates. Liquid fertilizer solutions included urea-ammonium nitrate (UAN-28%), 10-34-0, 0-0-12 (derived from potassium chloride), 0-0-30 (derived from potassium hydroxide), 12-0-0-26S (ATS, ammonium thiosulfate), 0-0-25-17S (KTS, potassium thiosulfate), 9-18-9, and phosphoric acid (52 to 62% P_2O_5). Fertilizer P_2O_5 and K_2O application rates (20 lb/a) were based on previous research conducted in Wisconsin (Ghodrati, 1983; Wolkowski and Kelling, 1985). Starter fertilizer N rates (20 lb/a) are double the rate that past research found to maximize yield response. The reason for doubling the rate is to more closely match the rates used by Mallarino (2009). The amount of N plus K_2O was limited to 10 lb/acre when placed with the seed (pop-up) to avoid potential reductions in corn emergence (Laboski et al., 2006). Fertilizer S rates in the starter fertilizer treatments (10 lb/a) are slightly less than the approximate amount of S removal in corn grain (about 13 lb S/a assuming 200 bu/acre). The micronutrients applied to the 2 x 2 treatments consist of micronutrients with a relative medium or high requirement for corn and include zinc (high), copper (medium), and manganese (medium). Micronutrient application rates were 0.5 lb/a Zn EDTA, 0.5 lb/a Mn EDTA, and 0.3 lb/a Cu EDTA.

Treatment 1 consisted of all nutrients components (N, P, K, S, and micros) in a 2 x 2 placement method with a high sidedress N rate (185 lb N/a), foliar fungicide applied at the R1 growth stage, and a high seeding rate (41,000 seeds/a). The remaining 2 x 2 placed starter fertilizer treatments have one or more factors removed or reduced and are individually compared with treatment 1. Factors removed or reduced include reduced N in starter (treatment 2), removal of P in starter (treatment 3), removal of K in starter (treatment 4), removal of S in starter (treatment 5), removal of micronutrients in starter (treatment 6), removal of P and K in starter (treatment 7), removal of S and micronutrients in starter (treatment 8), removal of P, K, S, and micronutrients in starter (treatment 9), removal of N, P, K, S, and micronutrients in starter (treatment 10); reduced sidedress N rate to 150 lb N/a (treatment 11), no foliar fungicide (treatment 12), and reduced seeding rate to 35,000 seeds/a (treatment 13). To evaluate the effect of low nutrient application rates of pop-up vs. the higher rates of 2 x 2 starter fertilizer, three commonly used pop-up starter fertilizers (treatments 14 to 16) were compared with 2 x 2 placement of all nutrients at the 185 lb N/a rate with foliar applied fungicide at a seeding rate of 35,000 seeds/acre (treatment 13).

Fertilizer solutions for each treatment were individually weighed and mixed immediately prior to application and were agitated continually during application using a variable rate fertilizer applicator electronically controlled using a Raven console coupled with a rate control system (on/off valve and flow meter) using a controller area network (CAN) mounted on a four-row corn planter. Corn (Pioneer P36V53; 102-day RM; HX1, LL, RR2) was planted on 18 May at Arlington and 21 May at Lancaster in 30-in. row at the two treatment seeding rates (35,000 or 41,000 seeds/a) and included Lorsban 15G (8.7 lb/a) soil insecticide in a T-band placement. Conventional herbicides were used for weed control. Sidedress N fertilizer (as UAN-28%) treatments (150 or 185 lb N/a) were sidedress-injected between rows in mid-June when corn was

in the V6 stage of growth. A foliar fungicide (5 oz/a Stratego® YLD) application was made to select treatments at the R1 corn growth stage in late July/early August.

Individual plot size was 10 ft wide (four rows) by 40 ft long. Growing season measurements included: i) plant density by recording the total number of plants in the middle two rows of each plot at the V3-V4 stage of growth; ii) whole-plant sampling at the early vegetative stage (V5-V6; 10 plants/plot), at the mid vegetative stage (V11-V12; 10 plants/plot), and at physiological maturity (10 plants/plot); iii) canopy reflectance meter readings using a Crop Circle (Minolta SPAD-502) at early vegetative, mid vegetative, and R1 corn growth stages; iv) ear leaf samples (15 leaves/plot) when corn was at the R1 growth stage; v) lodging measurements (push test of 10 plants/plot); and vi) grain yield, moisture, and test weight by machine harvesting the middle two rows of each plot. Ear leaf, whole-plant, and grain subsamples were dried in a force-draft dryer at 140^{o}F, ground to pass a 1-mm sieve, and are currently being analyzed for total N and minerals.

Treatments 2 to 13 were individually compared with treatment 1 (all nutrient components planted at a high seeding rate, high sidedress N rate, and foliar fungicide) and treatments 14 to 16 were individually compared with treatment 13 (all nutrient components planted at 35,000 seeds/a, high sidedress N rate, and foliar fungicide) using the PROC MIXED procedure (SAS Institute, 2002). The treatments were treated as fixed effects and replication was treated as a random effect.

Precipitation was less than the 30-year average and air temperature was greater than the 30-year at both locations in 2012 (Tables 4 and 5). Climatological conditions were classified as abnormally dry (26 June), moderate drought (3 July), and severe to extreme drought (10 July) through the remainder of the growing season (http://droughtmonitor.unl.edu/archive.html).

The effect of treatment (2 x 2 starter nutrient component, foliar fungicide at R1, and seeding rate) on plant population at the V3 corn growth stage at Arlington and Lancaster is shown in Tables 6 and 7, respectively. Plant populations were significantly lower for some treatments (2, 6, 12, and 13) contrasted with treatment 1 at Arlington and significantly higher for some treatments (2, 5, 8, 9, 10, 12, and 13) contrasted with treatment 1 at Lancaster. Plant populations were significantly lower where the seeding rate was 35,000 seeds/acre compared with 41,000 seeds/acre at both locations as expected. The effect of starter fertilizer treatment as pop-up when contrasted with the complete suite of nutrients in a 2 x 2 placement (treatment 13) was generally not significant at either location.

The effect of treatment (2 x 2 starter nutrient component, foliar fungicide at R1, and seeding rate) on corn mid vegetative biomass at the V11 to V12 corn growth stage at Arlington and Lancaster is shown in Tables 8 and 9, respectively. Biomass was significantly higher where no P was included in the starter (treatment 3) contrasted with treatment 1 at Arlington and but no significant contrasts occurred with treatment 1 at Lancaster. The only significant effect of starter fertilizer treatment as pop-up when contrasted with the complete suite of nutrients in a 2 x 2 placement (treatment 13) occurred where 6-20-4-3S was applied (treatment 16).

Silage yields averaged 7.02 and 8.01 ton dry matter/acre at Arlington and Lancaster, respectively (Tables 10 and 11). Contrasts with treatment 1 (complete suite of nutrients, high

seeding rate, foliar fungicide at R1, and high N rate) at Arlington resulted in a significantly higher silage yields for three treatments (4, 5, and 12) where no K, no S, or no foliar fungicide was applied. Contrasts with treatment 10 (no starter applied at the high N rate with high seeding rate and foliar fungicide at R1) at Arlington showed a significant yield increase with treatment 5 where N, P, K, and micros were applied. Contrasts with treatment 1 (complete suite of nutrients, high seeding rate, foliar fungicide at R1, and high N rate) at Lancaster resulted in a significantly lower silage yields for treatment 11 where the lower sidedress N rate was applied. Contrasts with treatment 10 (no starter applied at the high N rate with high seeding rate and foliar fungicide at R1) at Lancaster showed a significant yield increase for treatments 5 (N, P, K, plus micros) and 8 (N, P, and K only). There were no significant silage yield differences where pop-up starter was applied compared with the complete suite of nutrients at the 35,000 seed/acre rate at either location.

Grain yields averaged 147 and 117 bu/acre (15.5% moisture) at Arlington and Lancaster, respectively (Tables 12 and 13). Contrasts with treatment 1 (complete suite of nutrients, high seeding rate, foliar fungicide at R1, and high N rate) at Arlington resulted in a significantly higher grain yields for treatment 3 where no P was included in starter. Contrasts with treatment 10 (no starter applied at the high N rate with high seeding rate and foliar fungicide at R1) at Arlington showed a significant yield increase with treatment 3 where N, K, S, and micros were applied and treatment 9 where only N was applied in starter. Contrasts with treatment 1 (complete suite of nutrients, high seeding rate, foliar fungicide at R1, and high N rate) at Lancaster resulted in no significant grain yield differences. Contrasts with treatment 10 (no starter applied at the high N rate with high seeding rate and foliar fungicide at R1) at Lancaster showed a significant yield increase for treatments 3 (N, K, S, plus micros) and 7 (N, S, and micros). There were no significant silage yield differences where pop-up starter was applied compared with the complete suite of nutrients at the 35,000 seed/acre rate at either location.

Grain moisture averaged 17.0 and 17.9% at Arlington and Lancaster, respectively (Tables 14 and 15). Grain test weight averaged 55.5 and 54.8 lb/bu at Arlington and Lancaster, respectively (Tables 16 and 17). In general, there was no clear consistent distinction among the 16 treatments, which resulted in significant differences in corn growth and yield measurements determined in this study at either location in 2012.

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Table 1. Experimental conditions and procedures, Arlington, WI, 2012.

Soil type:

Plano silt loam.

Soil test, 0-6 in. (n=4):

pH: 6.6
Organic matter (%): 3.7
P (ppm): 101 (excessively high category)
K (ppm): 186 (excessively high category)
Ca (ppm): 2028 (high category)
Mg (ppm): 580 (high category)
Mn (ppm): 16 (optimum category)
Zn (ppm): 8 (optimum category)
S (ppm): 6. SAI = 53 (adequate availability index)
Na (ppm): 9

Cropping history:

Corn grain (2011), corn grain (2010), corn grain (2009), corn grain (2008).

Growing season activities:

Tillage: Fall chisel plowed on 7 Nov 2011. Soil finisher on 26 April and 17 May. Cultimulcher on 17 May.
Planting: Pioneer P36V53 (102-day RM, HX1, LL, RR2) on 18 May in 30-in rows at two seeding rate treatments (35,000 or 41,000 seeds/a) including Lorsban 15G (8.7 lb/a) soil insecticide in a T-band placement.
Starter fertilizer treatments: See treatment list.
Weed control: Preemergence (Dual II Magnum, Simazine 4L, Callisto) on 23 May.
N fertilizer treatments: Sidedress injected 150 or 185 lb N/acre (as UAN-28%) on 19 June.
Plant population mean: 36,566 plants/acre (SD 1080) for the 35,000 seed/acre treatment and 41,634 plants/acre (SD 2494) for the 41,000 seed/acre treatment recorded on 7 June (V3 stage).
Fungicide treatment at the R1 corn growth stage: 5 fl. oz/acre Stratego® YLD (a.i. prothioconazole and trifloxystrobin) applied on 2 August.
Date of whole-plant harvest (early vegetative at V6 18-in. corn): 19 June.
Date of whole-plant harvest (mid vegetative at V11 growth stage): 12 July.
Date of ear leaf sampling (R1 growth stage): 31 July.
Date of whole-plant harvest (physiological maturity): 24 September.
Date of Crop Circle reflectance meter readings (V7 28-in. corn): 22 June.
Date of Crop Circle reflectance meter readings (V11): 10 July.
Date of Crop Circle reflectance meter readings (R1): 31 July.
Date of lodging/push test: 17 October.
Date of grain harvest: 31 October.

Notes:

31 May – V1 to V2, 90% emerged, excellent weed control.
21 and 25 June – V7 28-in. tall.
2 July – V8, drought stress.
12 July - Severe drought stress.
18 July – about 48 in. tall, early tassel, likely will not get ears due to severe drought stress.
23 July – VT, looks terrible due to drought stress, about 48 to 60 in. tall, rootworm beetle feeding.
27 July – R1, rootworm beetle feeding has diminished and plants growing well.
20 August – R3, good pollination except about 2 in. of the ear tip. Small ears.
19 September – about ½ milk line.

Table 2. Experimental conditions and procedures, Lancaster, WI, 2012.

Soil type:

Fayette silt loam.

Soil test, 0-6 in. (n=4):

pH: 7.1
Organic matter (%): 2.0
P (ppm): 46 (excessively high category)
K (ppm): 150 (high category)
Ca (ppm): 1318 (excessively high category)
Mg (ppm): 400 (optimum category)
Mn (ppm): 22 (high category)
Zn (ppm): 3 (low category)
S (ppm): 6. SAI = 51 (adequate availability index)
Na (ppm): 10

Cropping history:

Corn grain (2011).

Growing season activities:

Tillage: Fall 2011 chisel plowed. Soil finisher on 21 May.
Planting: Pioneer P36V53 (102-day RM, HX1, LL, RR2) on 21 May in 30-in rows at two seeding rate treatments (35,000 or 41,000 seeds/a) including Lorsban 15G (8.7 lb/a) soil insecticide in a T-band placement.
Starter fertilizer treatments: See treatment list.
Weed control: Preemergence.
N fertilizer treatments: Sidedress injected 150 or 185 lb N/acre (as UAN-28%) on 20 June.
Plant population mean: 34,657 plants/acre (SD 1037) for the 35,000 seed/acre treatment and 40,419 plants/acre (SD 1300) for the 41,000 seed/acre treatment recorded on 14 June (V3-V4 stage).
Fungicide treatment at the R1 corn growth stage: 5 fl. oz/acre Stratego® YLD (a.i. prothioconazole and trifloxystrobin) applied on 31 July.
Date of whole-plant harvest (early vegetative at V5-V6 18-in. corn): 20 June.
Date of whole-plant harvest (mid vegetative at V12 growth stage): 13 July.
Date of ear leaf sampling (R1 growth stage): 30 July.
Date of whole-plant harvest (physiological maturity): 25 September.
Date of Crop Circle reflectance meter readings (V5-V6 18-in. corn): 20 June.
Date of Crop Circle reflectance meter readings (V12): 13 July.
Date of Crop Circle reflectance meter readings (R1): 30 July.
Date of lodging/push test: 5 November.
Date of grain harvest: 5 and 8 November.

Notes:

3 July – V8, some moisture stress, but not as severe as Arlington.
7 September –milk line just visible.

Table 3. Treatment list.

Trt no.	Starter placement	Nutrient components	Fertilizer source †	Starter nutrient component					Sidedress N rate	Foliar fungicide	Seed rate
				N	P_2O_5	K_2O	S	Micro			
				-- application rate, lb/a --							
1	2 x 2	N+P+K+S+ micros	UAN, 10-34-0, KTS, 0-0-12, Micro	20	20	20	10	yes	185	yes	41,000
2‡	2 x 2	P+K+S+ micros	Phos. Acid, 0-0-30, ATS, Micro (3.4-15-15-7.5S-micros)	5	20	20	10	yes	185	yes	41,000
3	2 x 2	N+K+S+ micros	UAN, 0-0-12, KTS, Micro	20	0	20	10	yes	185	yes	41,000
4§	2 x 2	N+P+S+ micros	UAN, 10-34-0, ATS, Micro	20	20	0	10	yes	185	yes	41,000
5	2 x 2	N+P+K+ micros	UAN, 10-34-0, 0-0-12, Micro	20	20	20	0	yes	185	yes	41,000
6	2 x 2	N+P+K+S	UAN, 10-34-0, 0-0-12, KTS	20	20	20	10	no	185	yes	41,000
7	2 x 2	N+S+ micros	UAN, ATS, Micro	20	0	0	10	yes	185	yes	41,000
8	2 x 2	N+P+K	UAN, 10-34-0, 0-0-12	20	20	20	0	no	185	yes	41,000
9	2 x 2	N	UAN	20	0	0	0	no	185	yes	41,000
10	-	-	-	0	0	0	0	no	185	yes	41,000
11	2 x 2	N+P+K+S+ micros	UAN, 10-34-0, KTS, 0-0-12, Micro	20	20	20	10	yes	150	yes	41,000
12	2 x 2	N+P+K+S+ micros	UAN, 10-34-0, KTS, 0-0-12, Micro	20	20	20	10	yes	185	no	41,000
13	2 x 2	N+P+K+S+ micros	UAN, 10-34-0, KTS, 0-0-12, Micro	20	20	20	10	yes	185	yes	35,000
14¶	Pop-up	N+P	10-34-0	10	34	0	0	no	185	yes	35,000
15	Pop-up	N+P+K	9-18-9	5	11	5	0	no	185	yes	35,000
16	Pop-up	N+P+K+S	10-34-0, KTS	6	20	4	3	no	185	yes	35,000

† UAN, urea-ammonium nitrate; ATS, ammonium thiosulfate; KTS, potassium thiosulfate; Micro (Zn, Mn, and Cu EDTA at 0.5, 0.5, and 0.3 lb/a, respectively).
‡ Treatment 2 at Arlington 2012; water not added, actual application rates were 7 lb N/a, 28 lb P_2O_5 and K_2O/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.
§ Treatment 4 at Arlington 2012; water not added, actual application rates were 27 lb N/a, 27 lb P_2O_5/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.
¶ Treatment 14 at Arlington and Lancaster 2012; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 4. Monthly total precipitation and average air temperature (NOAA) at Arlington, WI, 2012.

Month	Precipitation	Average air temperature
	inches	°F
April	3.07 (-0.17) †	43.5 (-1.9)
May	2.94 (-0.49)	59.0 (1.9)
June	0.26 (-3.78)	67.7 (1.1)
July	2.20 (-1.66)	75.8 (5.3)
August ‡	2.89 (-1.35)	66.9 (-1.6)
September	1.01 (-2.63)	57.7 (-2.8)
October	3.97 (1.54)	44.4 (-5.0)

† Numbers in parentheses are the departure from the 30-year average from 1971 to 2000 (NOAA).
‡ Values for August to October are preliminary.

Table 5. Monthly total precipitation and average air temperature (NOAA) at Lancaster, WI, 2012.

Month	Precipitation	Average air temperature
	inches	°F
April	3.07 (-0.27) †	49.3 (3.4)
May	3.91 (0.19)	64.5 (6.8)
June	1.48 (-3.25)	70.7 (3.8)
July	2.26 (-1.83)	79.0 (7.9)
August ‡	1.52 (-3.07)	71.1 (2.2)
September	3.22 (0.03)	61.4 (0.9)
October	3.79 (1.38)	48.6 (-0.3)

† Numbers in parentheses are the departure from the 30-year average from 1971 to 2000 (NOAA).
‡ Values for August to October are preliminary.

Table 6. Treatment effect on corn emergence/plant population recorded at the V3 growth stage at Arlington, WI, 7 June 2012.

		Starter nutrient component										
Trt no.	Starter placement	N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Plant population	Contrast w/ Trt no.	*p*
		---------- lb/a ----------					lb N/a		seeds/a	plants/a		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	42,907	-	-
2†	2 x 2	5	20	20	10	yes	185	yes	41,000	41,955	1	0.10
3	2 x 2	20	0	20	10	yes	185	yes	41,000	42,476	1	0.47
4‡	2 x 2	20	20	0	10	yes	185	yes	41,000	42,550	1	0.53
5	2 x 2	20	20	20	0	yes	185	yes	41,000	43,022	1	0.84
6	2 x 2	20	20	20	10	no	185	yes	41,000	41,437	1	0.03
7	2 x 2	20	0	0	10	yes	185	yes	41,000	43,089	1	0.74
8	2 x 2	20	20	20	0	no	185	yes	41,000	42,743	1	0.88
9	2 x 2	20	0	0	0	no	185	yes	41,000	41,818	1	0.15
10	-	0	0	0	0	no	185	yes	41,000	42,798	1	0.88
11	2 x 2	20	20	20	10	yes	150	yes	41,000	41,600	1	0.26
12	2 x 2	20	20	20	10	yes	185	no	41,000	41,739	1	0.08
13	2 x 2	20	20	20	10	yes	185	yes	35,000	36,808	1	<0.01
14§	Pop-up	10	34	0	0	no	185	yes	35,000	35,665	13	0.05
15	Pop-up	5	11	5	0	no	185	yes	35,000	35,537	13	0.18
16	Pop-up	6	20	4	3	no	185	yes	35,000	35,883	13	0.34

† Treatment 2 at Arlington 2012; water not added, actual application rates were 7 lb N/a, 28 lb P_2O_5 and K_2O/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

‡ Treatment 4 at Arlington 2012; water not added, actual application rates were 27 lb N/a, 27 lb P_2O_5/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

§ Treatment 14 at Arlington; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 7. Treatment effect on corn emergence/plant population recorded at the V3-V4 growth stage at Lancaster, WI, 14 June 2012.

Trt no.	Starter placement	Starter nutrient component: N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Plant population	Contrast w/ Trt no.	*p*
		lb/a					lb N/a		seeds/a	plants/a		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	39,204	-	-
2	2 x 2	5	20	20	10	yes	185	yes	41,000	39,860	1	<0.01
3	2 x 2	20	0	20	10	yes	185	yes	41,000	40,457	1	0.14
4	2 x 2	20	20	0	10	yes	185	yes	41,000	39,963	1	0.16
5	2 x 2	20	20	20	0	yes	185	yes	41,000	41,690	1	0.02
6	2 x 2	20	20	20	10	no	185	yes	41,000	40,147	1	0.24
7	2 x 2	20	0	0	10	yes	185	yes	41,000	40,347	1	0.18
8	2 x 2	20	20	20	0	no	185	yes	41,000	41,036	1	0.07
9	2 x 2	20	0	0	0	no	185	yes	41,000	40,674	1	0.09
10	-	0	0	0	0	no	185	yes	41,000	41,164	1	0.07
11	2 x 2	20	20	20	10	yes	150	yes	41,000	39,803	1	0.34
12	2 x 2	20	20	20	10	yes	185	no	41,000	39,984	1	0.04
13	2 x 2	20	20	20	10	yes	185	yes	35,000	34,685	1	<0.01
14†	Pop-up	10	34	0	0	no	185	yes	35,000	33,813	13	0.33
15	Pop-up	5	11	5	0	no	185	yes	35,000	34,739	13	0.93
16	Pop-up	6	20	4	3	no	185	yes	35,000	35,393	13	0.39

† Treatment 14 at Lancaster 2012; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 8. Treatment effect on mid vegetative corn biomass at the V11 growth stage at Arlington, WI, 12 July 2012.

		Starter nutrient component										
Trt no.	Starter placement	N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Biomass at V11	Contrast w/ Trt no.	*p*
		---------- lb/a ----------					lb N/a		seeds/a	lb/a		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	3349	-	-
2†	2 x 2	5	20	20	10	yes	185	yes	41,000	3530	1	0.39
3	2 x 2	20	0	20	10	yes	185	yes	41,000	3989	1	0.08
4‡	2 x 2	20	20	0	10	yes	185	yes	41,000	3394	1	0.89
5	2 x 2	20	20	20	0	yes	185	yes	41,000	3784	1	0.22
6	2 x 2	20	20	20	10	no	185	yes	41,000	3311	1	0.86
7	2 x 2	20	0	0	10	yes	185	yes	41,000	3473	1	0.58
8	2 x 2	20	20	20	0	no	185	yes	41,000	3750	1	0.18
9	2 x 2	20	0	0	0	no	185	yes	41,000	3390	1	0.91
10	-	0	0	0	0	no	185	yes	41,000	3450	1	0.70
11	2 x 2	20	20	20	10	yes	150	yes	41,000	3832	1	0.36
12	2 x 2	20	20	20	10	yes	185	no	41,000	3377	1	0.95
13	2 x 2	20	20	20	10	yes	185	yes	35,000	3413	1	0.86
14§	Pop-up	10	34	0	0	no	185	yes	35,000	2907	13	0.14
15	Pop-up	5	11	5	0	no	185	yes	35,000	3049	13	0.16
16	Pop-up	6	20	4	3	no	185	yes	35,000	2617	13	0.05

† Treatment 2 at Arlington 2012; water not added, actual application rates were 7 lb N/a, 28 lb P_2O_5 and K_2O/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

‡ Treatment 4 at Arlington 2012; water not added, actual application rates were 27 lb N/a, 27 lb P_2O_5/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

§ Treatment 14 at Arlington; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 9. Treatment effect on mid vegetative corn biomass at the V12 growth stage at Lancaster, WI, 13 July 2012.

		Starter nutrient component										
Trt no.	Starter placement	N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Biomass at V12	Contrast w/ Trt no.	*p*
		---------- lb/a ----------					lb N/a		seeds/a	lb/a		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	4548	-	-
2	2 x 2	5	20	20	10	yes	185	yes	41,000	4527	1	0.97
3	2 x 2	20	0	20	10	yes	185	yes	41,000	3748	1	0.12
4	2 x 2	20	20	0	10	yes	185	yes	41,000	3812	1	0.18
5	2 x 2	20	20	20	0	yes	185	yes	41,000	4231	1	0.46
6	2 x 2	20	20	20	10	no	185	yes	41,000	3882	1	0.18
7	2 x 2	20	0	0	10	yes	185	yes	41,000	4129	1	0.38
8	2 x 2	20	20	20	0	no	185	yes	41,000	3691	1	0.11
9	2 x 2	20	0	0	0	no	185	yes	41,000	4630	1	0.86
10	-	0	0	0	0	no	185	yes	41,000	3979	1	0.16
11	2 x 2	20	20	20	10	yes	150	yes	41,000	4448	1	0.23
12	2 x 2	20	20	20	10	yes	185	no	41,000	4385	1	0.76
13	2 x 2	20	20	20	10	yes	185	yes	35,000	4036	1	0.37
14†	Pop-up	10	34	0	0	no	185	yes	35,000	3944	13	0.85
15	Pop-up	5	11	5	0	no	185	yes	35,000	4442	13	0.46
16	Pop-up	6	20	4	3	no	185	yes	35,000	3571	13	0.19

† Treatment 14 at Lancaster 2012; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 10. Treatment effect on corn silage yield (whole plant biomass) at physiological maturity at Arlington, WI, 24 September 2012.

		Starter nutrient component										
Trt no.	Starter placement	N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Silage yield	Contrast with trt no. (*p*)	
		---------- lb/a ----------					lb N/a		seeds/a	ton/a		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	6.53	-	10(0.56)
2†	2 x 2	5	20	20	10	yes	185	yes	41,000	6.92	1(0.51)	10(0.37)
3	2 x 2	20	0	20	10	yes	185	yes	41,000	7.15	1(0.40)	10(0.62)
4‡	2 x 2	20	20	0	10	yes	185	yes	41,000	7.51	1(<0.01)	10(0.84)
5	2 x 2	20	20	20	0	yes	185	yes	41,000	8.71	1(<0.01)	10(0.03)
6	2 x 2	20	20	20	10	no	185	yes	41,000	7.11	1(0.40)	10(0.76)
7	2 x 2	20	0	0	10	yes	185	yes	41,000	6.74	1(0.79)	10(0.49)
8	2 x 2	20	20	20	0	no	185	yes	41,000	7.97	1(0.09)	10(0.38)
9	2 x 2	20	0	0	0	no	185	yes	41,000	7.35	1(0.30)	10(0.89)
10	-	0	0	0	0	no	185	yes	41,000	6.89	1(0.56)	-
11	2 x 2	20	20	20	10	yes	150	yes	41,000	7.29	1(0.48)	
12	2 x 2	20	20	20	10	yes	185	no	41,000	8.30	1(0.05)	
13	2 x 2	20	20	20	10	yes	185	yes	35,000	6.21	1(0.67)	
14§	Pop-up	10	34	0	0	no	185	yes	35,000	6.97	13(0.47)	
15	Pop-up	5	11	5	0	no	185	yes	35,000	6.44	13(0.67)	
16	Pop-up	6	20	4	3	no	185	yes	35,000	6.65	13(0.59)	

† Treatment 2 at Arlington 2012; water not added, actual application rates were 7 lb N/a, 28 lb P_2O_5 and K_2O/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

‡ Treatment 4 at Arlington 2012; water not added, actual application rates were 27 lb N/a, 27 lb P_2O_5/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

§ Treatment 14 at Arlington; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 11. Treatment effect on corn silage yield (whole plant biomass) at physiological maturity at Lancaster, WI, 25 September 2012.

		Starter nutrient component										
Trt no.	Starter placement	N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Silage yield	Contrast with trt no. (*p*)	
		---------- lb/a ----------					lb N/a		seeds/a	ton/a		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	8.30	-	10(0.25)
2	2 x 2	5	20	20	10	yes	185	yes	41,000	7.71	1(0.27)	10(0.97)
3	2 x 2	20	0	20	10	yes	185	yes	41,000	8.46	1(0.80)	10(0.34)
4	2 x 2	20	20	0	10	yes	185	yes	41,000	8.07	1(0.72)	10(0.64)
5	2 x 2	20	20	20	0	yes	185	yes	41,000	8.29	1(0.99)	10(0.02)
6	2 x 2	20	20	20	10	no	185	yes	41,000	8.07	1(0.71)	10(0.21)
7	2 x 2	20	0	0	10	yes	185	yes	41,000	8.44	1(0.74)	10(0.24)
8	2 x 2	20	20	20	0	no	185	yes	41,000	8.89	1(0.17)	10(0.02)
9	2 x 2	20	0	0	0	no	185	yes	41,000	8.35	1(0.93)	10(0.37)
10	-	0	0	0	0	no	185	yes	41,000	7.69	1(0.25)	-
11	2 x 2	20	20	20	10	yes	150	yes	41,000	7.32	1(0.10)	
12	2 x 2	20	20	20	10	yes	185	no	41,000	8.33	1(0.93)	
13	2 x 2	20	20	20	10	yes	185	yes	35,000	7.70	1(0.28)	
14†	Pop-up	10	34	0	0	no	185	yes	35,000	7.69	13(0.99)	
15	Pop-up	5	11	5	0	no	185	yes	35,000	7.93	13(0.75)	
16	Pop-up	6	20	4	3	no	185	yes	35,000	7.02	13(0.39)	

† Treatment 14 at Lancaster 2012; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 12. Treatment effect on corn grain yield at Arlington, WI, 31 October 2012.

Trt no.	Starter placement	Starter nutrient component: N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Grain yield	Contrast with trt no. (*p*)	
		lb/a					lb N/a		seeds/a	bu/a		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	148	-	10(0.80)
2†	2 x 2	5	20	20	10	yes	185	yes	41,000	141	1(0.18)	10(0.26)
3	2 x 2	20	0	20	10	yes	185	yes	41,000	159	1(0.08)	10(0.09)
4‡	2 x 2	20	20	0	10	yes	185	yes	41,000	151	1(0.53)	10(0.77)
5	2 x 2	20	20	20	0	yes	185	yes	41,000	152	1(0.67)	10(0.65)
6	2 x 2	20	20	20	10	no	185	yes	41,000	148	1(0.91)	10(0.96)
7	2 x 2	20	0	0	10	yes	185	yes	41,000	144	1(0.28)	10(0.58)
8	2 x 2	20	20	20	0	no	185	yes	41,000	144	1(0.55)	10(0.71)
9	2 x 2	20	0	0	0	no	185	yes	41,000	139	1(0.14)	10(0.04)
10	-	0	0	0	0	no	185	yes	41,000	147	1(0.80)	-
11	2 x 2	20	20	20	10	yes	150	yes	41,000	151	1(0.67)	
12	2 x 2	20	20	20	10	yes	185	no	41,000	152	1(0.63)	
13	2 x 2	20	20	20	10	yes	185	yes	35,000	142	1(0.26)	
14§	Pop-up	10	34	0	0	no	185	yes	35,000	140	13(0.83)	
15	Pop-up	5	11	5	0	no	185	yes	35,000	144	13(0.61)	
16	Pop-up	6	20	4	3	no	185	yes	35,000	147	13(0.42)	

† Treatment 2 at Arlington 2012; water not added, actual application rates were 7 lb N/a, 28 lb P_2O_5 and K_2O/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

‡ Treatment 4 at Arlington 2012; water not added, actual application rates were 27 lb N/a, 27 lb P_2O_5/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

§ Treatment 14 at Arlington; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 13. Treatment effect on corn grain yield at Lancaster, WI, 5 November 2012.

Trt no.	Starter placement	Starter nutrient component: N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Grain yield	Contrast with trt no. (*p*)	
		lb/a					lb N/a		seeds/a	bu/a		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	109	-	10(0.76)
2	2 x 2	5	20	20	10	yes	185	yes	41,000	98	1(0.31)	10(0.33)
3	2 x 2	20	0	20	10	yes	185	yes	41,000	127	1(0.25)	10(0.09)
4	2 x 2	20	20	0	10	yes	185	yes	41,000	118	1(0.52)	10(0.19)
5	2 x 2	20	20	20	0	yes	185	yes	41,000	108	1(0.90)	10(0.94)
6	2 x 2	20	20	20	10	no	185	yes	41,000	115	1(0.65)	10(0.26)
7	2 x 2	20	0	0	10	yes	185	yes	41,000	126	1(0.27)	10(0.10)
8	2 x 2	20	20	20	0	no	185	yes	41,000	115	1(0.65)	10(0.21)
9	2 x 2	20	0	0	0	no	185	yes	41,000	105	1(0.72)	10(0.77)
10	-	0	0	0	0	no	185	yes	41,000	107	1(0.76)	-
11	2 x 2	20	20	20	10	yes	150	yes	41,000	124	1(0.28)	
12	2 x 2	20	20	20	10	yes	185	no	41,000	123	1(0.30)	
13	2 x 2	20	20	20	10	yes	185	yes	35,000	123	1(0.45)	
14†	Pop-up	10	34	0	0	no	185	yes	35,000	140	13(0.38)	
15	Pop-up	5	11	5	0	no	185	yes	35,000	131	13(0.65)	
16	Pop-up	6	20	4	3	no	185	yes	35,000	116	13(0.70)	

† Treatment 14 at Lancaster 2012; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 14. Treatment effect on corn grain moisture at Arlington, WI, 31 October 2012.

Trt no.	Starter placement	Starter nutrient component: N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Grain moisture	Contrast with trt no. (*p*)	
		lb/a					lb N/a		seeds/a	%		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	16.9	-	10(0.44)
2†	2 x 2	5	20	20	10	yes	185	yes	41,000	16.9	1(0.58)	10(0.89)
3	2 x 2	20	0	20	10	yes	185	yes	41,000	17.1	1(0.33)	10(0.67)
4‡	2 x 2	20	20	0	10	yes	185	yes	41,000	16.9	1(0.88)	10(0.69)
5	2 x 2	20	20	20	0	yes	185	yes	41,000	16.9	1(0.78)	10(0.77)
6	2 x 2	20	20	20	10	no	185	yes	41,000	17.1	1(0.31)	10(0.75)
7	2 x 2	20	0	0	10	yes	185	yes	41,000	16.9	1(0.92)	10(0.57)
8	2 x 2	20	20	20	0	no	185	yes	41,000	16.7	1(0.65)	10(0.38)
9	2 x 2	20	0	0	0	no	185	yes	41,000	16.5	1(0.30)	10(0.16)
10	-	0	0	0	0	no	185	yes	41,000	17.1	1(0.44)	-
11	2 x 2	20	20	20	10	yes	150	yes	41,000	16.9	1(0.92)	
12	2 x 2	20	20	20	10	yes	185	no	41,000	16.9	1(0.74)	
13	2 x 2	20	20	20	10	yes	185	yes	35,000	17.5	1(0.07)	
14§	Pop-up	10	34	0	0	no	185	yes	35,000	17.1	13(0.04)	
15	Pop-up	5	11	5	0	no	185	yes	35,000	17.1	13(0.03)	
16	Pop-up	6	20	4	3	no	185	yes	35,000	17.4	13(0.67)	

† Treatment 2 at Arlington 2012; water not added, actual application rates were 7 lb N/a, 28 lb P_2O_5 and K_2O/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

‡ Treatment 4 at Arlington 2012; water not added, actual application rates were 27 lb N/a, 27 lb P_2O_5/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

§ Treatment 14 at Arlington; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 15. Treatment effect on corn grain moisture at Lancaster, WI, 5 November 2012.

Trt no.	Starter placement	Starter nutrient component					Sidedress N rate	Foliar fungicide	Seeding rate	Grain moisture	Contrast with trt no. (*p*)	
		N	P_2O_5	K_2O	S	Micro						
		---------- lb/a ----------					lb N/a		seeds/a	%		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	18.1	-	10(0.20)
2	2 x 2	5	20	20	10	yes	185	yes	41,000	18.5	1(0.36)	10(0.12)
3	2 x 2	20	0	20	10	yes	185	yes	41,000	17.3	1(0.03)	10(0.52)
4	2 x 2	20	20	0	10	yes	185	yes	41,000	18.2	1(0.78)	10(0.25)
5	2 x 2	20	20	20	0	yes	185	yes	41,000	17.6	1(0.02)	10(0.92)
6	2 x 2	20	20	20	10	no	185	yes	41,000	18.0	1(0.63)	10(0.37)
7	2 x 2	20	0	0	10	yes	185	yes	41,000	17.6	1(0.23)	10(0.87)
8	2 x 2	20	20	20	0	no	185	yes	41,000	18.1	1(0.90)	10(0.24)
9	2 x 2	20	0	0	0	no	185	yes	41,000	17.4	1(0.05)	10(0.36)
10	-	0	0	0	0	no	185	yes	41,000	17.6	1(0.20)	-
11	2 x 2	20	20	20	10	yes	150	yes	41,000	17.1	1(0.01)	
12	2 x 2	20	20	20	10	yes	185	no	41,000	17.5	1(0.12)	
13	2 x 2	20	20	20	10	yes	185	yes	35,000	17.9	1(0.61)	
14†	Pop-up	10	34	0	0	no	185	yes	35,000	18.2	13(0.52)	
15	Pop-up	5	11	5	0	no	185	yes	35,000	18.2	13(0.43)	
16	Pop-up	6	20	4	3	no	185	yes	35,000	18.5	13(0.17)	

† Treatment 14 at Lancaster 2012; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 16. Treatment effect on corn grain test weight at Arlington, WI, 31 October 2012.

Trt no.	Starter placement	Starter nutrient component: N	P_2O_5	K_2O	S	Micro	Sidedress N rate	Foliar fungicide	Seeding rate	Test weight	Contrast with trt no. (*p*)	
		---------- lb/a ----------					lb N/a		seeds/a	lb/bu		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	55.6	-	10(0.62)
2†	2 x 2	5	20	20	10	yes	185	yes	41,000	55.6	1(0.98)	10(0.90)
3	2 x 2	20	0	20	10	yes	185	yes	41,000	55.7	1(0.90)	10(0.77)
4‡	2 x 2	20	20	0	10	yes	185	yes	41,000	55.7	1(0.74)	10(0.68)
5	2 x 2	20	20	20	0	yes	185	yes	41,000	55.8	1(0.51)	10(0.38)
6	2 x 2	20	20	20	10	no	185	yes	41,000	55.6	1(0.93)	10(0.69)
7	2 x 2	20	0	0	10	yes	185	yes	41,000	55.3	1(0.24)	10(0.23)
8	2 x 2	20	20	20	0	no	185	yes	41,000	55.4	1(0.59)	10(0.66)
9	2 x 2	20	0	0	0	no	185	yes	41,000	54.9	1(0.06)	10(0.06)
10	-	0	0	0	0	no	185	yes	41,000	55.5	1(0.62)	-
11	2 x 2	20	20	20	10	yes	150	yes	41,000	55.8	1(0.63)	
12	2 x 2	20	20	20	10	yes	185	no	41,000	55.7	1(0.86)	
13	2 x 2	20	20	20	10	yes	185	yes	35,000	55.4	1(0.22)	
14§	Pop-up	10	34	0	0	no	185	yes	35,000	55.5	13(0.88)	
15	Pop-up	5	11	5	0	no	185	yes	35,000	55.1	13(0.26)	
16	Pop-up	6	20	4	3	no	185	yes	35,000	55.6	13(0.76)	

† Treatment 2 at Arlington 2012; water not added, actual application rates were 7 lb N/a, 28 lb P_2O_5 and K_2O/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

‡ Treatment 4 at Arlington 2012; water not added, actual application rates were 27 lb N/a, 27 lb P_2O_5/a, 14 lb S/a, 0.7 lb Zn and Mn/a, and 0.4 lb Cu/a.

§ Treatment 14 at Arlington; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.

Table 17. Treatment effect on corn grain test weight at Lancaster, WI, 5 November 2012.

Trt no.	Starter placement	Starter nutrient component					Sidedress N rate	Foliar fungicide	Seeding rate	Test weight	Contrast with trt no. (*p*)	
		N	P_2O_5	K_2O	S	Micro						
		---------- lb/a ----------					lb N/a		seeds/a	lb/bu		
1	2 x 2	20	20	20	10	yes	185	yes	41,000	54.8	-	10(0.40)
2	2 x 2	5	20	20	10	yes	185	yes	41,000	54.4	1(0.48)	10(0.91)
3	2 x 2	20	0	20	10	yes	185	yes	41,000	54.8	1(0.93)	10(0.53)
4	2 x 2	20	20	0	10	yes	185	yes	41,000	55.1	1(0.54)	10(0.17)
5	2 x 2	20	20	20	0	yes	185	yes	41,000	55.0	1(0.72)	10(0.17)
6	2 x 2	20	20	20	10	no	185	yes	41,000	54.9	1(0.83)	10(0.32)
7	2 x 2	20	0	0	10	yes	185	yes	41,000	54.6	1(0.78)	10(0.80)
8	2 x 2	20	20	20	0	no	185	yes	41,000	54.9	1(0.93)	10(0.29)
9	2 x 2	20	0	0	0	no	185	yes	41,000	54.4	1(0.47)	10(0.94)
10	-	0	0	0	0	no	185	yes	41,000	54.4	1(0.40)	-
11	2 x 2	20	20	20	10	yes	150	yes	41,000	55.2	1(0.44)	
12	2 x 2	20	20	20	10	yes	185	no	41,000	54.8	1(0.97)	
13	2 x 2	20	20	20	10	yes	185	yes	35,000	55.0	1(0.64)	
14†	Pop-up	10	34	0	0	no	185	yes	35,000	55.8	13(0.07)	
15	Pop-up	5	11	5	0	no	185	yes	35,000	54.9	13(0.64)	
16	Pop-up	6	20	4	3	no	185	yes	35,000	54.6	13(0.22)	

† Treatment 14 at Lancaster 2012; actual application rate was 7 lb N/a and 25 lb P_2O_5/a.