STARTER FERTILIZER SLOWS THE MOVEMENT OF CORN ROOTS ACROSS THE ROW

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ABSTRACT

Applications of starter fertilizer may alter the root morphology of young developing plants by causing lateral roots to proliferate when the root system enters the highly concentrated fertilizer band. This may affect the timing of root movement across the row when starter fertilizer is used. The timing of root movement across the row was determined by placing 20 12-inch-long perforated cylinders vertically in the soil at the V2 leaf stage. The cylinders were placed approximately every 15" in a line parallel to the corn row 5" and 10" away from the row on both sides of the corn row. The cylinders were checked for the presence of corn roots every other day until roots were visible in all cylinders. At each observation the percentage of cylinders with a visible root penetrating the cylinder void was used to compare the effect of two starter fertilizer treatments (no starter versus 47 lb N and 42 lb P_2O_5 $acre^{-1}$ in a 2" by 2" band) on the growth of roots across the row. Starter fertilizer did not affect the percentage of cylinders with roots at 5" from the row ($P>0.10$), except at 15 days after emergence (DAE) when more cylinders at 5" had roots with starter fertilizer than without. Contrasting results occurred in the cylinders 10" from the row from 15 through 21 DAE. Within the treatment receiving starter fertilizer, a lower percentage of cylinders 10" from the row on the side of the row with the fertilizer band contained roots than cylinders on the opposite side of the row or in the control treatment ($P<0.10$). Thus, it appeared that starter fertilizer, compared to no starter, slowed the appearance of roots across the row, but only on the side of the row where the fertilizer was placed.

INTRODUCTION

In the early 1930s a researcher from Michigan determined that placing nutrients in close proximity to the side and below the seed would precisely align with developing corn roots (Millar, 1930). And thus, this research was the advent of starter fertilizer. Since then researchers have claimed that starter fertilizer may alter the root morphology of young developing plants when roots enter the highly concentrated fertilizer band. Results from early greenhouse work proposed that roots may proliferate when intercepted by a starter fertilizer band (Duncan and Ohlrogge, 1958). By dividing corn roots from a single plant into separate jars containing various combinations of N and P fertilizer their work reported that the portion of roots placed into jars enriched with N and P fertilizer had greater root growth and additional root-hairs than the opposite portion of roots placed into jars with zero nutrients. This concept was further explained several years later by Granato and Raper (1989) who found that root proliferation near a fertilizer band is a function of increased lateral roots rather than stimulation of the primary root system. More recently, a study in Switzerland found that when N and P starter fertilizer was applied

directly below and to one side of the seed that root growth on the side of the fertilizer band typically had greater total root growth versus the opposite side containing no fertilizer band (Qin et al., 2005).

The previous studies draw a clear conclusion that roots seemingly tend to proliferate when intercepted by a high concentration of N and P starter fertilizer. Thus, one could speculate that due to the proliferation of lateral roots near the starter fertilizer band the total root system is perhaps delayed in reaching the middle of the row. If our hypothesis is correct, and depending on how long it takes roots to grow to the center, then additional research could focus on optimal placement of side-dressed nitrogen (N) when starter fertilizer is used. Perhaps plants would benefit more if side-dress N was placed closer to the row.

MATERIALS AND METHODS

A field experiment was conducted at the Throckmorton Purdue Agricultural Center (TPAC - 40.300631 lat., -86.902829 long.) in 2016. The predominant soil type was a Toronto (fine-silty, mixed, superactive, mesic Udollic Epiaqualfs) - Millbrook (fine-silty, mixed, superactive, mesic Udollic Endoaqualfs) complex and Throckmorton silt loam (fine-silty, mixed, superactive, mesic Mollic Oxyaquic Hapludalfs). Experimental design was a randomized block with two treatments, starter or no starter fertilizer, and three replications.

Corn seed (Specialty 46R02GENVT3P [RM 109]) were sown on May 24th at 33,000 seeds acre^{-1}. The field has been managed without tillage for more than 10 years, and was in the 2nd season of continuous corn. In the starter fertilizer plots, 19-17-0 was applied 2” below and 2” to the side of the seed providing 47 lb N and 42 lb P_2O_5 acre^{-1}. Control plots did not receive any starter fertilizer; however, the starter fertilizer coulters on the planter were left in place to achieve the same level of soil disturbance as the starter-applied plots. To equalize N rates between treatments, liquid N fertilizer (28-0-0) was applied around V15 to the starter and control treatments at 173 and 220 lb N acre^{-1}, respectively.

The timing of root movement across the row was determined by placing 20 12-inch-long perforated cylinders vertically in the soil at the V2 leaf stage. The cylinders were placed in a line parallel to the corn row 5” and 10” away from the row on both sides of the corn row (Fig. 1). Within the row, cylinders were inserted approximately 15” apart and located directly across from a plant. Prior to planting, soil samples were taken in a systematic grid pattern (60’ by 85’ spacing) across the entire field. Based on the lab results from these samples, groups of cylinders in each plot were placed in areas of the field that contained adequate and similar levels of soil test P (25 – 30 ppm P by the Bray-P1 method). Cardboard caps were placed in each cylinder to prevent rain and light from entering. The cylinders were checked every other day until roots were visible in all cylinders. At each observation the number of cylinders with a visible root penetrating the cylinder void was used to compare the effect of starter fertilizer treatments on the growth of roots across the row.

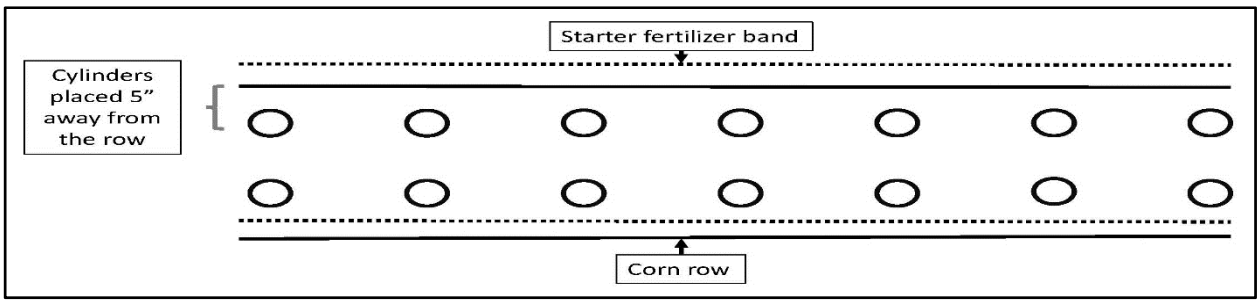

Figure 1: Cylinders placed 5" away from the row. In another section of the same row would be another group of cylinders placed 10" away from the row. Cylinder spacing within the row was 15 inches. Only 7 out of 20 cylinders in each group are shown.

RESULTS & DISCUSSION

Plant roots successfully entered the cylinders allowing us to estimate the extant of the total root system at 5 and 10" from the corn row over a period of time after plant emergence.

Starter fertilizer did not affect the percentage of cylinders with roots at 5" from the row ($P>0.10$), except at 15 days after emergence (DAE) where more cylinders had roots with starter fertilizer than without. The position of the starter fertilizer band on either side of the row did not affect the movement of roots to the 5" cylinders ($P>0.10$; data not shown). Approximately 13 DAE, when plants were between the V3 and V4 leaf stage, 50% of the cylinders 5" from the row contained at least 1 root (Fig. 2). Approximately 4 days later, essentially all cylinders at 5" in both treatments contained at least one plant root.

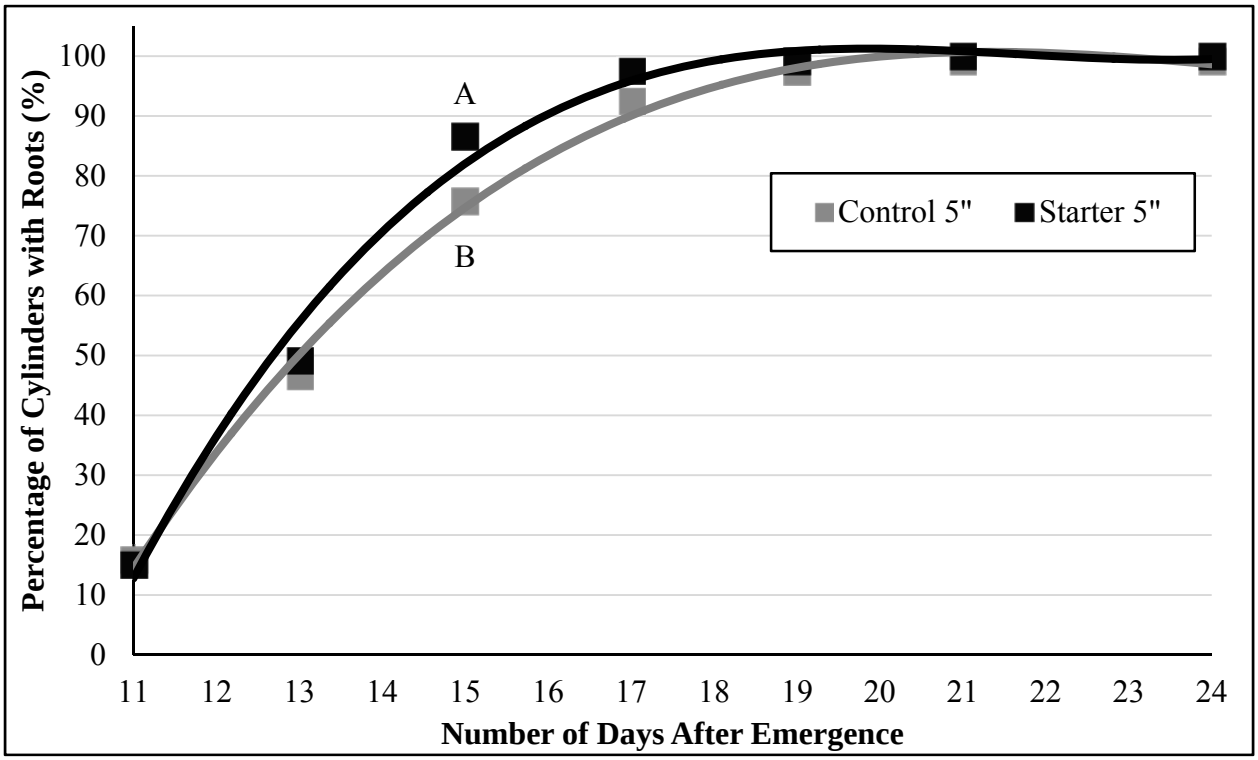

Figure 2: The effect of control and starter fertilizer treatments on the percent of 20 cylinders at 5" from the planted row with one or more roots, 11 to 24 days after corn emergence. Data points on a specific day after emergence with different letters are statistically different ($P\leq0.10$).

Within the starter fertilizer treatment from 15 to 21 DAE, fewer cylinders 10" from the row contained roots on the side of the row with starter fertilizer, compared to the other side of the row (P≤0.10; Fig. 3). During this same time period, the percentage of cylinders with roots on the opposite side of the row from the fertilizer band was similar to that of the control treatment on either side of the row (P>0.10; Fig. 3). In contrast to Abendroth et al. (2011) who reported that plant roots enter the middle of the row around V3, our data suggests that root appearance in the row middle may take longer under some conditions, especially on the starter fertilizer side of a row.

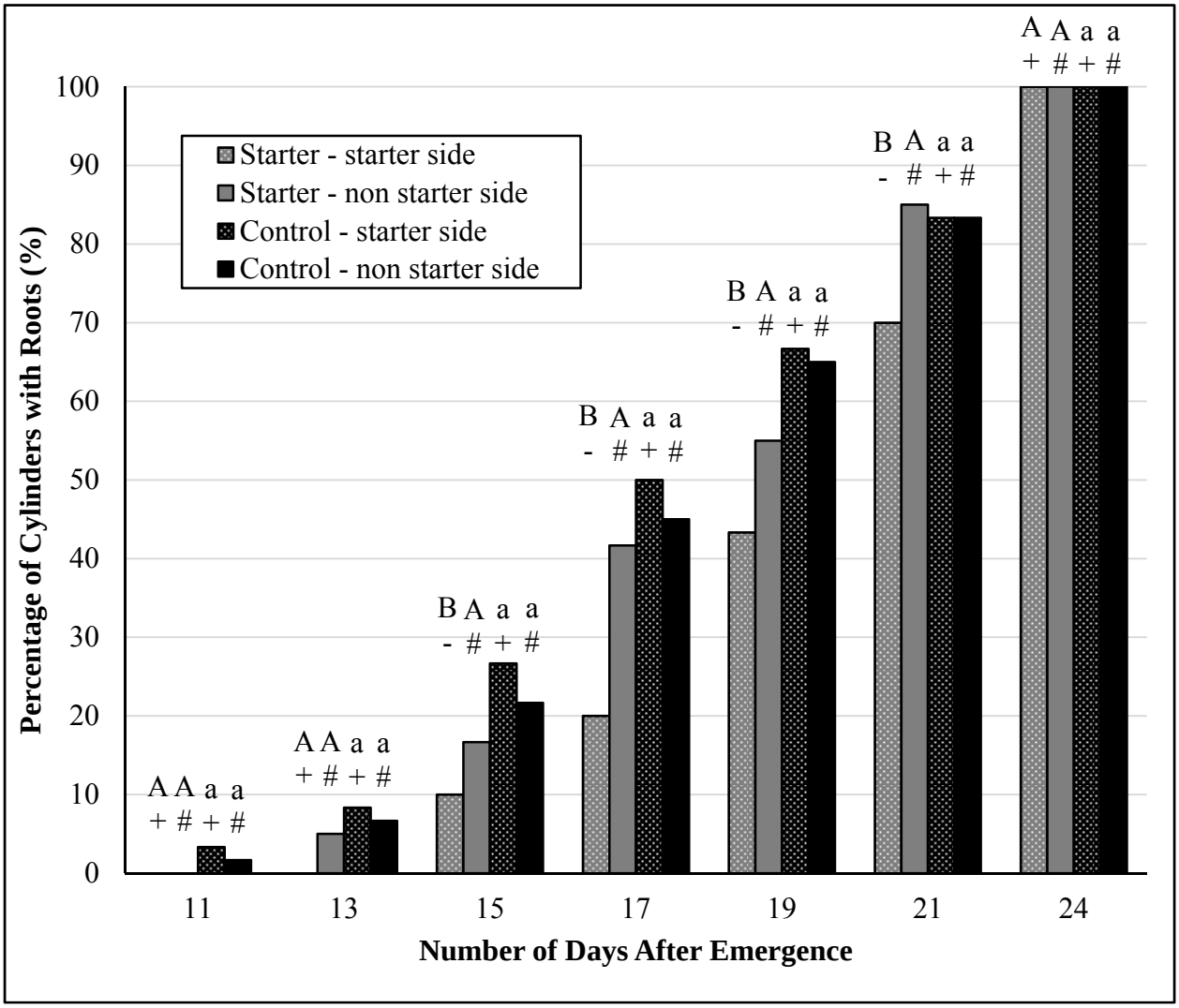

Figure 3. The effect of starter fertilizer treatment and side of the row on the percentage of 20 cylinders with one or more roots at 10" from the planted row at 11 to 24 days after corn emergence (DAE). Gray bars followed by an "A or B" on a specific DAE are statistically different (P<0.10). Black bars followed by an "a or b" on a specific DAE are statistically different (P<0.10). Checkered bars followed by a "+ or –" on a specific DAE are statistically different (P<0.10). Solid bars followed by a "# or $" on a specific DAE are statistically different (P<0.10)

SUMMARY

- Starter fertilizer had essentially no effect on the percentage of cylinders containing roots at 5" away on either side of the corn row.
- Starter fertilizer, compared to no starter, slowed the appearance of roots in cylinders 10" from the row, but only on the side of the row where the fertilizer was placed.
- The perforated cylinders offered an inexpensive, minimally laborious, and effective way to measure the timing of root movement across the row. Continued evaluation of this technique is required; however, in it its preliminary stages it appears to be a viable way to measure root movement in a field setting.

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