

EXPLORING THE IMPACT OF TEMPORAL VARIABILITY IN EMERGENCE ON CORN GRAIN YIELD AND DEVELOPMENT PATTERNS

L. Dorissant, P. Kovacs, J. Clark
South Dakota State University, Brookings, SD
Larousse.dorissant@jacks.sdstate.edu (605) 846 5741

ABSTRACT

The objective of this study was to investigate the impact of starter fertilizer placement on the seedlings emergence and uniformity and assess whether the timing of seedling emergence influences the developmental stages and eventual single-plant grain yield. An early planting date was compared with a normal planting date with different starter fertilizer combination and placement. Liquid Starter fertilizers were placed in-furrow low and high rate, 2 x 2 normal rate, and a combination of in-furrow low rate and 2 x 2 placement, and provided 9, 14, 23, and 32 lbs. P₂O₅ a⁻¹ respectively. These placements were compared to a control treatment without starter fertilizer application. Final emergence percentage was calculated based on the number of seedlings emerged as a percentage of seeds planted. Starter fertilizer placement did not influence daily seedlings emergence in either planting dates ($p > 0.05$). Delayed seedlings emergence highly correlated with shorter plant height, delayed silk and tassel emergence, lower ears weight, and single-plant grain yield ($p < 0.01$) regardless of the planting dates. Early seedling emergence demonstrated a clear association with early silk and tassel emergence across both planting dates. Plant height decreased as a function of delayed seedlings emergence at all growth stages. The findings highlighted that uniform seedling emergence is critical in optimizing crop productivity.

INTRODUCTION

Concerns have been raised among farmers in the Midwest regarding the impacts of uneven emergence of corn (*Zea mays* L.) seedlings. They believe that even a minor delay in emergence of a few hours could have a substantial influence on plant performance (Kimmelshue et al., 2022). According to Liu et al., 2004, corn emergence delay decreases plant height, leaf area index, dry matter accumulation, and grain yield compared to early emerging plant. This suggests that if plants within a crop have consistent growth and emergence patterns, it can positively impact overall yield, indicating that plant emergence variability plays a crucial role single plant grain yield potential.

One of the contributing factors to uneven seedling emergence in corn is the application of starter fertilizer. Research has shown that placing fertilizer in the seed furrow during planting or seeding is an efficient method for cultivating small grains in low temperature soils. This approach, particularly crucial for ensuring an early nutrient supply for initial crop growth and development; however, if applied in close proximity to the seed in excessive amount, the fertilizers tend to increase the salt concentration surrounding the seed and as a result, delays seedling emergence, reduces crop stand and grain yield (Qian et al., 2010). Therefore, the objectives of these study were to Investigate the

impact of starter fertilizer placement on seedlings emergence and uniformity as well as assess whether the timing of seedling emergence influences corn developmental stages and eventual single-plant grain yield.

MATERIALS AND METHODS

This experiment was conducted in Brookings, South Dakota in 2022 (44.3114° N, 96.7984° W). Soil in this area is a Fine-silty, mixed, superactive, frigid Pachic Hapludolls, which are well-drained and have a slope of 2%. The tillage practice of the field was conventional on a corn soybean [*Glycine max* (Merr) L.] rotation. The plot dimensions were 10 feet wide and 50 feet long and 34 000 seeds ac^{-1} were planted on a 4'30-inch row.

An early planting date was compared with a normal planting date with different starter fertilizer combination and placement. The first planting date was on October 23rd and the second was on June 3rd, 2022. Liquid Starter fertilizer (10-34-0, 10-34-0 + Zn, 8-21-5, 8-21-5 + Zn, were placed in-furrow low (IFL) and high rate (IFH), 2 x 2 normal rate, and a combination of in-furrow low rate and 2 x 2 placement (Both), and provide 9, 14, 23, and 32 lbs. $\text{P}_2\text{O}_5 \text{ a}^{-1}$ respectively. These placements were compared to a control treatment without starter fertilizer application (UTC). The field experiment was a split plot design with 4 replications where the main was the planting dates and the subplots were the starter fertilizer types and placements. Urea was applied to balance the nitrogen requirements of the corn plants regardless of the starter treatment at a rate of 150 lbs. a^{-1} .

Emerged seedlings from the central 10 feet of the second row of each plot were marked on a 12-hour basis and the emergence date was recorded. Colored stakes were used to facilitate visual identification of emergence date throughout the experiment. After 10 observations following the first emergence date recorded for each plot, emergence was considered complete. Final emergence percentage was calculated based on the number of seedlings emerged as a percentage of seeds planted. Total days to emergence were identified as accumulated growing degree units. Individual plant height was measured throughout the growing season (V4, V10 and R6). Silk and tassel emergence were recorded. Individual ears were hand harvested, tagged, and processed for yield and yield components analysis, and the weight was adjusted to 15.5% moisture.

RESULTS AND DISCUSSION

Starter fertilizer placement did not influence emergence regardless of the planting dates (Figures 1,2). The 2*2 normal rate placement increased seedling emergence in the first observations and the control treatments ended up with the lowest percent of emerged seedlings for the first planting; however, the differences were not significant (Figure 1). The patterns observed in the second planting date were similar for all the treatments (Figure 2), indicating that the placement of starter fertilizer did not result in a significant difference in uniformity of corn seedling emergence. This finding suggests that, in the specific conditions or context of the study, the application of starter fertilizer in the seed furrow did not provide a obvious advantage in promoting early seedling emergence.

Delayed seedlings emergence was highly correlated with shorter plant height ($p < 0.01$) regardless of the planting dates throughout of the season (Figures 3,4). Plant height decreased as a function of delayed seedlings emergence at all growth stages. Late-emerging corn did not grow as tall as earlier-emerging corn when plant emergence is delayed. Our study corroborates the findings of previous research, specifically Liu et al., 2004, which reported decreased plant height are associated with delayed emergence, which could be attributed to the intensified competition late emerging plants face for incoming solar radiation, moisture, and nutrients.

Delayed seedlings emergence highly correlated with delayed silk and tassel emergence ($p < 0.01$) regardless of the planting dates (Figure 5). There is a linear relationship between both silk and tassel and seedlings emergence timings. The early emerging corn were able to emerge silk and tassel earlier compared to the late emerging plants. The clear association that early seedling emergence demonstrated with early tassel and silk emergence across both planting dates (Figure 5), underlining the importance of synchronized developmental stages.

Single plant grain yield decreased with delayed emergence for both planting dates (Figure 6). This yield loss could be attributed to the drought conditions recorded in the 2022 growing season which caused more stress on the late emerging corn compared to the early emerging corn.

The findings highlighted that uniform seedling emergence is critical in optimizing crop productivity and emphasizing the importance of synchronized developmental stages for minimizing plant competition.

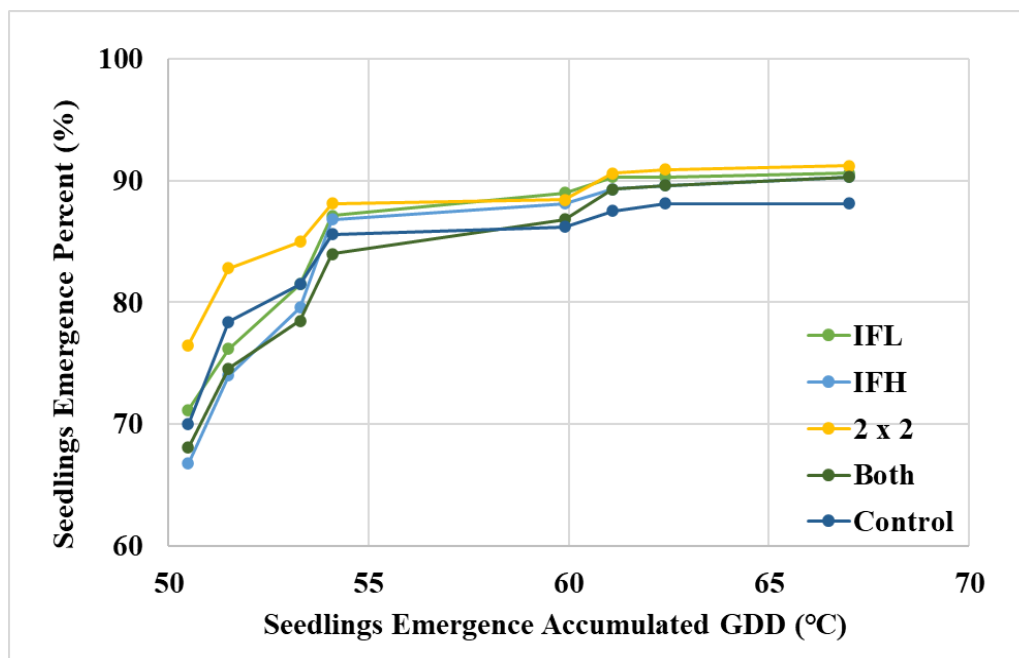


Figure 1: Cumulative seedlings emergence progress to starter fertilizer placement in corn planted on May 23rd, 2022 (first planting date). Seedlings emergence means are averaged for each observation.

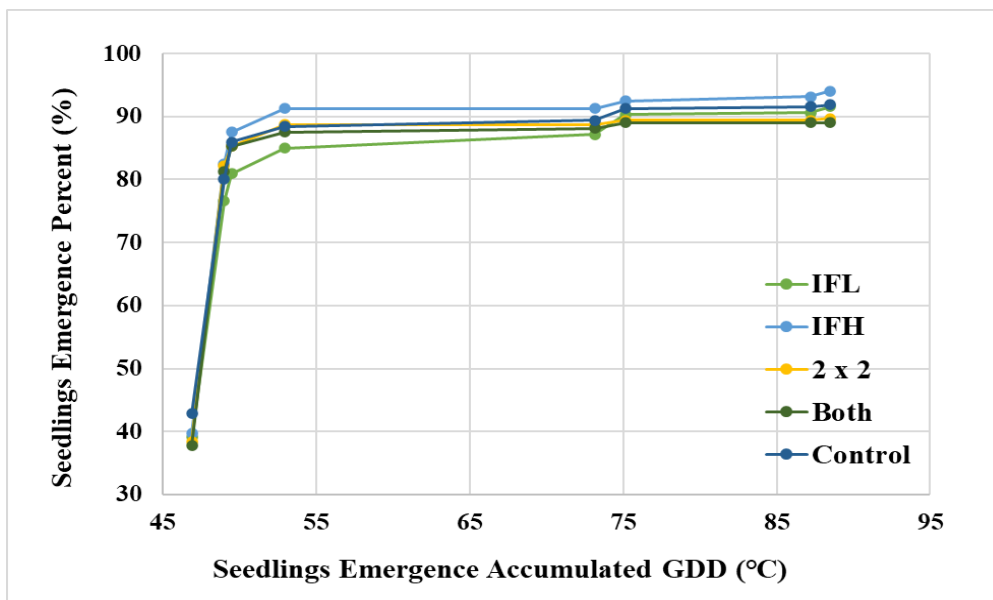
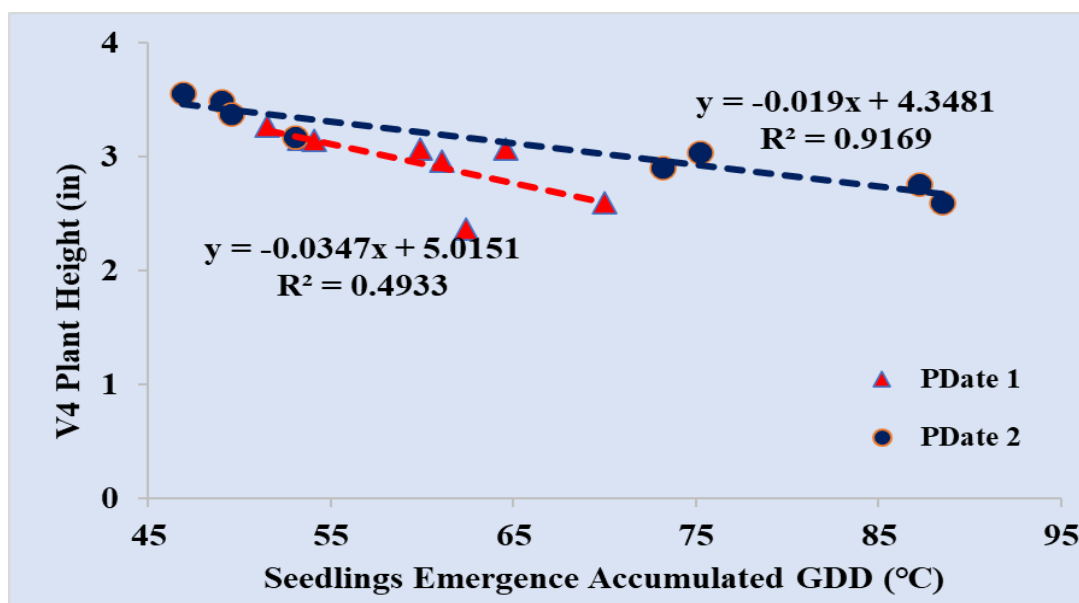


Figure 2: Cumulative seedlings emergence progress to starter fertilizer placement in corn planted on June 3rd, 2022 (second planting date). Seedlings emergence means are averaged for each observation.



Figures 3: Correlation between seedlings emergence accumulated GDD and early season (V4) plant height across both planting dates. Seedlings emergence means are averaged across each starter fertilizer placement for each observation.

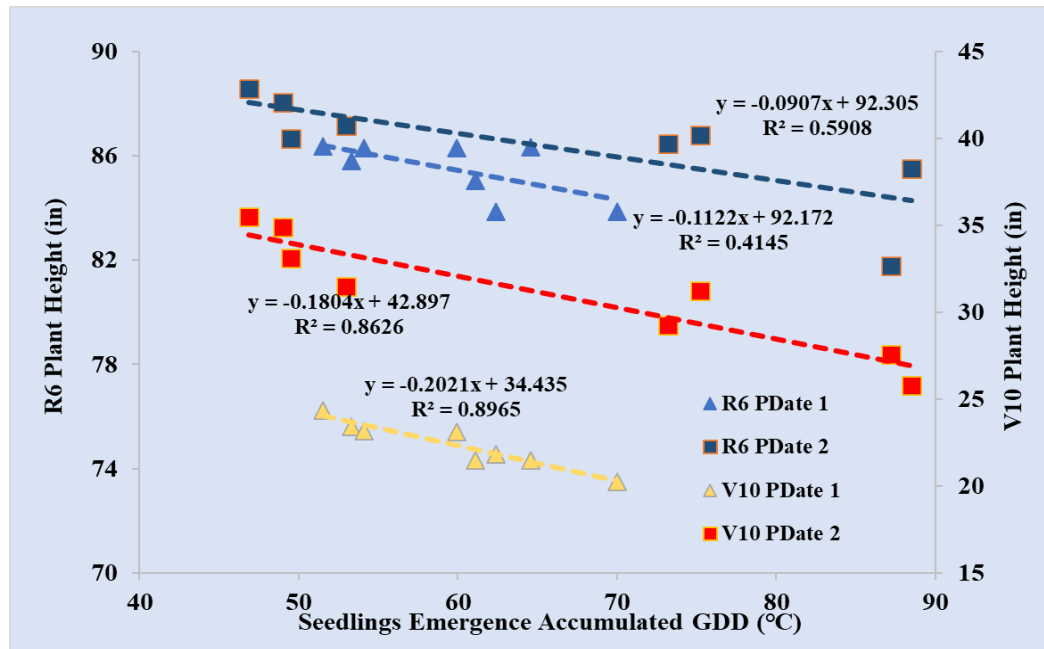


Figure 4: Correlation between seedlings emergence accumulated GDD, mid-season (V10, secondary axis) and whole-season (R6 physiological maturity, primary axis) plant height across both planting dates. Seedlings emergence means are averaged across each starter fertilizer placement for each observation.

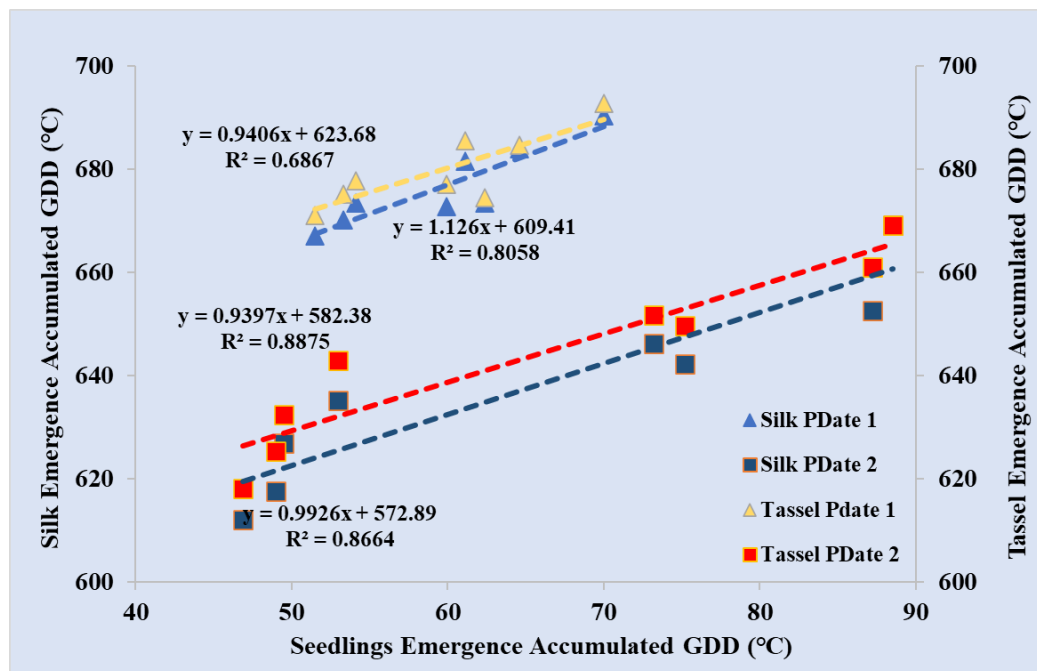


Figure 5: Correlation between seedlings emergence accumulated GDD, tassel (secondary axis) and silk (primary axis) plant height across both planting dates. Seedlings emergence means are averaged across each starter fertilizer placement for each observation.

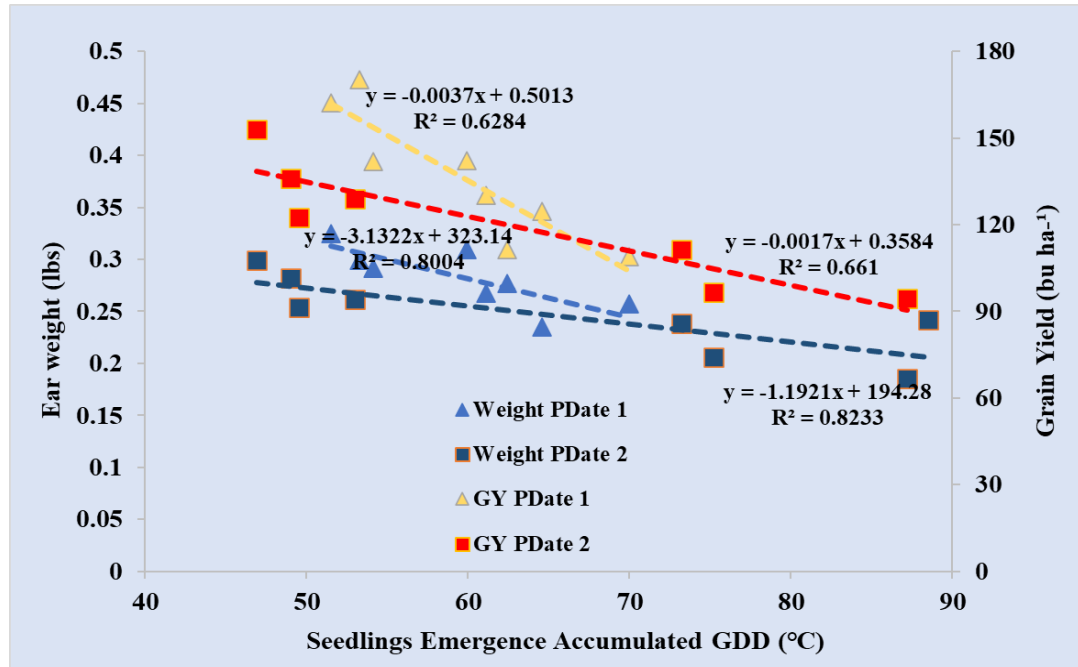


Figure 6: Correlation between seedlings emergence accumulated GDD, single plant grain yield (secondary axis) and ear weight (primary axis) plant height across both planting dates. Seedlings emergence means are averaged across each starter fertilizer placement for each observation.

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