PRECISION TOOLS TO EVALUATE BENEFITS OF TILE DRANAGE IN A CORN AND SOYBEAN ROTATION IN IOWA

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ABSTRACT

Large areas of soils in the US Midwest require drainage for removal of excess water from fields early in the growing season. Few well-controlled studies have been done to quantify crop yield benefits from installing tile for drainage. This makes it difficult to document the long-term yield and economic benefits of tile drainage in on-farm conditions. Using digital aerial imagery and yield monitor technologies, we evaluated the long-term benefits of installing new or improving old tile drainage systems on Iowa corn yields. Three fields were selected for this study, each with a 5 to 10-yr history of recorded yield data and GPS. We used digital aerial imagery of the soil surface or the crop canopy to locate old and new tile. We then compared yields between tile and no-tile areas using at least three size-paired sampling areas in each field. Analysis showed that yield responses to new or improved tile systems increased over time, with the largest yield difference occurring in years when early season rainfall was above average. Using digital aerial imagery and yield monitoring data should help to better quantify yield and economic benefits of installing new and upgrading old tile drainage systems in production fields.

Keywords: tile drainage, digital aerial imagery, yield monitoring, paired sampling areas.

CASE STUDY 1

In this Humboldt County field, the original tiles were improperly installed, resulting in flooding during years when rainfall was above normal. We selected five paired sampling areas in this field and summarized 9 yrs of corn yield monitor data in the non-flooded vs flooded areas, which we based on the extent of flooding in 2005. A new tile system was installed in November of 2008, providing yield data 6 yrs before and 3yrs after the new tile installation. In the three wettest years prior to the new tile system, the non-flooded areas yielded about >4.4 Mg ha^{-1} than flooded areas. After the new tile system was installed, in the wettest year the non-flooded area yielded >2.3 Mg ha^{-1}. To estimate the benefit of the new tile, an additional pair of non-flooded vs flooded areas was selected in an area that did not receive new tile. Although we could not select multiple areas to compare new tile vs the original tile, one comparison showed hat in the wettest year a yield difference between new tile vs original tile was about

7.0 Mg ha^{-1}. This estimate indicates that the new tile substantially improved the drainage problems caused by the previous improper tile installation.

CASE STUDY 2

In this Fayette County field , historical digital aerial imagery was used to identify an existing clay tile drainage system. In 2000, corn yields from three sampling areas with old clay tile were compared with yields from areas that were not tiled. New tile lines were installed in the area without tile in the spring of 2002 and three paired yield comparisons were made to quantify the benefit of the new tile from seven corn growing seasons. Based on the paired t-test analysis, the sampling areas with old clay tiles had a significant corn yield increase by 1.1 Mg ha^{-1} compared with areas without tiles. In the first year after new tile system was installed, the areas with the old tiles yielded significantly higher. In the six years the field was in corn since then, however, yield differences between the new and old tiles were relatively small. Despite the fact that we had only one year of yield monitor data before new tile was installed, this analysis shows that the new tile system improved soil drainage and decreased a yield gap between the old clay tile and no tile drainage systems.

CASE STUDY 3

The old clay tile drainage system in this Bremer County field was spaced every 23 m and corn was planted parallel to the tile lines. Ten paired sampling areas were selected to compare corn yield near the old clay tiles to an area approximately midway between two tile lines. After new tile was installed between the old clay tiles, the same sampling areas were used to compare corn yields for the new tile lines vs old clay tile lines. Before new tile lines were installed, yield measured directly above the old clay tile lines was significantly higher by 0.1 to 1.2 Mg ha^{-1}in four out of five years. In the first year after the new tile was installed, the yield directly above the new tiles was 0.4 Mg ha^{-1} higher than the yield directly over the old clay tiles. This analysis shows that drainage and corn yield can be improved fields with older, widely spaced tile lines by installing additional tile lines to reduce the overall spacing.

CONCLUSIONS

Precision agriculture technologies can be used to locate old or poorly functioning tile systems within fields and to collect yield, soil, crop, and topography data. Analysis of such data enables researchers to identify yield benefits from installing new tile or upgrading existing tile systems. Because of the difficulty of conducting more accurate studies with a sufficient number of replications and meaningful comparisons, future studies should be focused more on developing and testing field methodology to quantify the benefits of improving soil drainage within fields.