Effect of tile drainage spacing on wheat production in heavy clay soils

Project Duration: 2018

Objectives

This study investigated the effects of three tile drainage configurations (15', 30' and 45' spacing) on the behaviour of the water table (WT), volume of drainage outflow, quality of drainage outflow and nutrient transport, as well as wheat growth and yield.

Collaborators: Agriculture and Agri-food Canada
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Results

Throughout the season, the water table in the 15' plots on the tile and between the tiles was consistent, indicating that there is unlikely to be variation in the field due to an uneven water table. On the 45' plots, the water table between the tiles was up to 1/2' closer to the surface at specific times throughout the season compared to the water table at the tile, indicating that variation in the water table would exist in the field.

The water quality from the tile showed low concentrations of nutrients (total nitrogen or total phosphorus), indicating that nutrient transport is dependent of both the concentration of nutrients in the soil as well as on the total volume of water leaving the field from each treatment (Table 1). Due to very low precipitation, water outflow volumes were too low to measure over the season and additional data collection is necessary to draw specific conclusions about the effect of tile spacing on nutrient transport.

Plots with 45' tiles had higher salt levels in the soil and also higher salt concentrations in the drainage water (Table 1). This indicates that wider spacing may remove more salts than narrower spacing (dependent on volume outflow), or that greater salt concentration in the soil results in greater salt concentration in drainage water, or both.

Table 1. Comparison of 15 and 45 ft tile spacing on water quality based on soils test results.

Tile Spacing (ft)	Water Quality				Soils Test			
	pH	Specific Conductivity (uS)	TN (mg/L)	TP (ug/L)	pH	EC (dS/m)	TN (lb/ac)	TP (lb/ac)
15	8.9	3.2	4.5	151	8.3	0.8	87	36
45	9.1	6.3	4.5	183	8.2	1.7	127	42

Tile drainage had no effect on wheat yield across any treatments. The yield varied between 63.5 – 74.9 bushels/acre among different treatments (Table 2). This was expected during 2018, as excess moisture was not a limiting factor in growth during this season. Tile drainage also did not appear to affect overall plant growth expect head counts. Different tile treatments did not differ for plant stand, plant height and lodging (data not shown in the table).

Table 2. Wheat growth and yield as affected by different tile spacing treatments.

Treatment	Plant Stand (# of plants/m row length)@	Plant Height (inches)*	Head Counts (plants/ft2)#	Yield (bu/acre)^
15'-in between	50.00a	26.90a	50.60ab	63.50a
15'- on tile	53.20a	26.58a	52.80ab	67.30a
30'-in between	60.47a	28.56a	62.80c	67.70a
30'- on tile	65.10a	26.60a	57.40bc	65.43a
45'-in between	62.90a	26.83a	57.00bc	70.37a
45'- on tile	57.77a	26.58a	48.07a	70.10a
No Tile	49.30a	26.75a	48.70a	74.85a
P value	0.743	0.383	0.038	0.584
CV (%)	23.8	4.23	9.39	9.57

**Based on 10 randomly selected plants/plot*
#Based on five samples/plot
^Based on two 6m long combine passes/plot
@Average of 15 samples / plot

Project findings

Between May 15 – August 21, PESAI site got 157mm of rainfall which was 70% of the normal for this time of year. Excess moisture was not a limiting factor in wheat production this season, meaning that it was difficult to assess the effect of tile drainage on crop production. Yield was statistically not affected by any tile drainage spacing treatment.

Neither moisture stress nor drought stress were limiting factors in production this season, meaning that it was difficult to assess the effect of tile drainage on crop production. As well, all plots were seeded on the same day instead of seeding when the field was actually ready for planting. This was due to the fact that PESAI relied on custom seeding for this project.

In dry seasons, tile at 15' in this soil type will still lower the water table (WT) more effectively than surface drainage alone (45' will not). This may be a concern if the crop is not receiving enough water for production. However, this can also be alleviated with the use of control structures to prevent drainage when it is not desirable. Similarly, if the tile is between 2-3 feet from the surface, this rapid lowering of the WT in this space may not be a large concern, considering the tile drainage does not generally affect the groundwater below it.

It is recommended to repeat this study to collect data during a year when excess moisture stress affects plant growth.

Background / References

Manitoba receives significant amounts of snowfall and sub-zero temperatures during the period between November and March. This leads to accumulation of snow over the ground and frozen soils. As temperatures rise during the month of April, melting of snow and frozen soils can cause excessive moisture in agricultural fields. Excessive soil moisture delays agronomic operations, such as field preparations or seeding, during the early cropping season. These delays can result in a shorter cropping season and sometimes a reduced yield.

The presence of heavy clay soils in the Interlake contributes to the presence of high moisture content, particularly during the spring. The province of Manitoba has identified the importance of surface drainage in peat areas of Interlake and built drains (Provincial waterways) for proper runoff after rainfall. In regions with heavy clay soils, removal of surface water alone might not be a solution to excess moisture if the soil below the surface remains saturated.

Draining water from the root zone is important to gain access to a field and to avoid loss of moisture-sensitive crops. Subsurface drainage systems help to remove excess soil moisture from the root zone. The amount of water removed daily is dependent on the drainage rate of the system, which must be carefully considered during the design process. The drainage rate determines the capability of the system to prevent soil saturation during high intensity rainfall events. Other parameters affecting the drainage rate are soil type, topography, tile installation depth and spacing of tile drains.

The Prairie East Sustainable Agricultural Initiative (PESAI) research site has various configurations of subsurface drainage installed and was used for this study. Soil at this site is classified in the Fyala (FYL) soil series as Class -3 agricultural capability due to limitations in high moisture conditions. Fyala soil is considered as poorly drained soil due to presence of clay particles throughout the profile. This site was chosen to investigate the effects of subsurface drainage in on water quality, yield, water table, and drainage volume outflow.

Materials and Methods

Three treatments were studied: 15' tile spacing, 45' tile spacing (4.6 m and 13.7 m spacing, respectively), and no tile spacing (check), and wheat was selected as the crop under study due to its prominence in Manitoba. The wheat yield of the 30' tile spacing plots were also observed. Wheat was planted on May 15, 2018 at a 1.5" depth with a target seeding rate of 2.5 bushels/acre. Wheat variety AAC Brandon was planted in all the treatment plots.

Level logger sensors were placed in two monitoring wells for one replication on each treatment (except 30'spacing). On tiled treatments, one was placed directly over the tile, and one was placed at the halfway point between two tiles in order to understand the uniformity of the water table. On check treatments, monitoring wells were placed randomly. Level loggers were also used with a V-notch weir in drainage control structures to monitor the volume of drainage outflow from tiled treatments (there was no adequate location to measure surface run-off from any treatments). Water quality samples were taken from control structures on a weekly basis and sent away to a third-party lab for analysis of total nitrogen, total phosphorus, and specific conductivity (salt concentration).

The data on plant stand, plant height, head counts, lodging and yield were taken from different treatment plots. Harvest took place on August 21. For harvesting, two 6-metre long strips were combined from each plot either on the tile or in between the tiles. The data of different growth parameters and yield were analysed using MINITAB.