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Effects of Tile Drain Depth and Spacing on Phosphorus Losses under Corn and Soybean Rotation

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Introduction

- Good soil drainage is essential to the proper management of wet, fertile soil to be used for agricultural production

- Proper management of drainage also plays a major role in improving the water quality from agricultural land

- Subsurface tile drain spacing and depth affect the quantity, quality of tile drainage water as well as crop productivity

- Phosphorus (P) losses from tile drained agricultural lands may differ with tile depth and spacing

- There are optimal combinations of tile drain depth and spacing that can reduce discharge and phosphorus losses while avoiding large reductions in crop yield

Objectives

Objective 1:

Effect of tile drain spacing on flow volume, flow weighted mean phosphorus concentration and dissolve reactive phosphorus (DRP) and total phosphorus (TP) losses (drain spacing:4.2m vs.7.5 m)

Objective 2:

Effect of tile drain depth on flow volume, flow weighted mean phosphorus concentration and dissolve reactive phosphorus (DRP) and total phosphorus (TP) losses (drain depth: 0.65 m vs. 0.85 m)

Materials and methods

Site 1- drain spacing-7.5 m & drain depth 0.65 m

Each plots was 15 m wide by 67 m long, each plot contained 2 subsurface drains with spacing 7.5 m between drains at an average depth of 0.65 m

Two water table management treatments controlled drainage with sub-irrigation (CDS); regular free drainage (RFD)

Site 2- drain spacing 4.2 m & drain depth 0.65 m

Each plot was 25 m wide by 131 m long, each plot contained six subsurface drains with spacing 4.2 m between drains at an average depth of 0.65 m

Two water table management treatments controlled drainage/sub-irrigation (CDS); regular free drainage (RFD)

Site 3- drain spacing 4.2 m & drain depth 0.85 m

Each plot was 15 m wide by 67 m long, each plot contained three subsurface drains with spacing 4.2 m between drains at an average depth of 0.85 m

Two water table management treatments controlled drainage/sub-irrigation (CDS); regular free drainage (RFD)

Agronomy

Corn and soybean rotation; the inorganic fertilizers were applied in the spring, then disced in to a depth of approximately 8 cm in a corn phase of the corn-soybean rotation. No fertilizer was applied in the soybean cropping season.

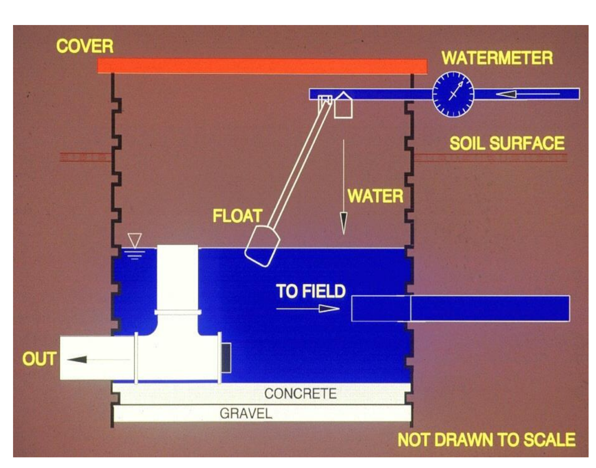
Fertilizer application

Corn phase: The inorganic fertilizer control was applied at the rate containing 50 kg P/ha, 200 kg N/ha and 100 kg K/ha in available form. Soybean phase: No fertilizer was added.

Water application

Controlled drainage and sub-irrigation system (CDS)

Regular free drainage system (RFD)



Flow measurement

Site1 & Site 3

Surface & tile discharge volume were measured continuously by water meter and Tricon E

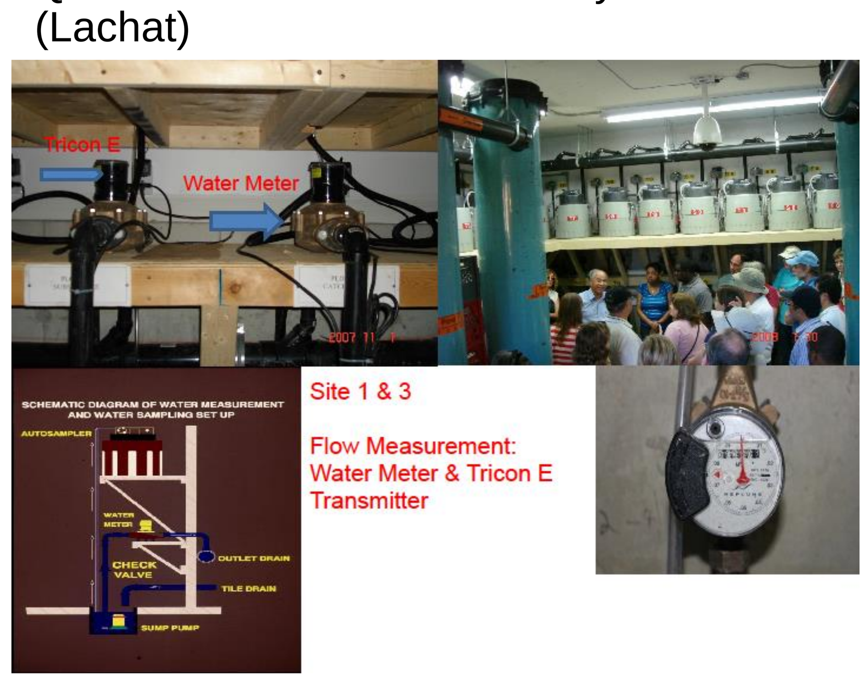
Site 2

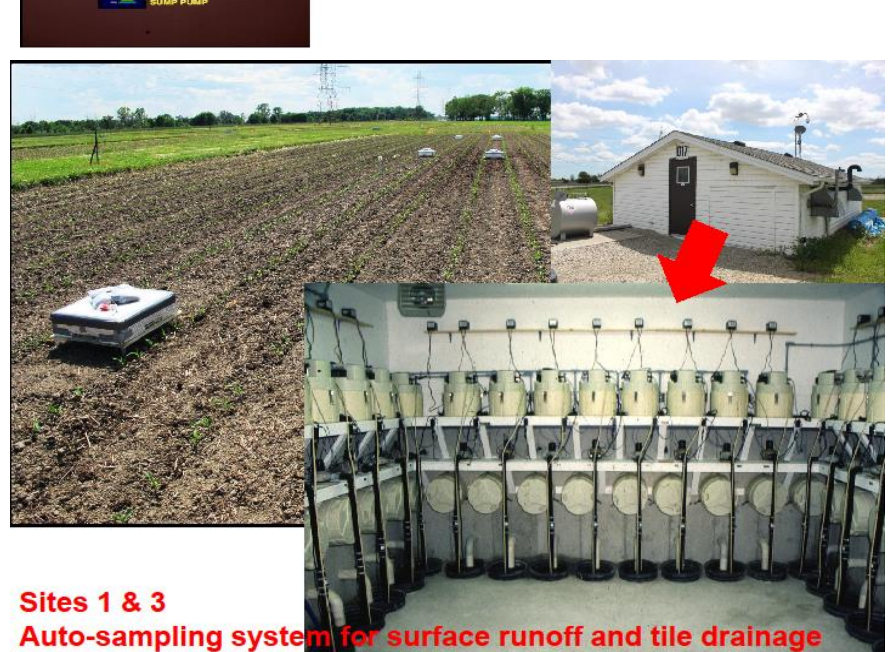
Surface & tile discharge volume were measured continuously using a calibrated tipping bucket

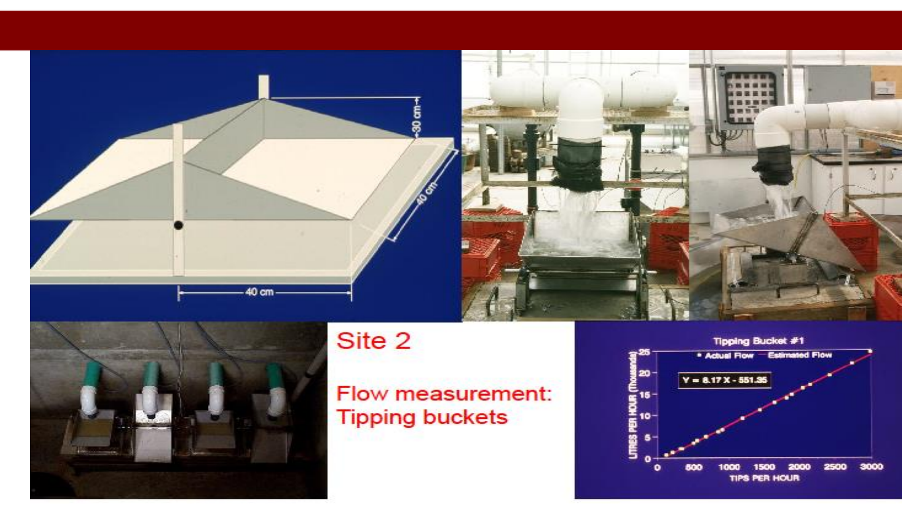
Phosphorus measurement

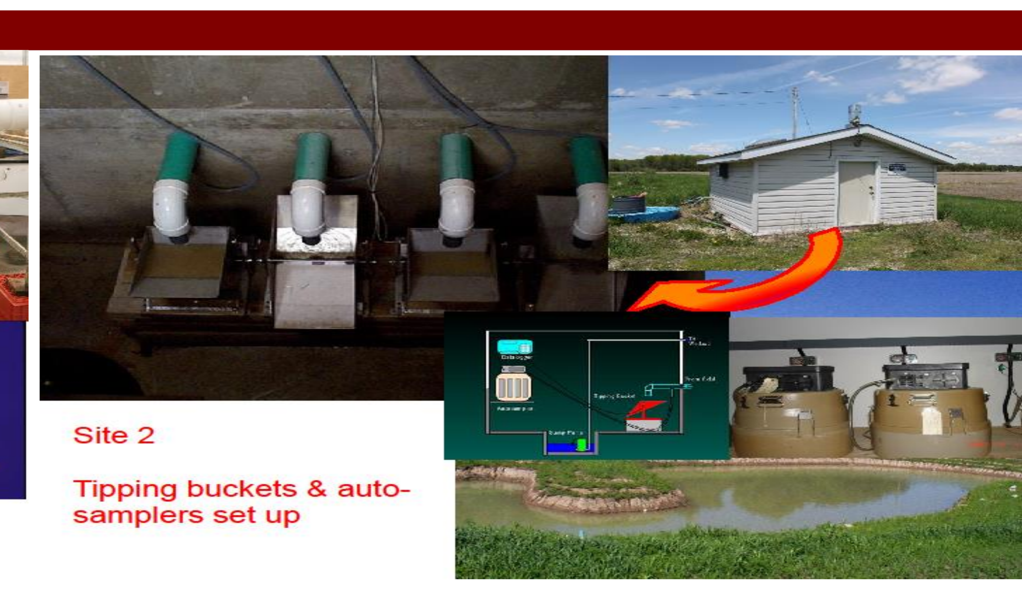
P fractionation in tile water: Total phosphorus (TP) & dissolve reactive phosphorus (DRP)

P determination: AA-Mo method using a QuickChem & FIA+ Auto-analyzer 8000 (Lachat)



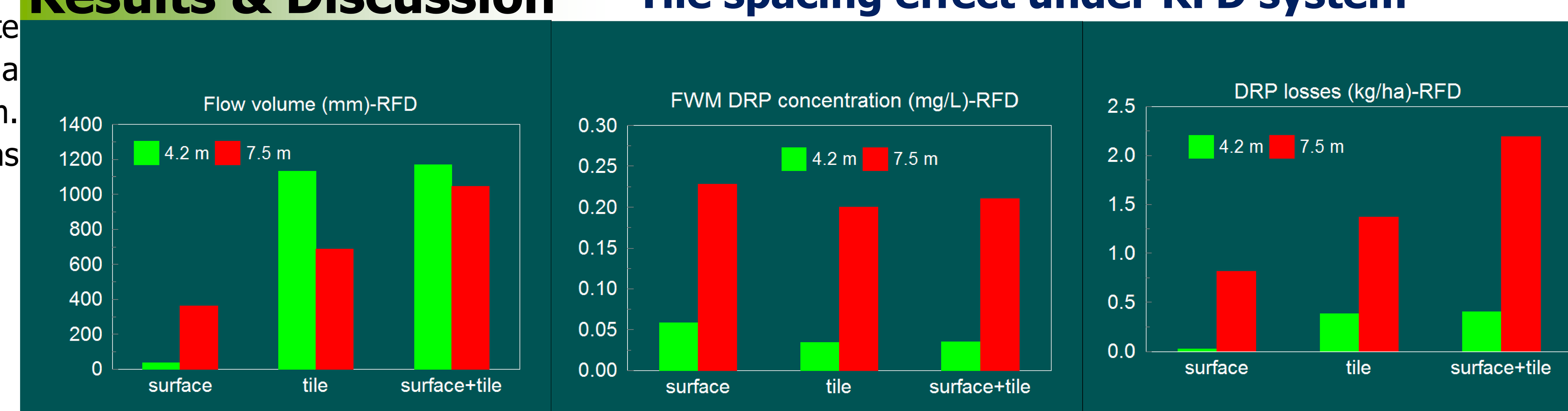


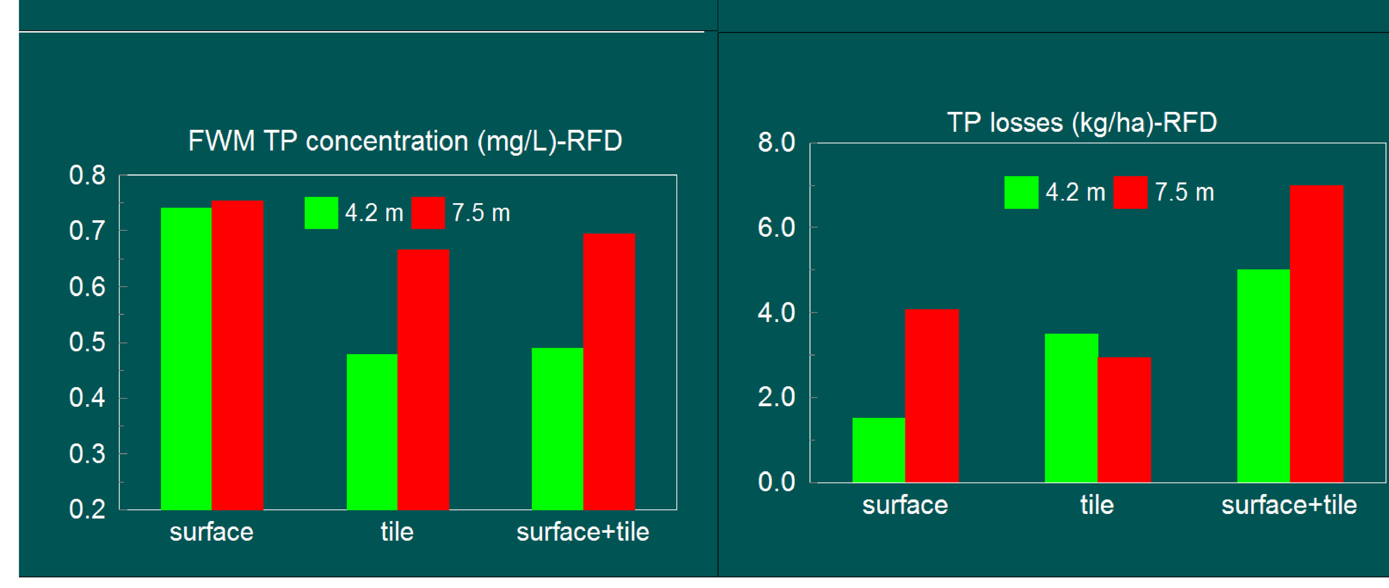




Results & Discussion

Tile spacing effect under RFD system

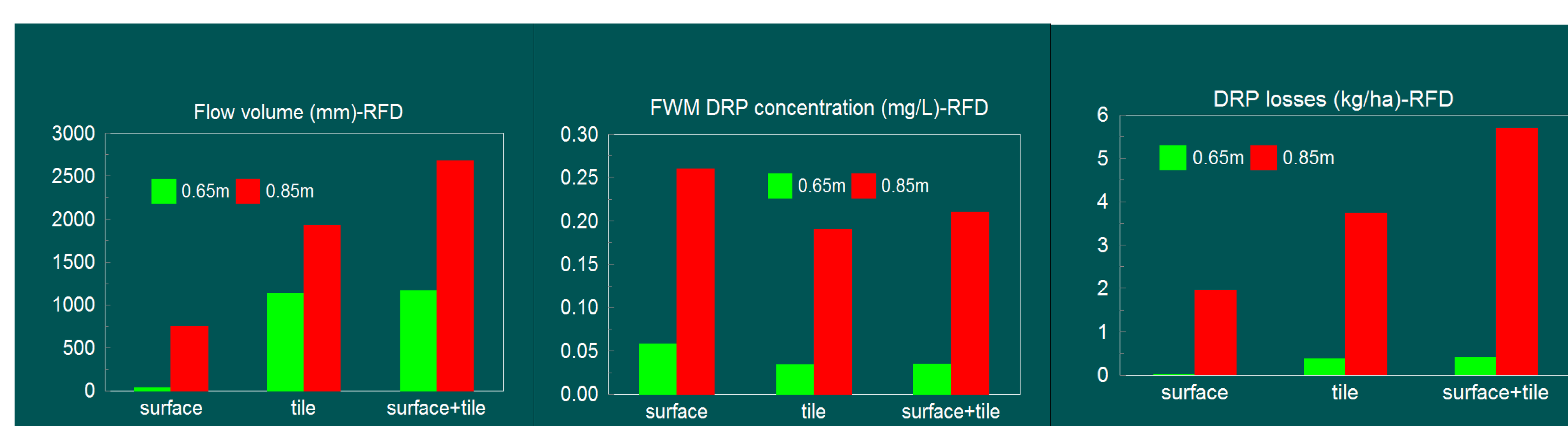


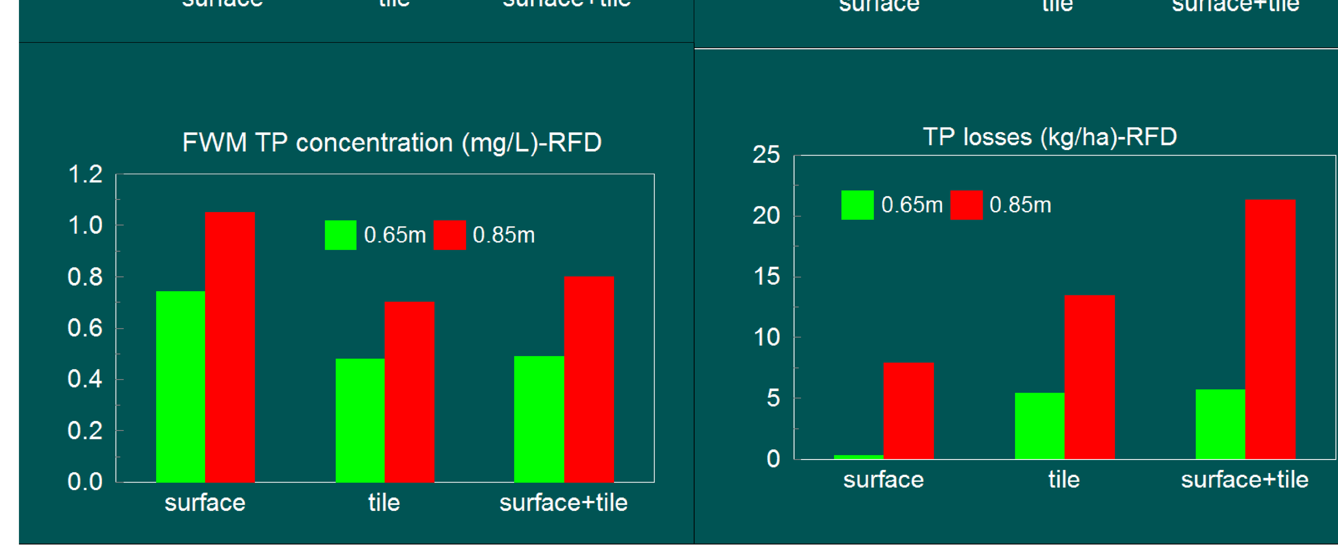


Under RFD system, an increase in tile spacing from 4.6 m to 7.5 m decreased total combined surface and sub-surface flow volume by 12 % but increased both DRP and TP losses. FWM DRP and TP concentrations also increased with wide tile spacing.

Results & Discussion

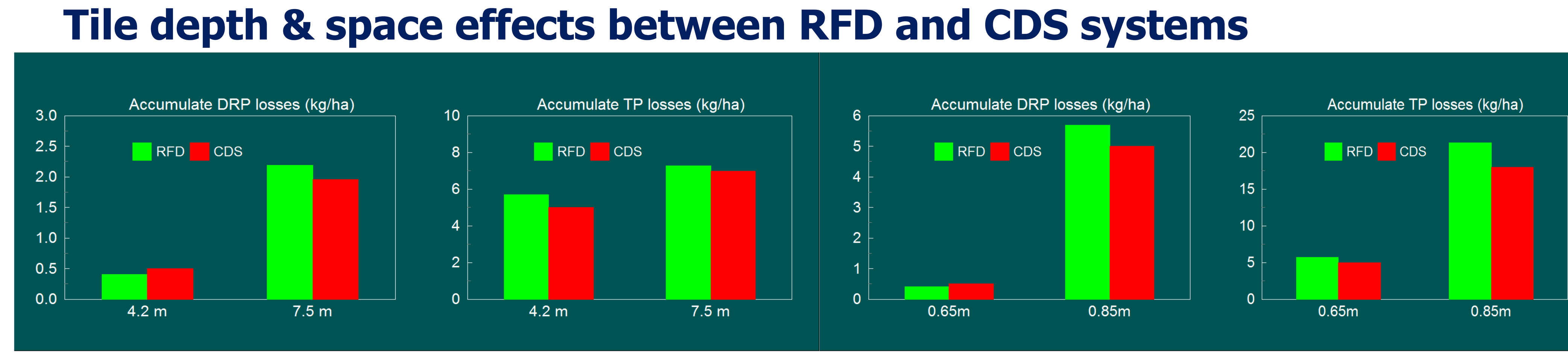
Tile depth effect under RFD system





Under RFD system, an increase in tile depth from 0.65 m to 0.85 m resulted in increasing total combined surface and sub-surface flow volume and total P loss by 56 % and 73 %, respectively. FWM DRP and TP concentrations also increased with deep tile depth.

Tile depth & space effects between RFD and CDS systems



Conclusions

It was evident that under RFD system decreasing tile drain depth reduced DRP and total P losses. Further 16 % total P reduction was also evident by CDS system. However tile spacing had less effect on DRP and total P losses. Therefore, under both RFD and CDS systems, decrease tile drain depth could be highly effective for reducing total P loading.

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