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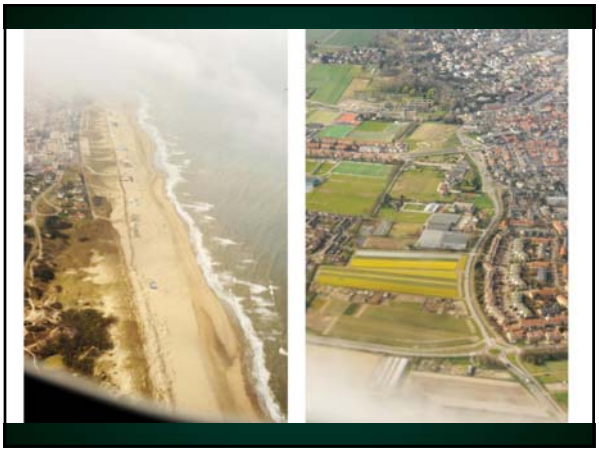
Use of Water Control Structures Within a Tile Drainage System

Hans Kandel, Extension Agronomist

STUDENT FOCUSED • LAND GRANT • RESEARCH UNIVERSITY



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Farmland Drainage Needs
Spring or Summer in Minnesota and North Dakota

Figures 1 (*left*) and 2. Corn growing in flooded or saturated soil is more likely to develop disease problems now and later in the season. (*Left photo courtesy of Jae Behn, UNL*).

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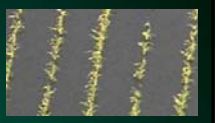
Impact of water logged conditions on yield of corn



- Yield reductions are significant even after 2 days
- Crop may look like it recovered and still have a yield reduction

Days Water Logged	Percent Yield Reduction
0	0%
2	-25%
5	-45%
8	-80%

Date of Planting	Percent Yield Reduction
By 5/1	0%
5/2-5/10	-7%
5/11-5/25	-13%
5/26-6/1	-24%

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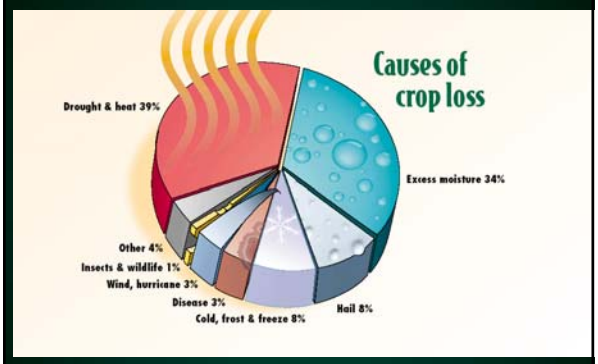

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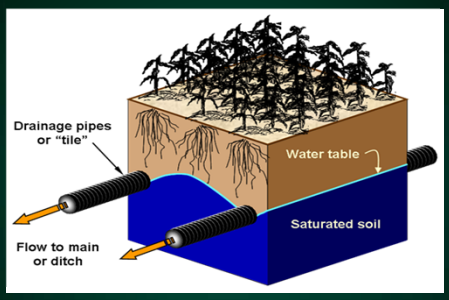

Source: G. Sands

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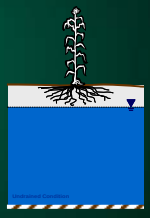
Why do water logged conditions after planting cause crop damage?

- Under water-logged conditions, the availability of oxygen is decreased



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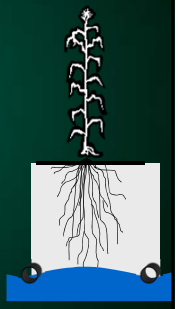
Why do water logged conditions after planting cause crop damage?

- When roots are subjected to low oxygen conditions, changes occur in the plant that generally decreases yield
- Root growth is restricted



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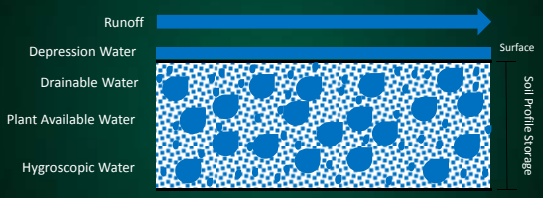
Partitioning of Soil and Surface Water



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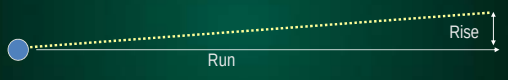
Source: BTSAC

Tile Grade

$$\text{Tile Grade} = \frac{\text{Rise}}{\text{Run}}$$



Tile Grade is usually expressed in percent grade
For Example, 0.1 percent grade would be a 1 foot rise or drop in 1000 feet and a 0.5 percent grade would be a 5 foot rise or drop in 1000 feet

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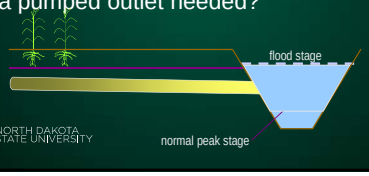
What's an Adequate Outlet for a Tile Drainage System?

- Carrying capacity (flow rate) must match system design
- Are there downstream impediments?
- Will the outflow drain by gravity?
- Can you live with some risk?
- Is a pumped outlet needed?



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Need For Lift Pump

- No Gravity Outlet
  - Shallow ditch, No permission to make ditch deeper

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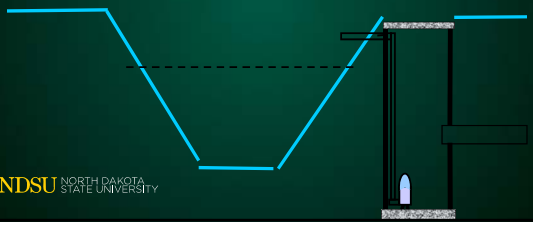
Need For Lift Pump

- Outlet (ditch) fills up after a large rain and takes several days to subside
- You want to have control of water leaving the field



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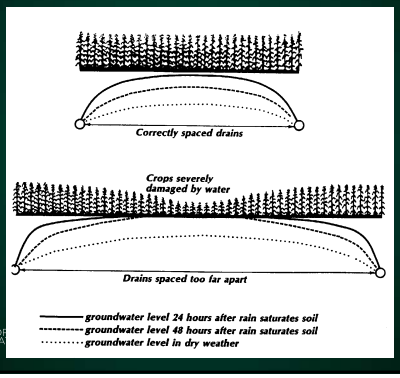
Tile Spacing is Important



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Generalized Spacing Recommendations

(*From the Minnesota Drainage Guide*)

Type of Soil	Subsoil Permeability	Tile Spacing in feet for Fair Drainage 1/4" d.c.	Good Drainage 3/8" d.c.	Excellent Drainage 1/2" d.c.	Tile Depth (ft)
Clay loam	Very low	70	50	35	3.0 - 3.5
Silty clay loam	Low	95	65	45	3.3 - 3.8
Silt loam	Moderately low	130	90	60	3.5 - 4.0
Loam	Moderate	200	140	95	3.8 - 4.3
Sandy Loam	Moderately high	300	210	150	4.0 - 4.5

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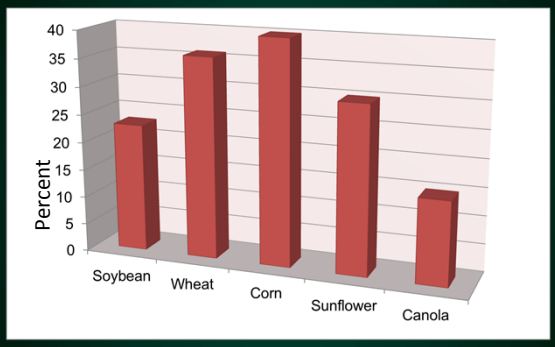
Crop Yield IncreaseTiled vs Untiled in %



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Pro Drainage Farm Drainage Contractors, Ontario
www.drainage.org/factsheets/fs11.htm

2011 NDSU Fargo Soybean Saturated-soil Roundup Ready Experiment, Author, T. Helms.

Company /Brand	Variety	Maturity	Seed Yield Dry[1]	Wet[2]	Average
		(date)	----------(bu/a)----------		
Seeds 2000	2051RR2Y	9/23	42.8	31.1	37.0
Asgrow	AG 0732	9/24	38.5	29.3	33.9
Kruger	K2-0601	9/27	38.2	36.2	37.2
Integra	20800	9/24	38.0	28.7	33.4
Mycogen	5B024R2	9/17	37.7	27.5	32.6
Mean	Trial	--	**33.5**	**27.8**	30.7

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20 Percent difference in yield

2012 NDSU Fargo Saturated-soil, neutral pH, Roundup Ready Soybean Variety Fee Test

Company	Entry	Maturity date	Dryland Yield* Bu/A	Saturated soil Yield** Bu/A	Dry-Wet average Yield Bu/A
Seeds 2000	2051RR2Y	12-Sep	43.1	31.7	37.4
REA Hybrids	65G22	13-Sep	39.9	29.0	34.4
Legend Seed	LS03R2	12-Sep	37.5	44.6	41.0
REA Hybrids	66G22	13-Sep	34.6	42.3	38.4
Proseed	P2 20-90	18-Sep	37.3	39.0	38.1
Average		14-Sep	32.4	27.3	29.8
LSD(0.05)		5	11.7	10.7	11.2

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19 % yield loss due to excess water

Salts in ND

- Salts found in North Dakota soils are of three types: sulfates (SO_4); carbonates (CO_3); and chlorides (Cl).
- Most saline soils in North Dakota are composed of sulfate salts
- However, the northern Red River Valley has extensive areas of saline soils that have high amounts of chloride salts.

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"Saline" vs "Sodic" Soils

- Saline soils
  - The major ions and cations are Cl^-, SO_4^{2-}, NO_3^-, HCO_3^-, Na^+, Ca^{2+}, Mg^{2+}, and K^+
  - Salinity is the "total concentration of dissolved mineral solutes that are found in waters and soils" (NRCS)
  - pH<8.5, EC>4, ESP<15, SAR<12
- Sodic soils
  - Soils affected by the sodium ion (Na^+)
  - pH>8.5, EC<4, ESP>15, SAR>12
  - Sodicity is the "accumulation of sodium"
- How do they differ?

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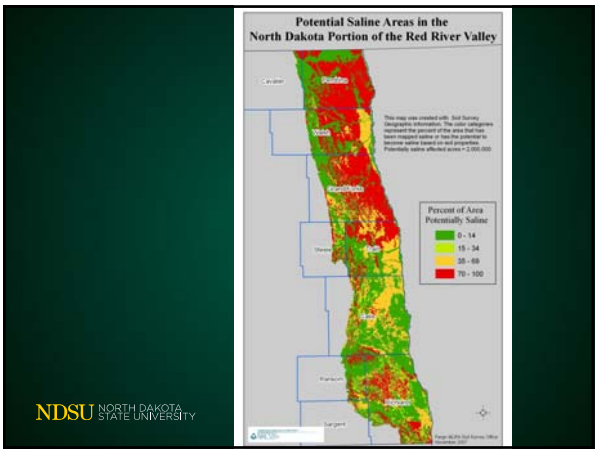

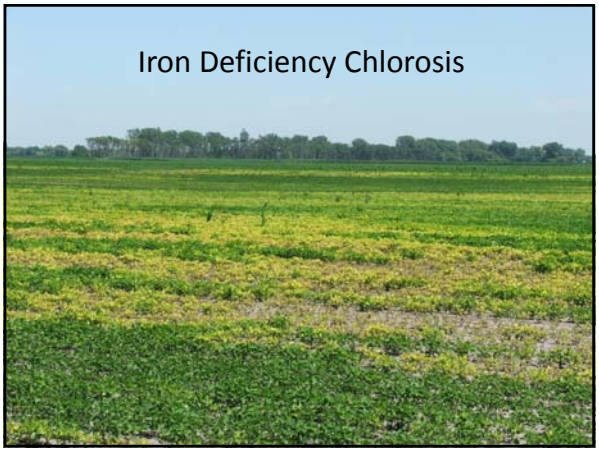

Factors "Known" to Increase Potential for Iron Deficiency Chlorosis

- Soluble Salts
- Excessive water
- Cool Temperatures
- Carbonates

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Management Options

1)Crop Selection (short-term)
2)Breeding (long-term)
3)Tillage and seed placement (short-term)
4)Sub-surface drainage

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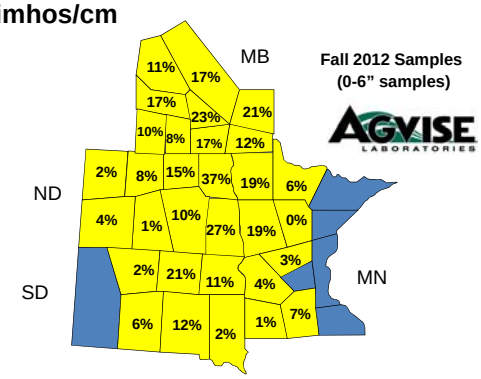
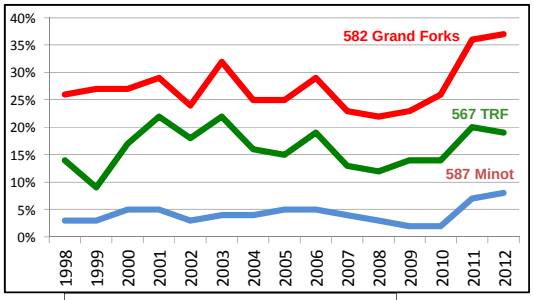
% Soil Samples with Salts greater than 1.0 **millimhos/cm**



North Dakota & NW Minnesota % Samples Testing with Salts greater than 1.0

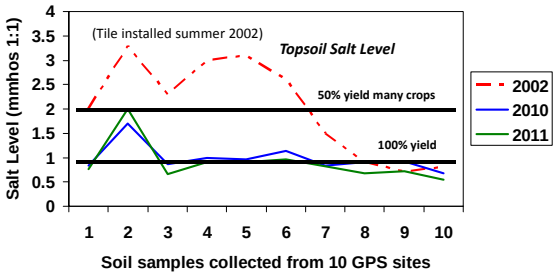


1:1 salt method – expressed as mmhos/cm

The Salt Problem may be Worse than this?

- Composite samples
  - Avoid areas that don't represent most of the field
    - Saline areas
    - Sandy ridges
- Many salty fields don't get tested
- Zone sampling
  - The salty zones often do not get tested or fertilized

Tile Drainage – Topsoil Soluble Salts Demonstration Project (2002, 2010, 2011)



Managing Saline Soils

- The only way to remove salts is to leach them out.
- Tile drainage permanently lowers the water table and provides an outlet for excess water.
- Time required to reduce salt levels depends on:
  - Soil characteristics
  - Amount of water removed through tile

Tile Drainage Results

- Topsoil salt levels have decreased a lot.
- Several crops now produce good yields
  - Corn, soybeans, sunflowers
- Subsoil salt levels take longer to be decreased
- High subsoil salt levels do not affect yield as much as high topsoil salt levels
  - Seedling salt sensitivity vs. general salt sensitivity

Grygla 2005

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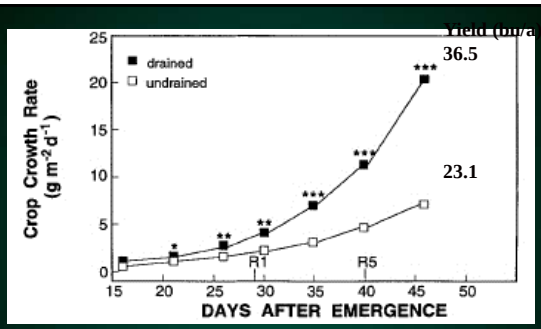

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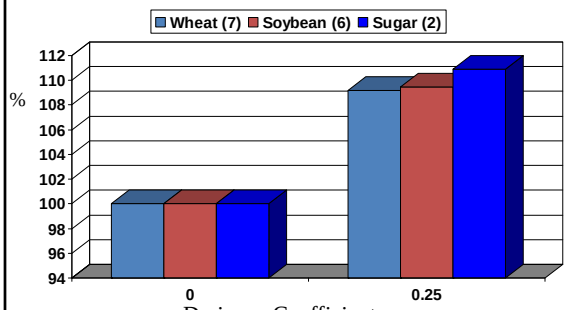
Linkemer et al., 1998

Average Wheat, Soybean, and Sugar Yield In % of non-tiled 2001-04



Location of research site

west

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Research Location NW 22

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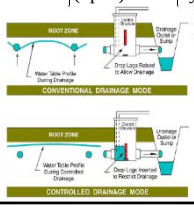
North	Controlled tile System (closed)	Controlled tile system (open)	Controlled tile system (closed)	Controlled tile system (open)
	Controlled tile system (open)	Controlled tile system (closed)	Controlled tile system (open)	Controlled tile system (closed)



Tile Drainage Reseach Site NW 22

- Plant Date: June 7, 2011
- June 27, 2011 Previous one week rainfall recorded: 2.54 inch

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SEE THE DIFFERENCE

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- Canopy Closure (%) August 8

Grouping	Mean	
A	80 %	Drained
B	62 %	Not Drained

- Plant Height (Inch) near PM September 16

Grouping	Mean	
A	29 inch	Drained
B	25 inch	Not Drained

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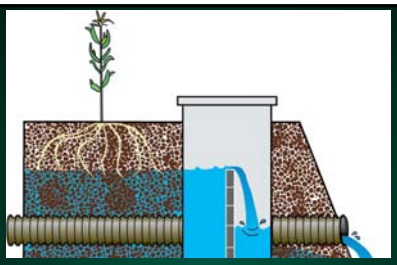

This illustration shows how using a water control structure in a pipe regulates water flow. Here, the outlet has been raised to store water for crop in midsummer. Illustration: Purdue University Extension

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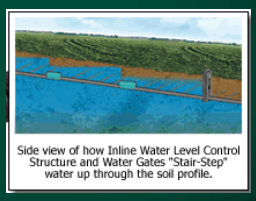
Control Structure



Side view of how Inline Water Level Control Structure and Water Gates "Stair-Step" water up through the soil profile.

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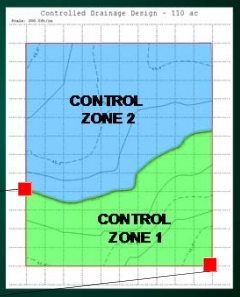
Source
http://www.agridrain.com/valveproduct.asp?prodtype=916

Designing by "Zones"



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Subsurface irrigation

Five-State CIG Results Managed v. Conventional Drainage 2007-2009

State	Drainage Outflow Reduction (%)	Nitrate Load Reduction (%)	Crop Yield Increase (%)
Ohio	60.9	53.4	4.9
Indiana	7.0	0.1	1.4
Illinois	58.3	68.0	1.3
Iowa	39.4	38.8	0.3
Minnesota	22.3	36.1	-0.5
All	34.9	34.4	1.3

USDA NRCS

ADMC Agricultural Drainage Management Coalition

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Soybean Yield Selected Varieties on Tile vs. No Tile at NW 22 2010