Remediation of Feedlot Nutrients Runoff by Plants

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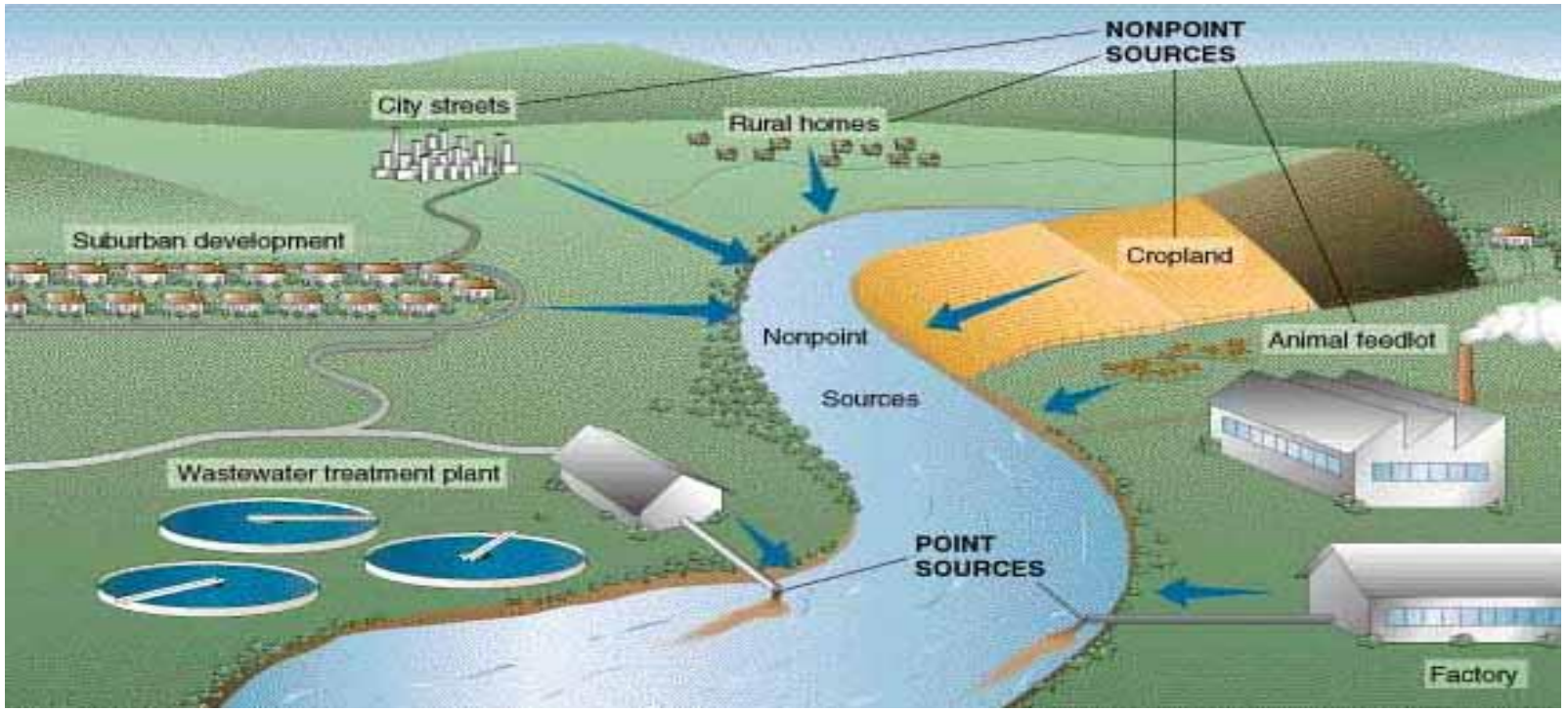
Introduction

- Animal feeding operations (AFOs) generate significant amount of manure and wastewater
- Manure and wastewater contain high concentration of nutrients and organic matters (Crane et al., 1983)
- Improper manure management may cause surface and ground water contamination

Water Pollution

- **Point Source (PS) Pollution:** Pollution originating at single and identifiable sources
- **Non-Point Source (NPS) Pollution:** Pollution originating from dispersed sources

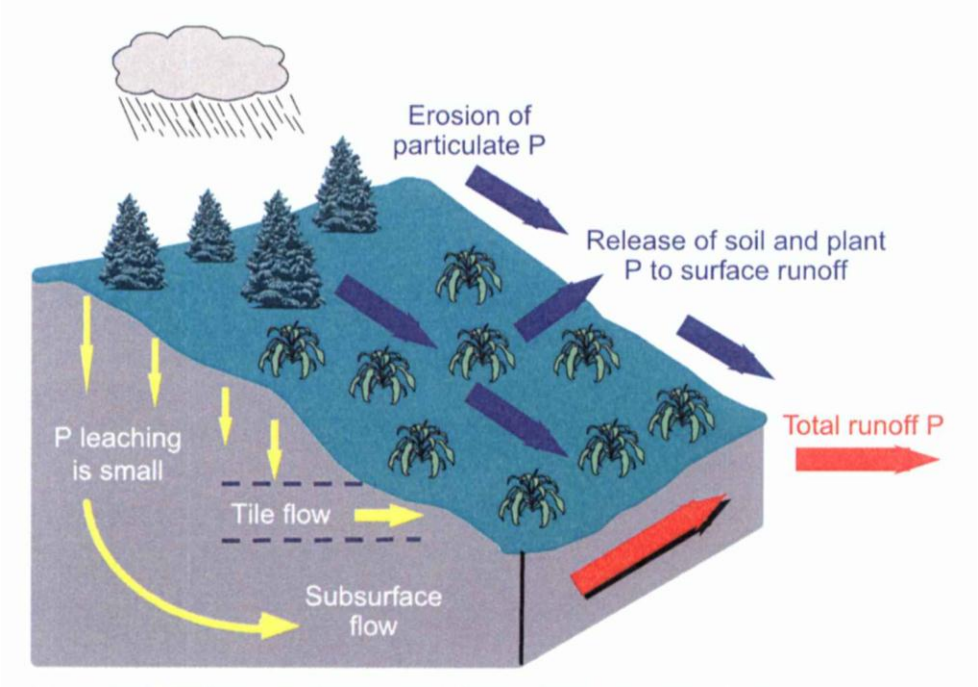


(Source: http://www.cord.edu/faculty/landa/courses/e103w00/sessions/water/sources.jpg

Water Pollution

Discharge of nutrients in to surface water may cause eutrophication and hypoxia of lagoon and estuaries (Dale et al., 2007).

Pathways for P from soils



Source: NRCS

What Can We Do ?

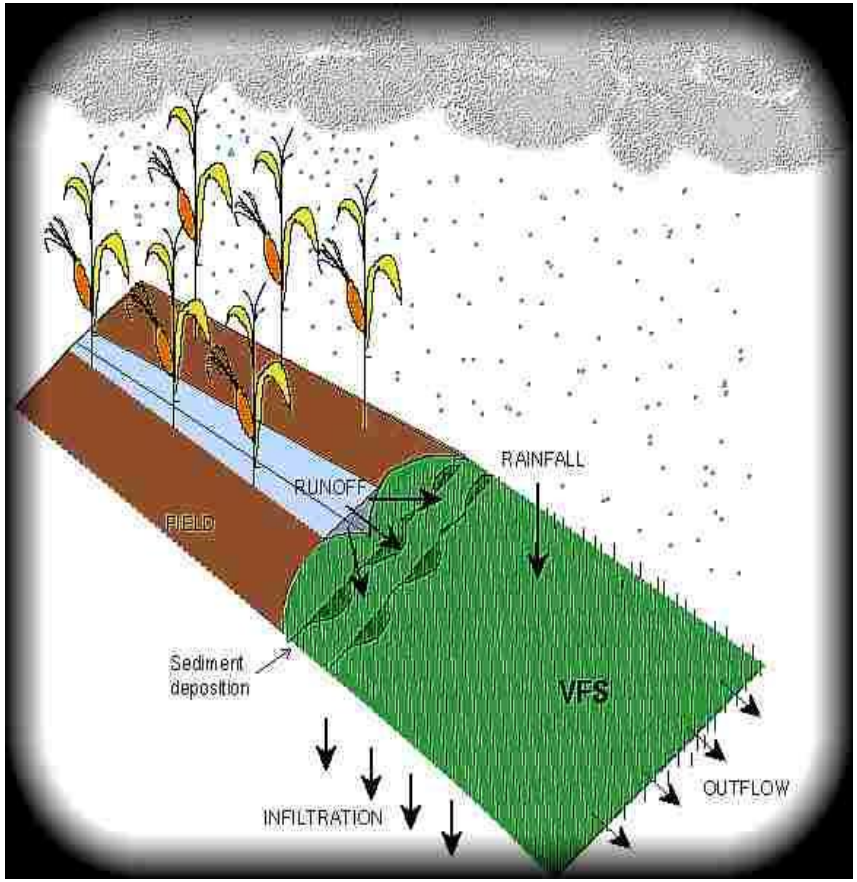
To reduce and prevent non point source pollution

Best Management Practices (BMPs)

BMPs for Nutrient Reduction

- Physical treatment : Sedimentation, screening, aeration, filtration, floating and skimming, degasification etc. eg. vegetative filter strips
- Chemical treatment : Chlorination, ozonation, neutralization, coagulation, adsorption, ion exchange etc.
- Biological treatment : A. Aerobic: lagoons, trickling
  B. Anaerobic: septic tank
  C. Algae and Plants

Vegetative Filter/Buffer Strip



- Reduce surface runoff
- Increase infiltration of runoff and nutrients
- Promote sediment deposition and filtering
- Provide nutrient uptake by plants

VFSs are not effective for all types of pollutants such as soluble nutrients

Remediation of feedlot nutrients runoff using plants in hydroponics condition

- It is a biological treatment of wastewater

- Plants uptake macro and micronutrients from the feedlot wastewater and purified it

Rational of Hydroponics Treatment of Feedlot Wastewater

- Less or no energy consumption
- Cost effective
- Nutrient can recover
- Avoiding use of chemicals
- Environment friendly
- Plants can be used for different purposes

Objectives of the experiment

1. To determine the feasibility of growing water hyacinth, water lettuce, and sorghum in feedlot runoff wastewater

2. To determine nutrient uptake capacities of those plants from feedlot runoff wastewater

Challenges

Plant selection is a vital factor (Qin., 2009)

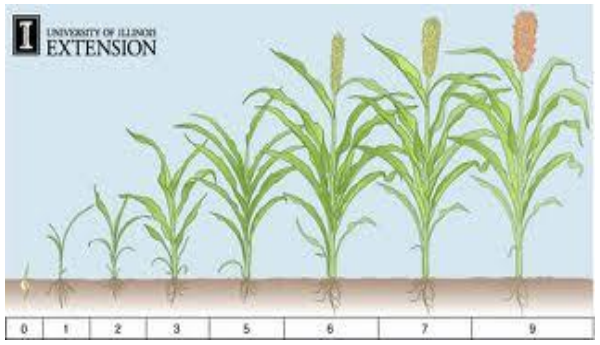
- Salt tolerance and easily adaptable in feedlot runoff wastewater

Plants Used

- Water hyacinth

- Water lettuce

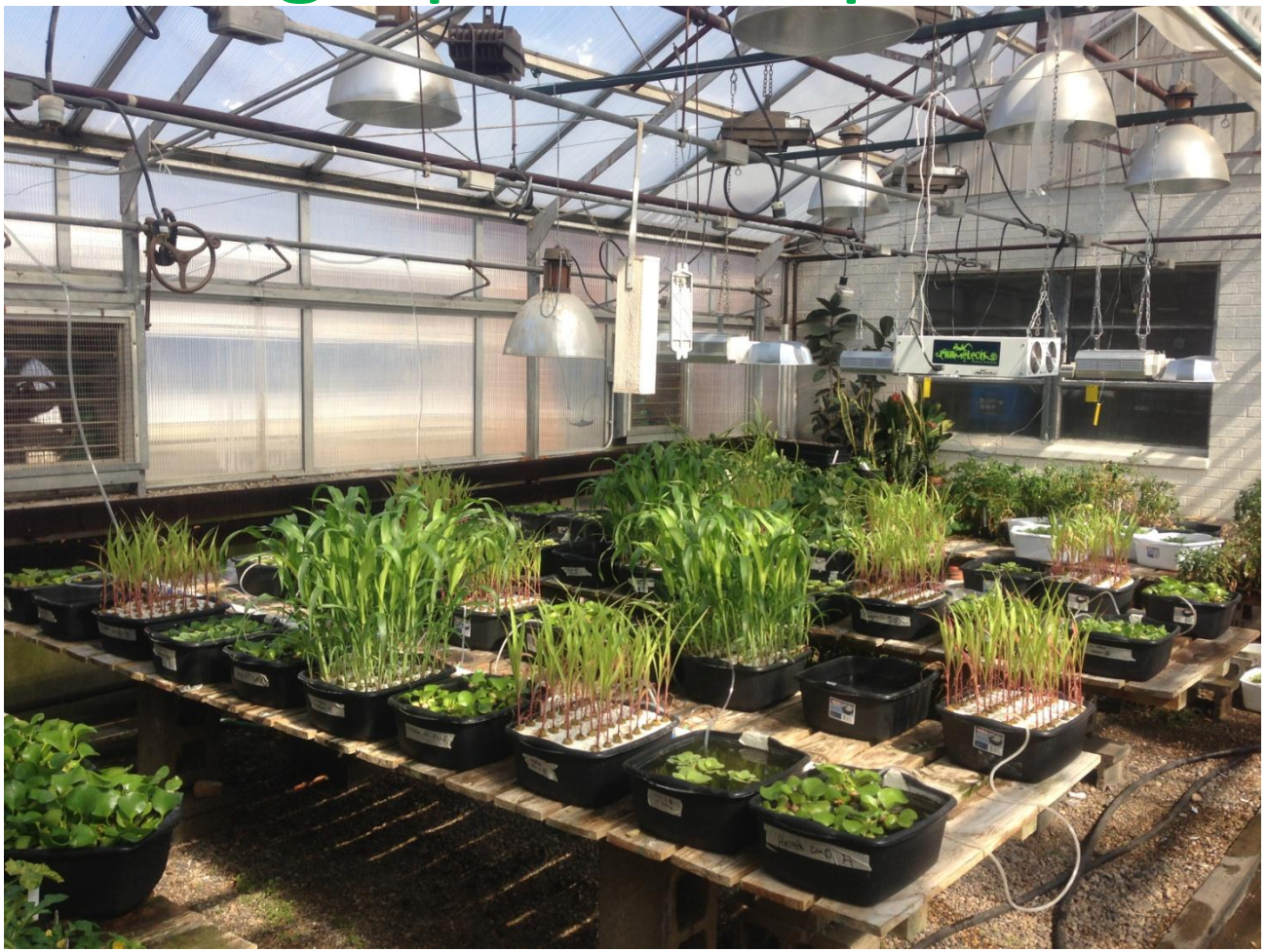
- Sorghum



Experimental Design

- This experiment was conducted in batches.
- A completely randomize design with three replicates were conducted in a greenhouse.
- Water hyacinth, water lettuce and sorghum were hydroponically planted in plastic bucket.
  - Runoff water (without dilution, 1:1 dilution, 1:2 dilution with Reverse Osmosis water)
  - Hoagland fertilizer solution

Photographs of experiment



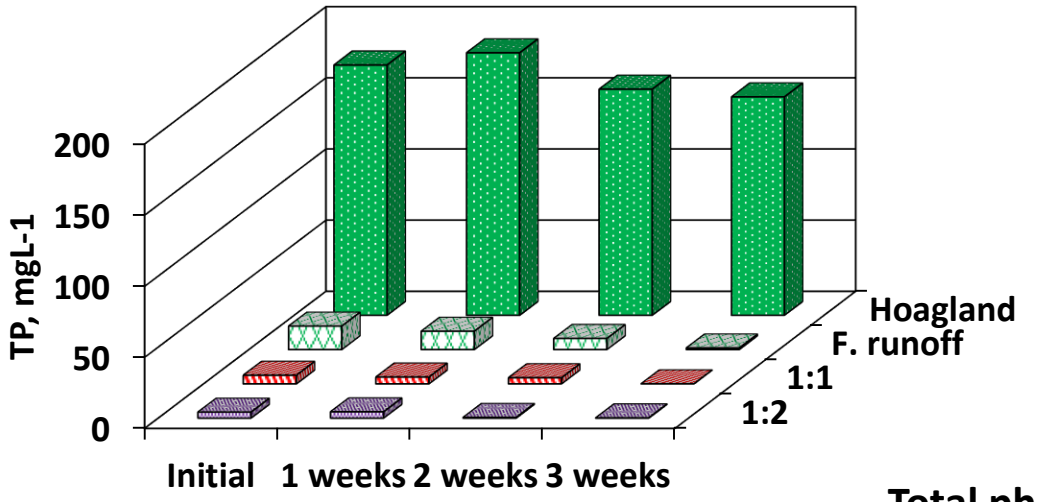
Photographs of experiment

Sampling and Measurement

- Plant samples were collected at the beginning and at the end of experiment for nutrients analysis
- Water samples were collected at the beginning, weekly, and at the end for nutrients analysis
- Samples were analyzed for:
  - pH, conductivity, TP, TKN, NH_4-N, NO_2-N+NO_3-N, K, etc.

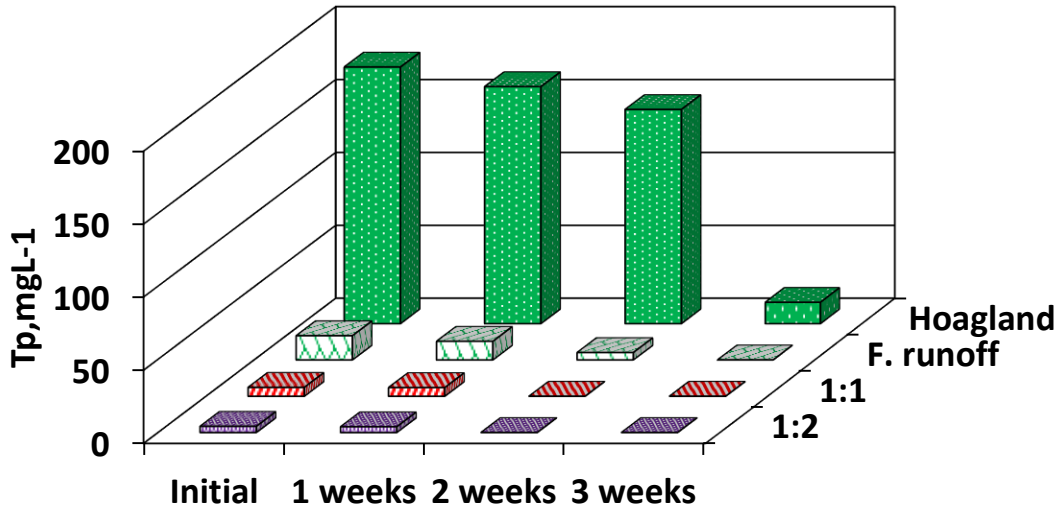
Results

Total phophorus in w. hyacinth

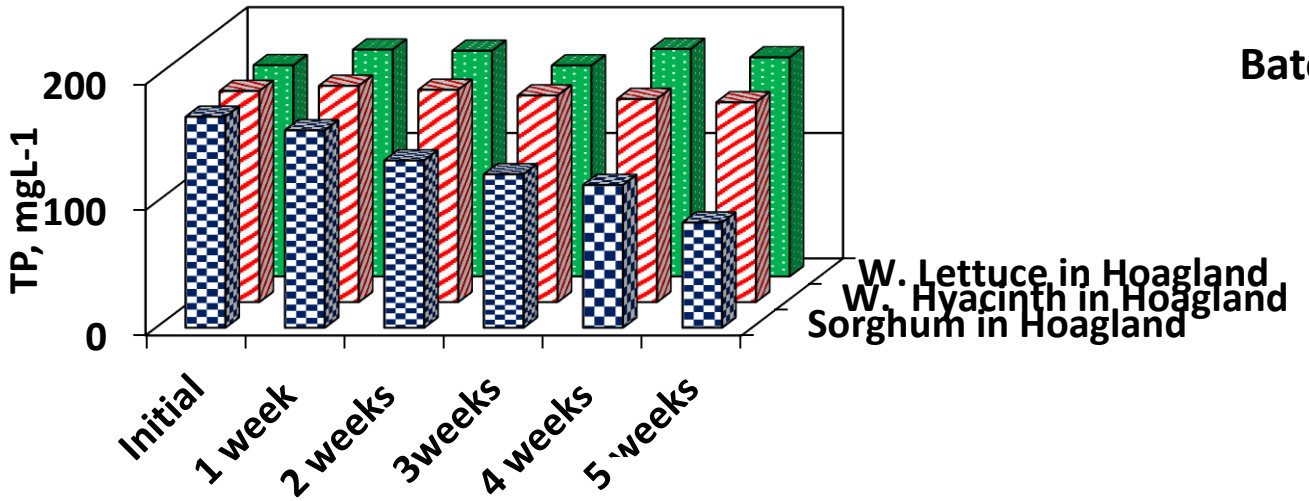


Batch #1

Total phosphorus in sorghum

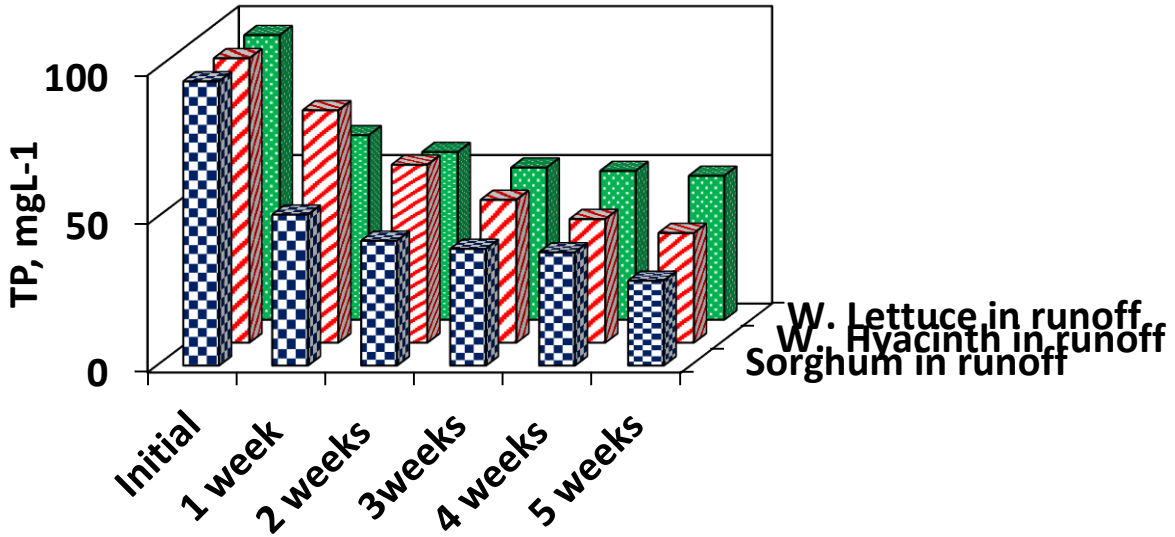


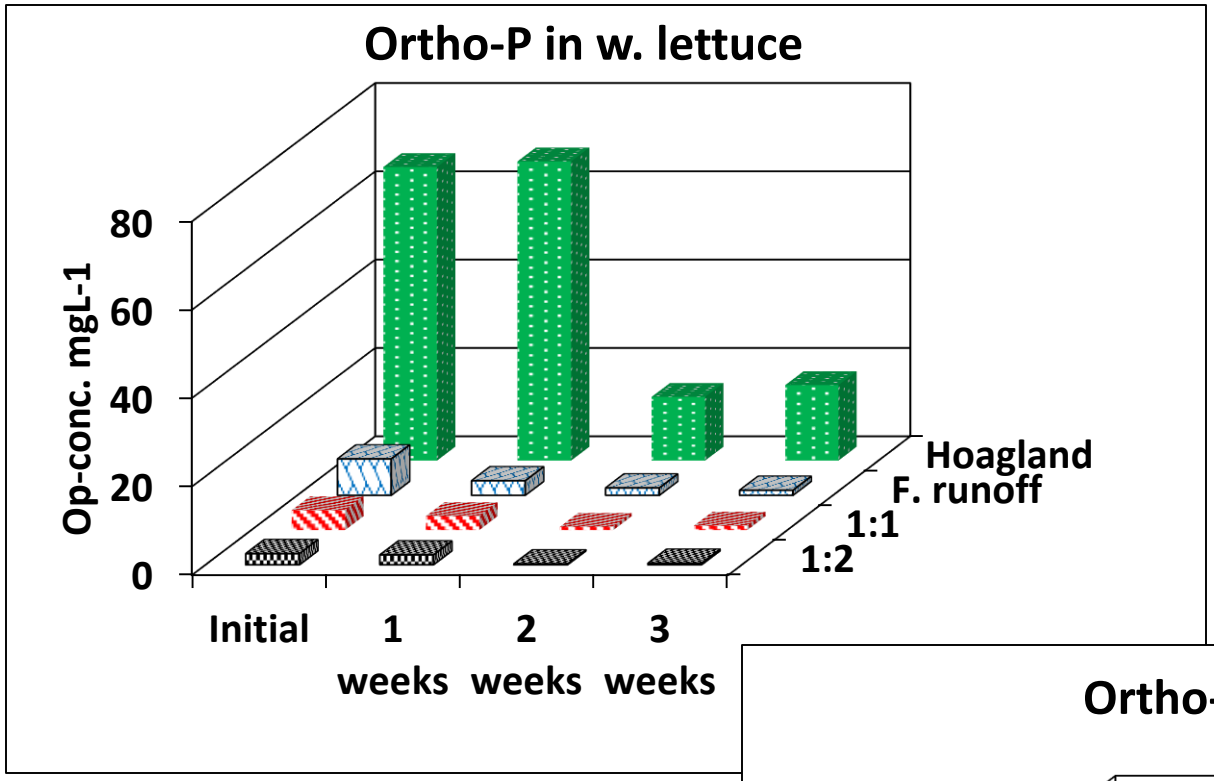
Total phosphorus in Hoagland solution



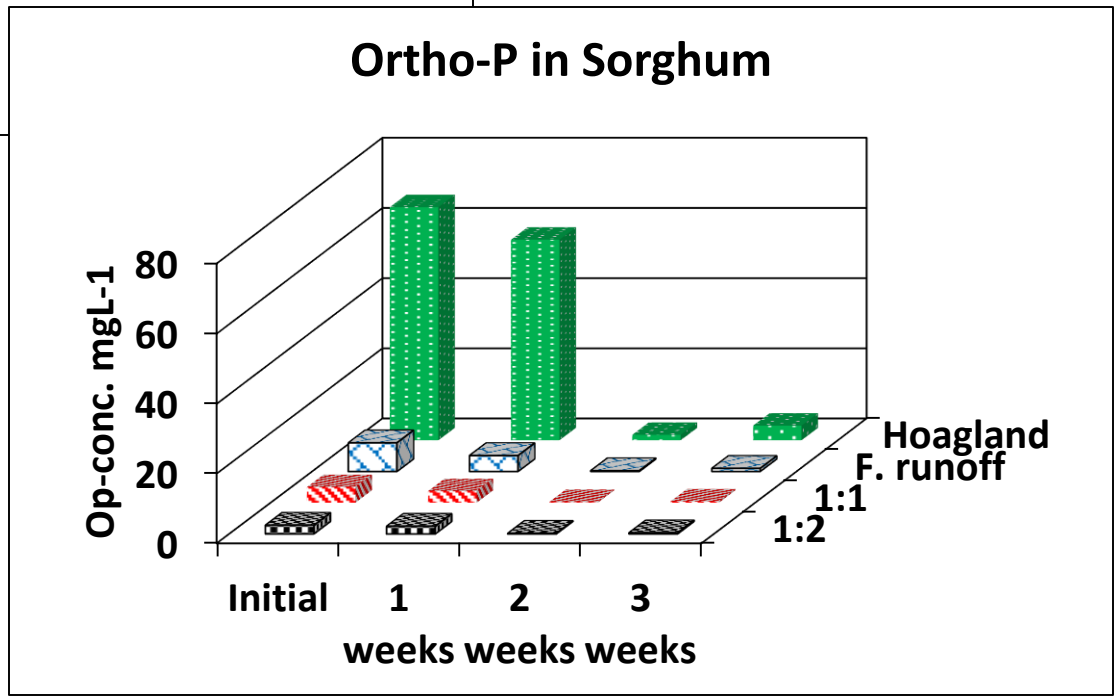
Batch #2

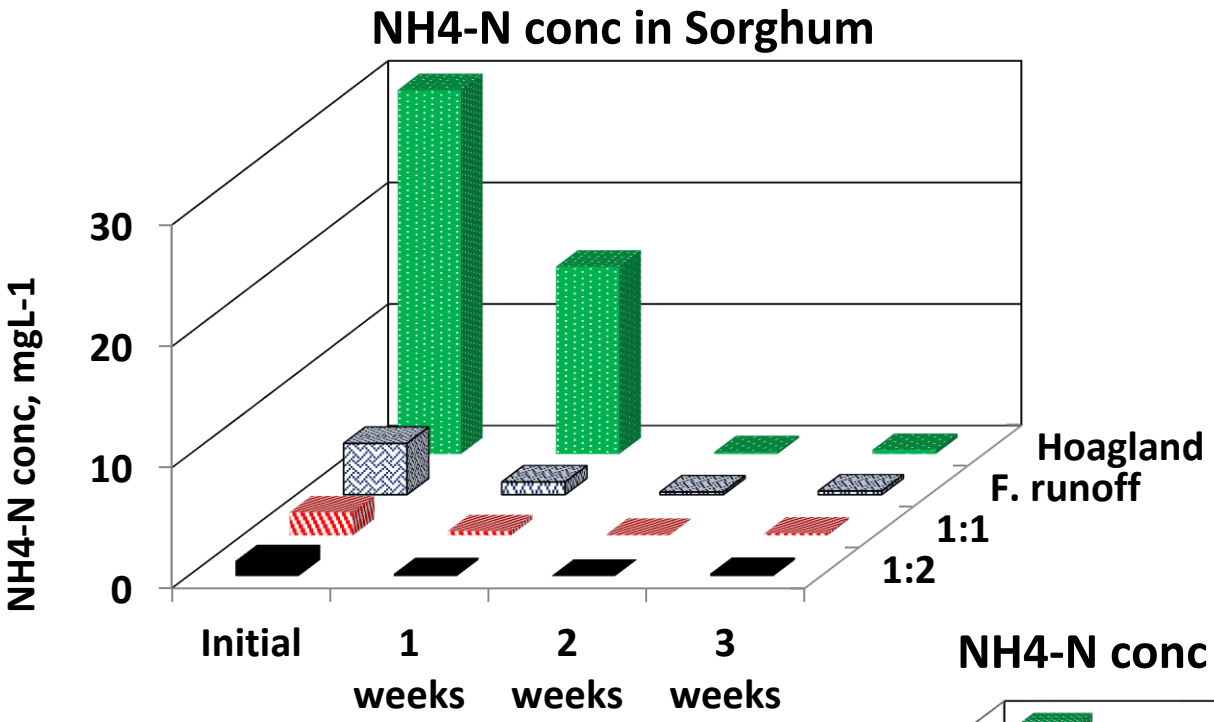
Total phosphorus in runoff



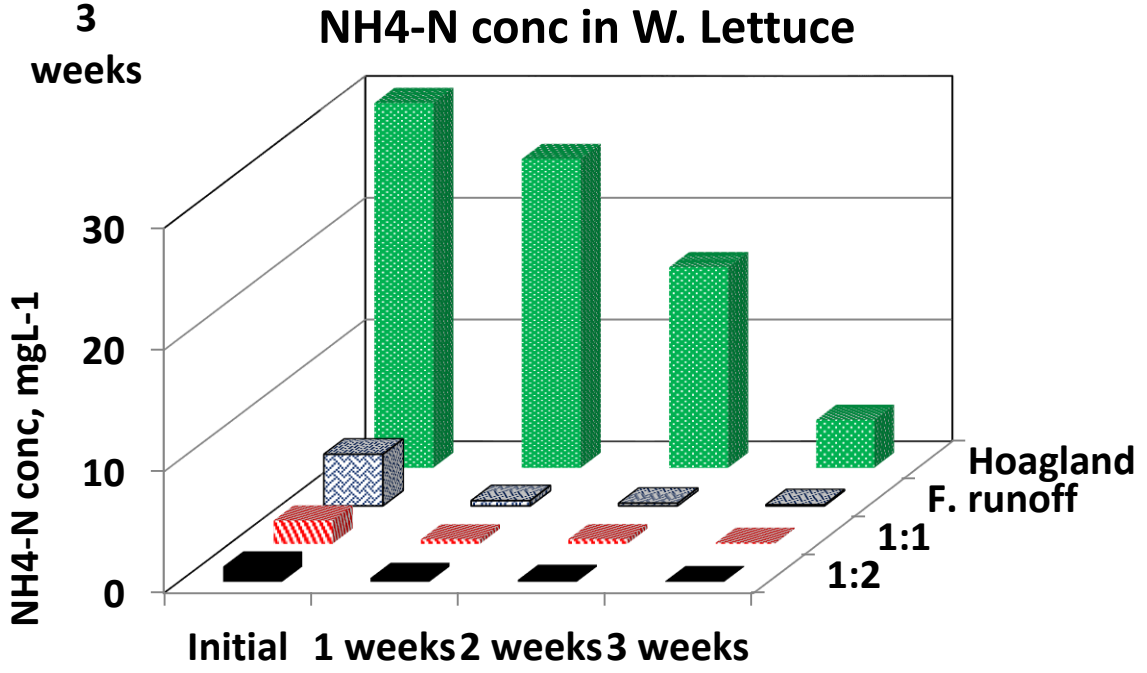

Ortho-P in w. lettuce
Op-conc. mgL-1
0
20
40
60
80
Initial
1 weeks
2 weeks
3 weeks
Hoagland
F. runoff
1:1
1:2

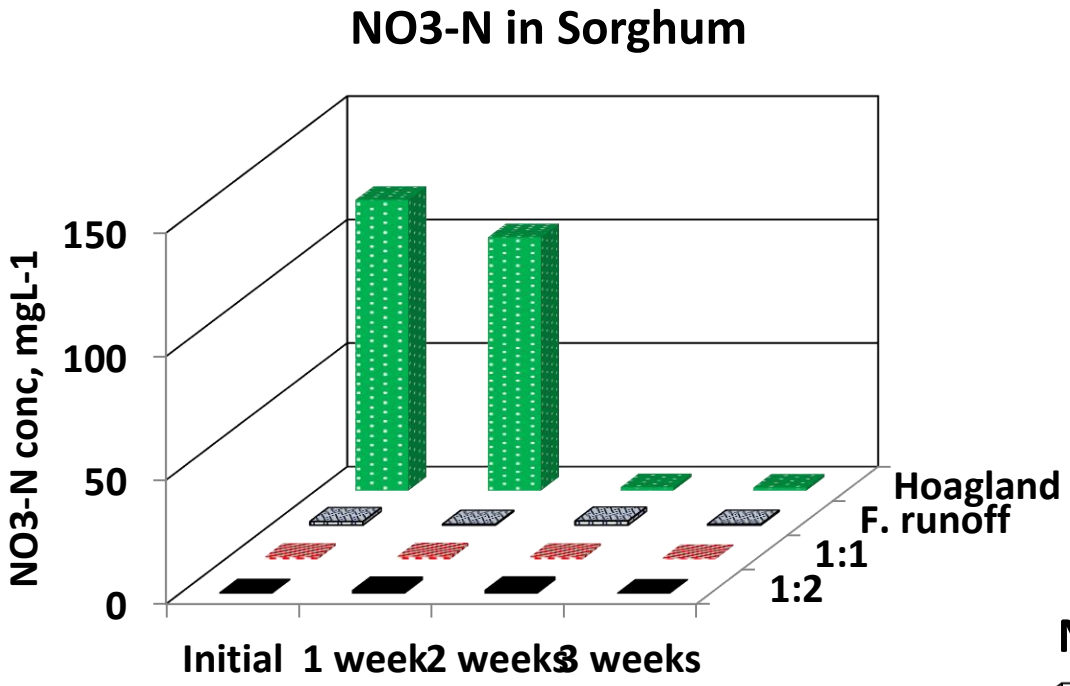
Batch #1


Ortho-P in Sorghum
Op-conc. mgL-1
0
20
40
60
80
Initial
1 weeks
2 weeks
3 weeks
Hoagland
F. runoff
1:1
1:2

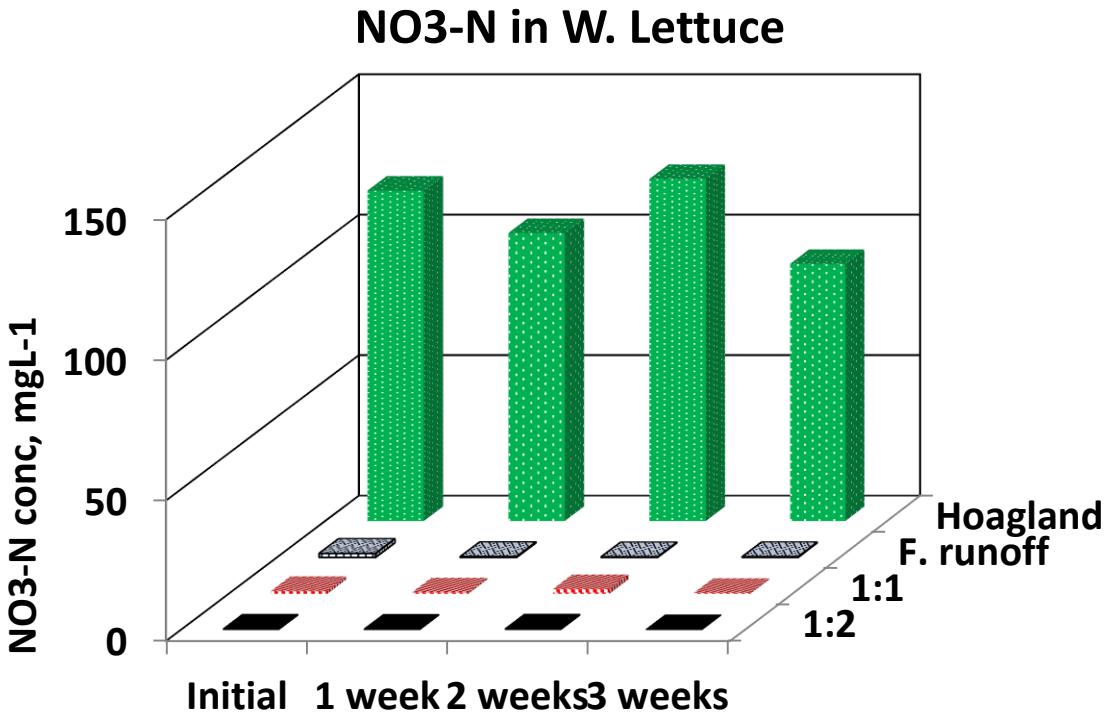

NH4-N conc in Sorghum
NH4-N conc, mgL-1
30
20
10
0
Initial
1 weeks
2 weeks
3 weeks
Hoagland
F. runoff
1:1
1:2

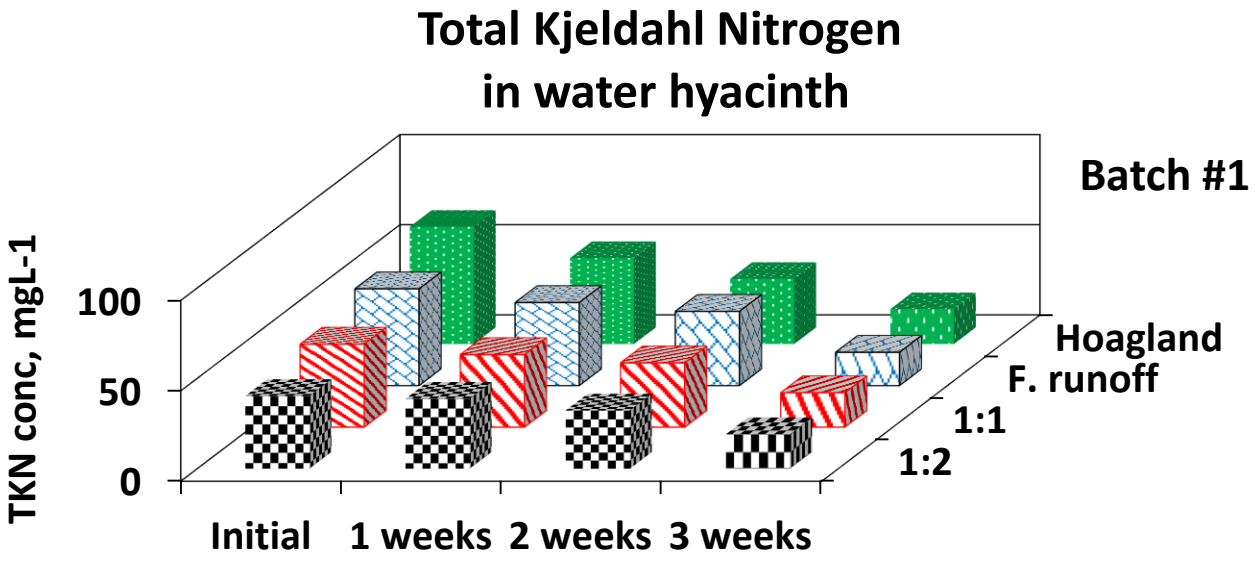
Batch #1

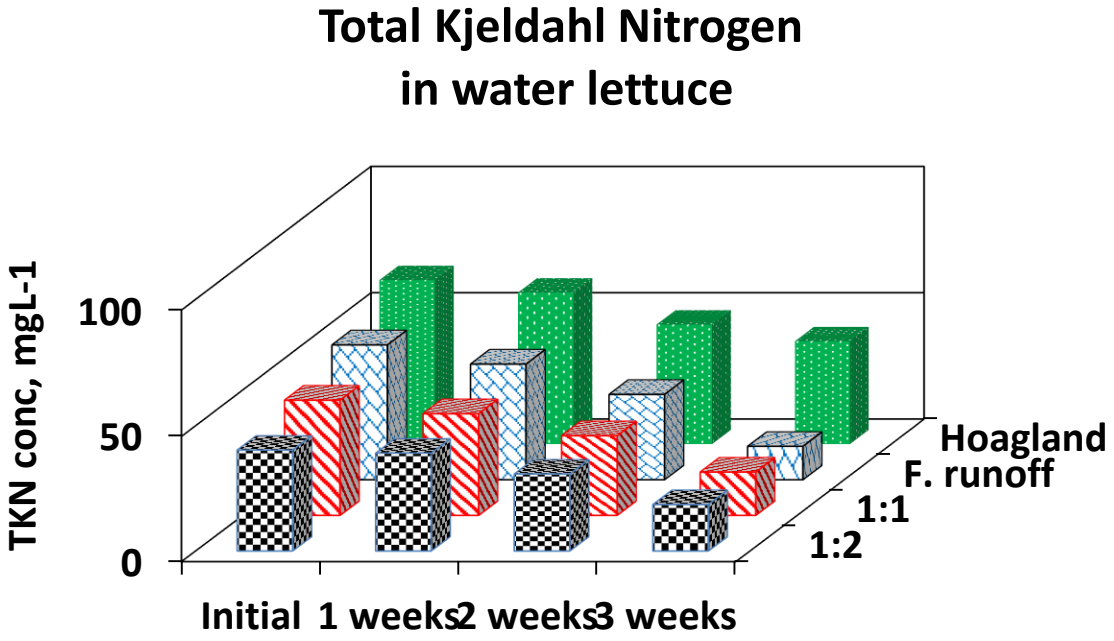

NH4-N conc in W. Lettuce
NH4-N conc, mgL-1
30
20
10
0
Initial
1 weeks
2 weeks
3 weeks
Hoagland
F. runoff
1:1
1:2


NO3-N in Sorghum
NO3-N conc, mgL-1
150
100
50
0
Initial
1 week
2 weeks
3 weeks
Hoagland
F. runoff
1:1
1:2

Batch #1

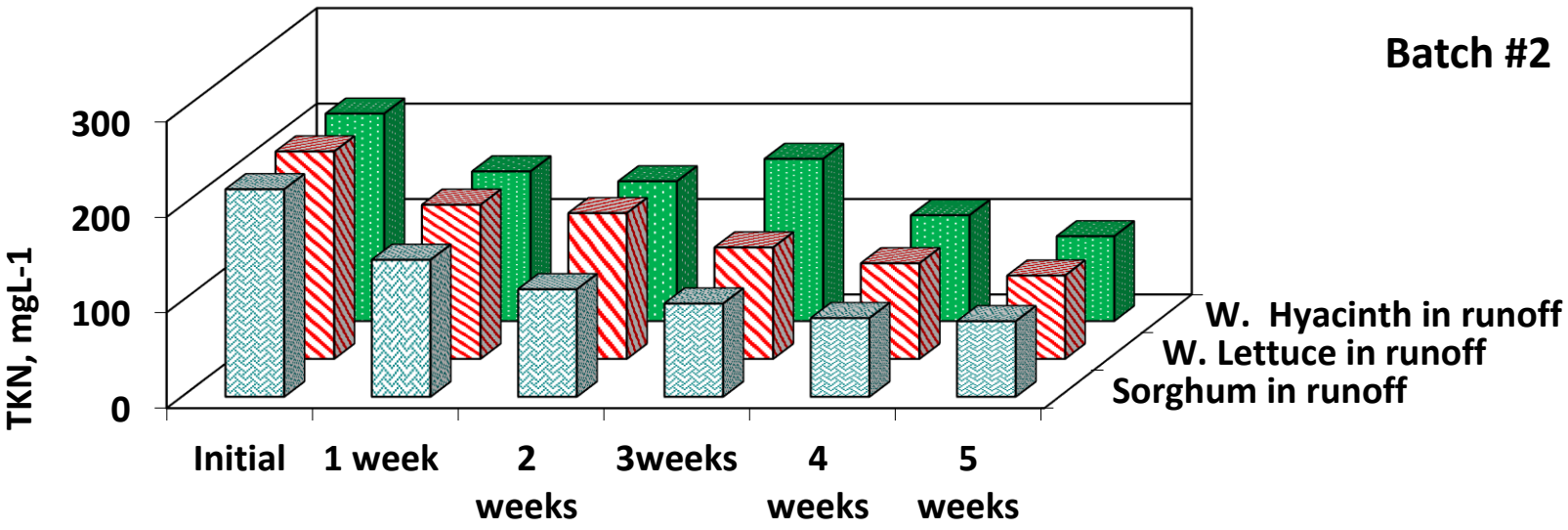

NO3-N in W. Lettuce
NO3-N conc, mgL-1
150
100
50
0
Initial
1 week
2 weeks
3 weeks
Hoagland
F. runoff
1:1
1:2


Total Kjeldahl Nitrogen
in water hyacinth
Batch #1
TKN conc, mgL-1
100
50
0
Hoagland
F. runoff
1:1
1:2
Initial
1 weeks
2 weeks
3 weeks

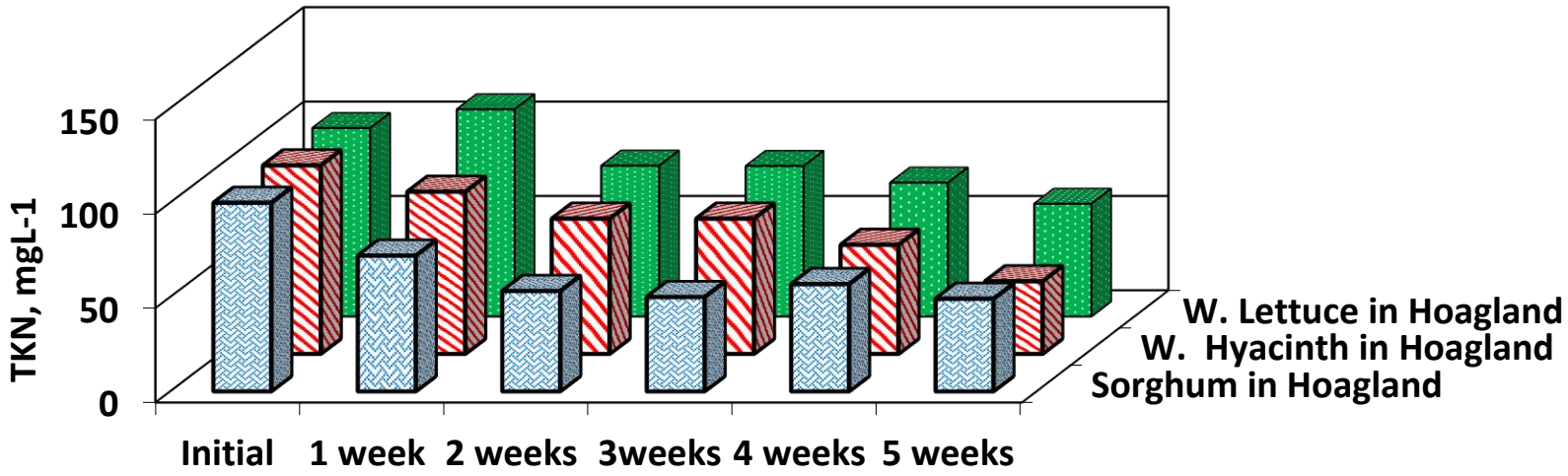

Total Kjeldahl Nitrogen
in water lettuce
TKN conc, mgL-1
100
50
0
Hoagland
F. runoff
1:1
1:2
Initial
1 weeks
2 weeks
3 weeks

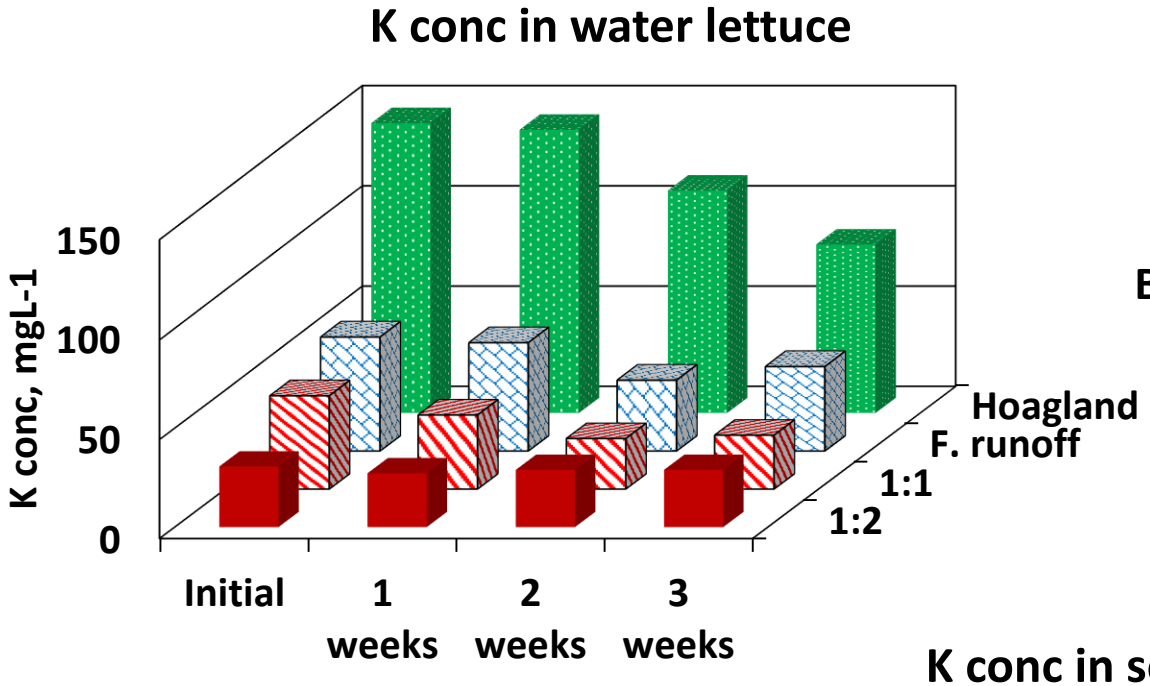
TKN in feedlot runoff

Batch #2

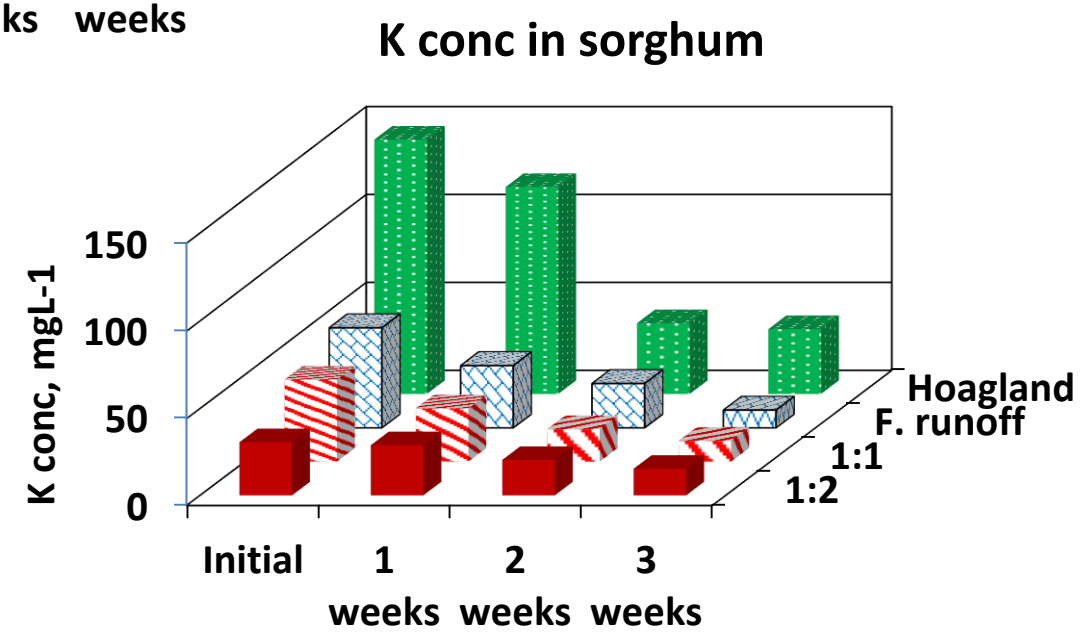


TKN in Hoagland solution

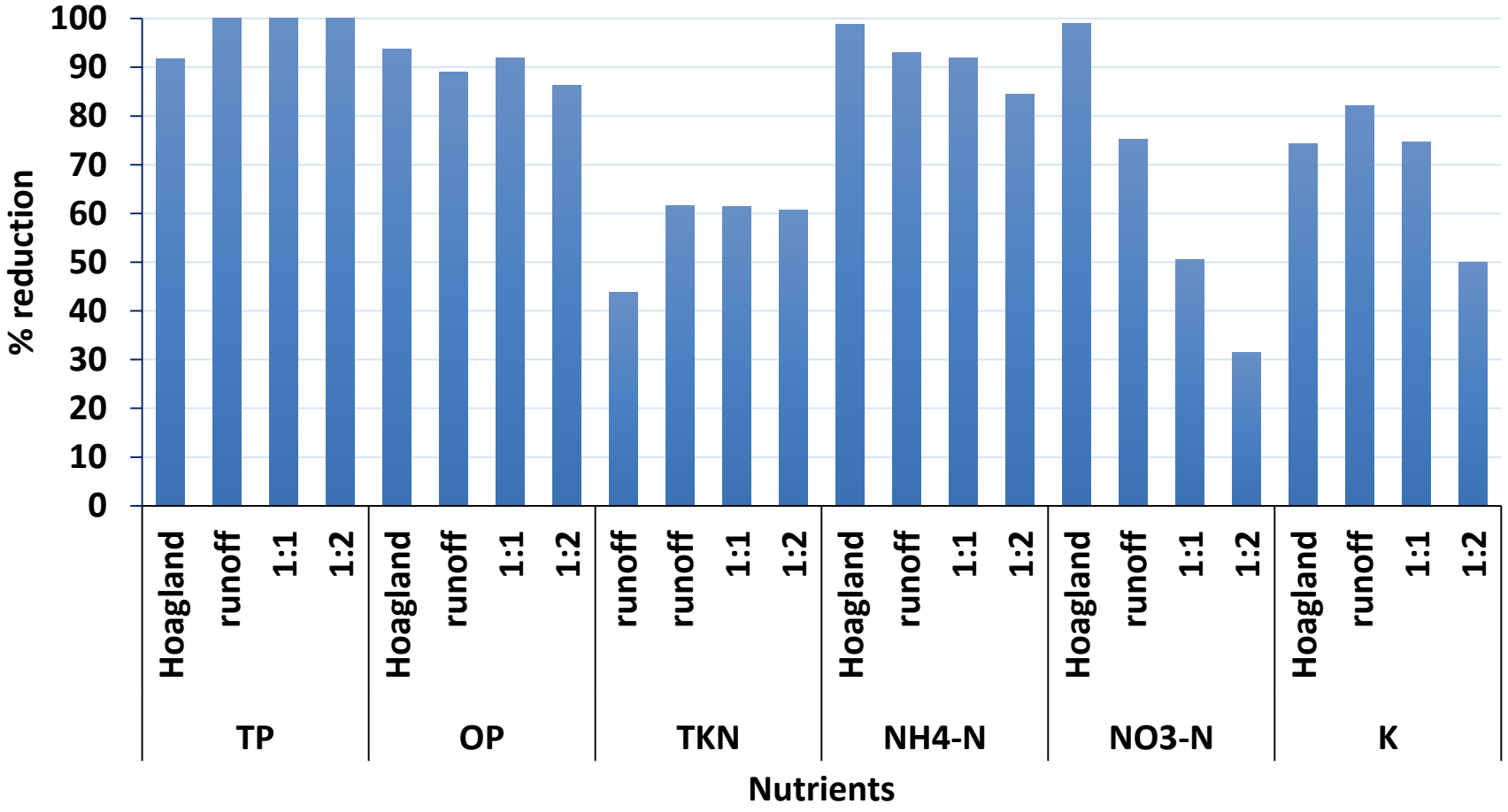



K conc in water lettuce
K conc, mgL-1
150
100
50
0
Initial
1 weeks
2 weeks
3 weeks
Hoagland
F. runoff
1:1
1:2

Batch #1


K conc in sorghum
K conc, mgL-1
150
100
50
0
Initial
1 weeks
2 weeks
3 weeks
Hoagland
F. runoff
1:1
1:2

% nutrient reduction by Sorghum



Conclusion

- Plants grew well in all solutions
- Dilution of feedlot runoff have little effect in nutrient reduction
- In terms of plant biomass growth and nutrients reduction, sorghum outperformed other plants

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Conclusions

- TP, NO_3-N and K concentrations reduction by sorghum were higher than other plants in both experiments
- Except TKN and NO_3-N, % reduction was >80%, especially for TP, OP and NH_4-N
- Any of these plants may be used to reduce nutrients from feedlot runoff or from runoff storage ponds

Thank You!

Questions?