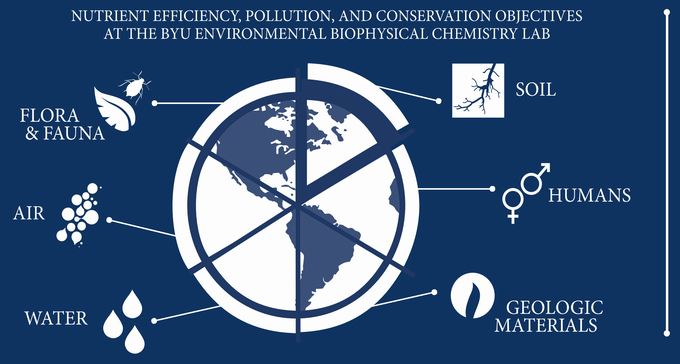

VARIABLE RATE IRRIGATION AND CROP WATER PRODUCTIVITY

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GLOBAL OBJECTIVES

CONSERVE WATER RESOURCES

SUSTAINABLE AGROECONOMICS

MAINTAIN CROP YIELDS WITH REDUCED WATER APPLICATION

MAP SOIL VARIATION IN AGRONOMIC FIELDS

INTRODUCTION

Common irrigation management practices apply a uniform rate regardless of field topography and/or natural soil variability often resulting in excess or under application in some areas of the field. Variable rate irrigation (VRI) is a precision irrigation technology that allows application of precise irrigation throughout the field based on soil texture, topography, crop growth potential, or other factors. Crop water productivity (CWP) is a common measurement of water management, but has not been used under a variable rate irrigation system.

Objectives

- Quantify crop water productivity in respected VRI zones
- Map spatial field variation of crop water productivity

METHODS

- Study location Grace ID, USA (42.607634, -111.788568)
- Growsmart ® Lindsey Precision VRI (Omaha, NE, USA) used with four irrigation rates: 1) 100% 2) 95% 3) 90% 4) 0%
- Eighty 122 cm depth cores sampled at spring green-up (May) and harvest (Aug) in 30 cm depth increments as soil conditions allowed (shallow bedrock sometimes inhibited sampling).
- Bulk density and volumetric soil moisture was calculated at each sample site for both sampling periods.
- Crop water productivity (CWP) was calculated as:

$$CWP = Y / ET$$

$$ET = P + I + \Delta S - RO - D$$

  - ET is total water use during the growing period
  - P precipitation, I irrigation, ΔS change in soil water content from spring to harvest. RO (runoff) and D (drainage) considered negligible
  - Delta S calculated for each 30.48 cm depth and summed for sample site total ΔS.
- Yield was collected with a New Holland IntelliView 4 yield monitor (CNH Industrial, Turin, Italy).
- Interpolation done with Kriging based on semivariogram computed in ArcMap (ESRI 2011. ArcGIS desktop: Release 10. Redlands, CA: Environmental Systems Research Institute).

Figure 2. *Aerial view of the wheat field after harvest (Aug2016). Variable rate pivot is used to water both wheat and permanent turf-grass. Topography of wheat field is a ridge on NW center of field, and "rock piles" at N edge of field where no irrigation is applied.*

RESULTS

Grain Yield

- The average grain yield for the field was 7880 kg ha^{-1}
- Spatial variation appears to be largely dominated by slope and soil characteristics

Crop Water Productivity

- The field average was 16.8 kg ha^{-1} mm^{-1} but ranged from 4.6-25.6 kg ha^{-1} mm^{-1} across field
- VRI CWP averages: 90, 17.9 kg ha^{-1} mm^{-1}; 95% 15.7 kg ha^{-1} mm^{-1}; 100%, same as field average
- CWP may be lower than predicted estimates as samples were taken at spring green-up and not all samples were taken to the bottom of the rooting zone (122 cm)

Variable Rate Irrigation

- Irrigation at the 100% rate was 20.1 cm and the 90% rate 18.1 cm, only decreasing the total ET by an average 4% for the 90% rate

Delta (Δ)S

- Delta S variation appears to follow field edges and low areas of field.
- Variation in ΔS may be due to bulk density variation throughout field

Evapotranspiration

- Spatial variation of evapotranspiration largely determined by ΔS spatial variation
- Average ET rates per VRI zone: 90%, 441 mm; 95%, 463 mm; 100%, 473 mm

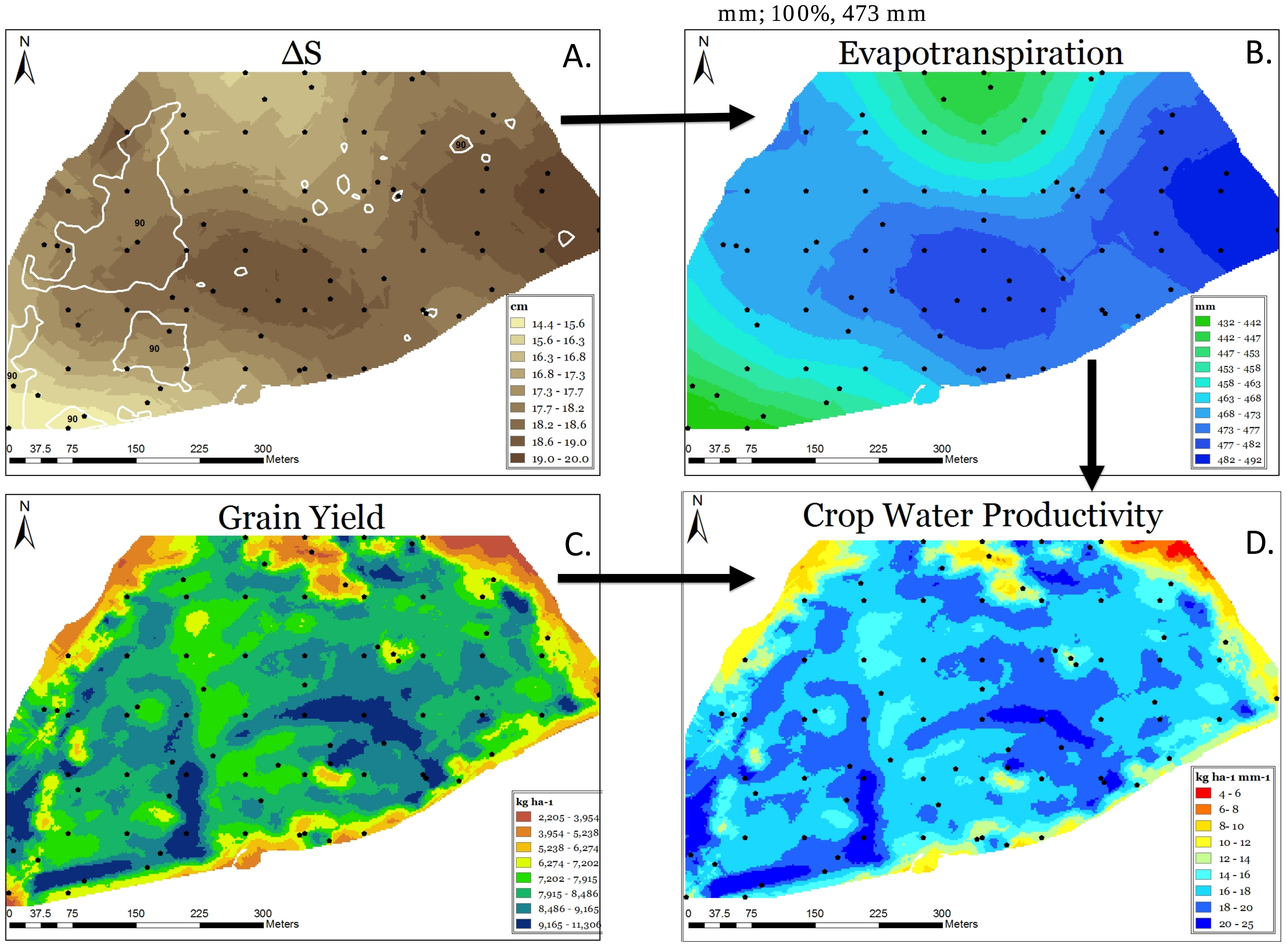

Figure 2: *Interpolated maps of field variation of A) difference in volumetric soil moisture between spring and harvest with 90% VRI zone outlined in white B) seasonal evapotranspiration C) grain yield D) crop water productivity. Arrows show process of calculating evapotranspiration an crop water productivity.*

CONCLUSIONS

The crop productivity ceiling of wheat is believed to be 20 kg ha^{-1} mm^{-1} under well managed systems. While this is may be true for field averages, potential for crop productivity may be greater than commonly believed as suggested by the data herein. Crop water productivity is largely determined by yield, while varying water does not influence CWP as great as anticipated. Seasonal ET variation is largely determined in irrigation fields by variation in soil water content. Spatial mapping of the crop water productivity may be a valuable asset in identifying potential management areas of agronomic fields; but more research is required to validate this hypothesis.

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