Quantification of Temporal Variability in Soil Hydraulic Properties in an Agricultural Plot

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1. Introduction

- SHPs ($\theta(h)$, $K(h)$) govern the retention and transport of water and nutrients in the soil and exhibit high spatio-temporal variability (Chandrasekhar et al., 2019).
- Most hydrological models neglect temporal variability of SHPs which is particularly not suitable for agricultural land (Geris et al., 2021).
- SHPs vary during the cropping season and from year to year depending on weather or climatic conditions (Geris et al., 2021).
- Natural and human induced factors lead to variability in SHPs..
- This study aims to quantify the temporal variations and trends in SHPs of an experimental agricultural plot in IIT Kanpur during rice and wheat crop seasons.

2 Study Area

- The study was carried out in an experimental agricultural plot having silt loam soil (20 m × 30 m) at IIT Kanpur (26.5168 N, 80.2314 E; 126 m AMSL) between 13th Aug'22 to 19th April 2023.
- The mean annual precipitation and temperature are 801.5 mm, and 32.2 °C respectively.
- The study area was divided in 24 subplots (11 m^2).

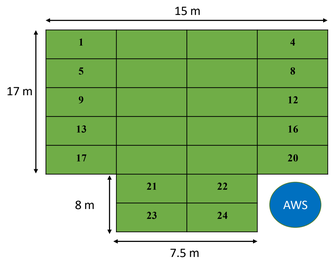

Figure 1: Index map of the experimental agricultural plot area at IIT KanpurHere. Here, AWS refers to the automatic weather station.

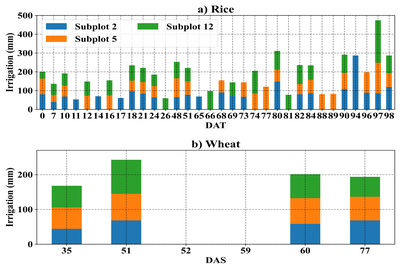

Figure 2: Amount of Irrigation applied at different subplots during rice and wheat crop.

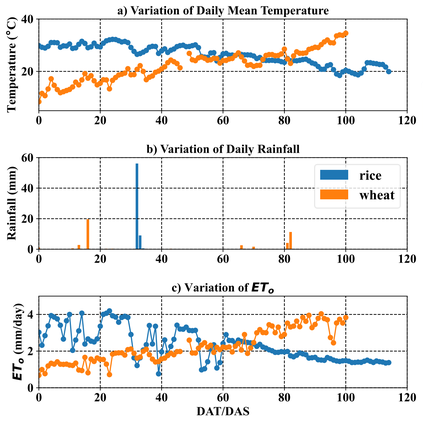

Figure 3: Plot of daily rainfall, daily mean Temperature and reference evapotranspiration (ET_o) under rice and wheat crop cover.

Table 1: Soil texture at different depths

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	D_{10} (mm)	D_{30} (mm)	D_{60} (mm)
10	14.54	78.49	6.97	0.003	0.010	0.032
20	13.87	78.74	7.39	0.003	0.009	0.029
30	12.18	81.11	6.71	0.003	0.011	0.034

Table 2: Details of the respective rice and wheat crops used in this study.

Crop	Rice	Wheat
Seed Name	PHB 71	K 7903 (HALNA)
Feature	Drought/Stress Tolerant	Irrigated
Growth duration	115- 120 days	100-110 days
Plant height	110-130 cm	70-80 cm
Yield potential	6500-7000 kg/hec	4000-4500 kg/hec
Date of Transplantation/Plantation	13-Aug-22	09-Jan-23
Harvesting Date	05-Dec-22	19-Apr-23

3. Methodology

- Total 180 undisturbed soil samples were collected from 3 subplots (Subplots 2,5 and 12) at depths of 10 cm, 25 cm, and 50 cm during rice and wheat seasons at regular interval during 2022-23.
- K_{sat} was measured by conducting falling head permeability test by KSAT (METER Group, Inc., Pullman, WA, USA).
- θ and h for SWRC was obtained using WP4C Dew Point Potential Meter (METER Group). From the SWRC, van Genuchten equation (VG) parameters (van Genuchten, 1980), θ_s, α and n, were estimated.
- Organic carbon (OC) was determined using the calorimetric method as per FAO manual "Guide to laboratory establishment for plant nutrient analysis" (Motsara and Roy, 2008).

4. Results

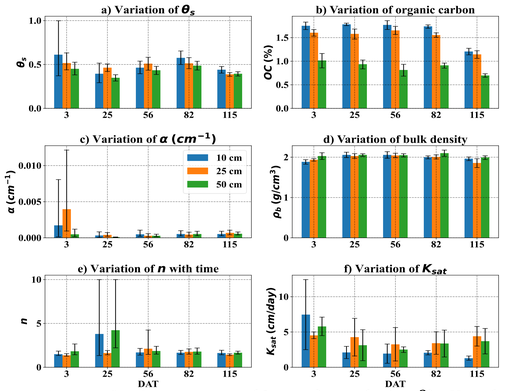

Figure 4: Depth wise variation of VG parameters (θ_s, α, n), ρ_b (g/cm^3), K_{sat} (cm/day) and OC %, with days after transplant (DAT) in the subplots during rice crop. Here, the bars represent standard deviation for OC, K_{sat} and ρ_b and 95 % CI for VG parameters

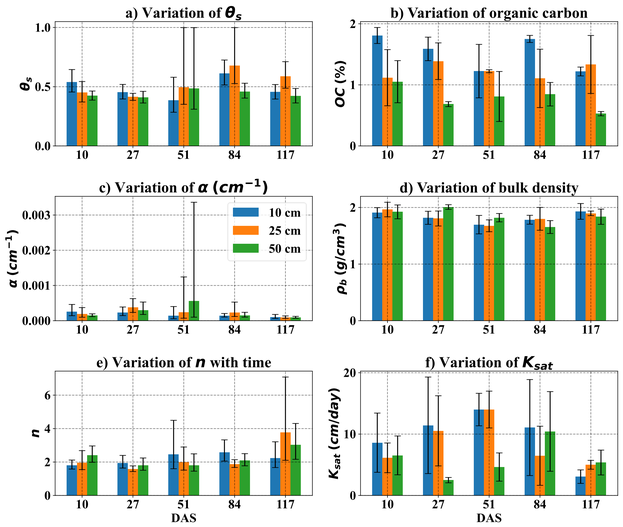

Figure 5: Depth wise variation of VG parameters (θ_s, α, n), ρ_b (g/cm^3), K_{sat} (cm/day) and OC %, with days after sowing (DAS) in the subplots during the wheat crop. Here, the bars represent standard deviation for OC, K_{sat} and ρ_b and 95 % CI for VG parameters

5. Conclusion

- The ρ_b tends to increase with depth and time. Significant temporal variations in ρ_b and θ_s. K_{sat} is negatively correlated with ρ_b and generally decreases with time and depth
- The lowest temporal variation in observed in OC (%) .
- Observed differences in soil properties between Rice and Wheat crops can be largely explained by their contrasting cultivation practices and environmental conditions.
- The temporal trends in SHPs for both rice and wheat crops offer valuable insights into the dynamic nature of soil during crop cultivation.

Acknowledgment

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