Cover Crop Performance Under a Changing Climate in Continuous Corn System over Nebraska

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BACKGROUND

- Dynamic interaction among cover crop (CC) benefits resulting in tradeoffs or synergies.
- Outcome depends on cropping system, climate, soil, crop management, and intended benefits.
- Managing agricultural systems to optimize multiple CC benefits will be challenging under the changing climate.
- Thus, it is crucial to assess how cover crops perform in the face of changing climate to make appropriate adjustments to crop management practices.



Figure 1: Multiple Cover crop benefits

DATA AND METHODS

- Decision Support System for Agrotechnology Transfer (DSSAT) crop model used to simulate CC under historical (Hist) and future climate.
- Study site: Eastern Nebraska Research and Extension Center, Mead, Nebraska.
- Cropping system: continuous corn under rainfed and irrigated conditions.
- Climate change scenario: Canadian Earth System Model 2 (CanESM2) downscaled using Canadian Centre for Climate Modelling and Analysis Regional Climate Model 4 (CanRCM4) under 2 Representative Concentration Pathways (i.e., RCP4.5 and 8.5).
- Treatments:
- Corn with (CC) & without (NCC) cereal rye cover crop; Hist (1991-2020) vs future (2041-2070) under RCP4.5 and RCP8.5.

RESULT AND DISCUSSION

Cover Crop Biomass

- >200% increase under RCP4.5/8.5 due to accelerated growth induced by warmer temperatures.
- More increase under rainfed because of higher residual Nitrogen after corn harvest.
- Biomass under RCP4.5 > RCP8.5 due to increased evapotranspiration and soil moisture depletion.
- Reduced biomass quality (high C:N ratio) under RCP4.5/8.5 as cover crop reached its later growth stages at termination.

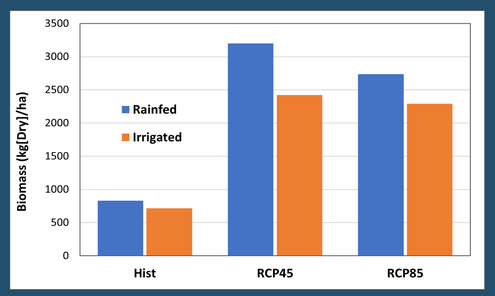


Figure 2: Average cover crop biomass (Kg[Dry] ha^{-1}) under historical, RCP4.5 and RCP8.5 scenarios

Corn Yield

- Yield declined due to climate change in all treatments except rainfed NCC under RCP4.5 scenario (5% increase).
- Yield reduction due to CC exacerbated by climate change (i.e., 4% Hist vs 9% & 11% for RCP4.5 & 8.5).
- For RCP4.5/8.5, corn matured 16/19 days sooner than Hist.
- Fewer days for grain filling & smaller kernel weight under RCP4.5/8.5 compared to Hist.

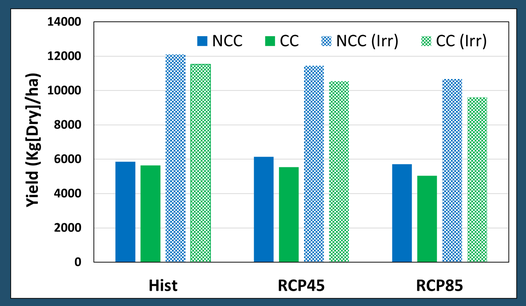


Figure 3: Average yield for rainfed/irrigated corn with CC & NCC treatments under Hist, RCP4.5 and RCP8.5 scenarios

Soil Moisture

- CC resulted in 9.4% reduction in soil moisture (top 40cm) at corn planting under historical climate.
- Soil moisture further depleted by 15.5% & 18.1% under RCP4.5 & 8.5 despite an increase in precipitation.
- CC reduced soil evaporation by 18%, 49%, and 47% and surface runoff by 10%, 28%, and 14% during cover crop season under Hist, RCP4.5 and RCP8.5 scenarios, respectively.

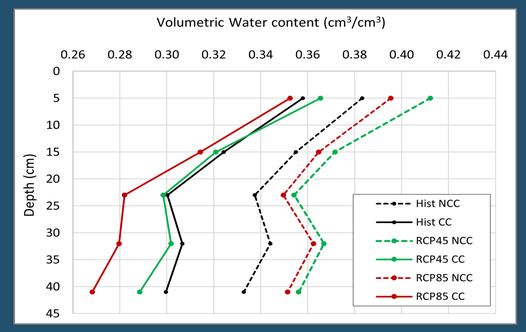


Figure 4: Average soil volumetric water content (cm^3/cm^3) at corn planting at different depth.

Soil Organic Carbon (SOC)

- For NCC treatment SOC increases at a higher rate under Hist than RCP4.5/8.5.
- Greater difference in rate of increase in SOC under irrigated corn due to large reduction in corn residue and increased decomposition rates.
- Under CC treatment SOC increased at a rate 23, 72, & 63% (1.3, 3.8, & 3.3 Mg ha^{-1} Dec^{-1}) faster than NCC under rainfed and 10, 35, & 31% (0.9, 2.6, & 2.3 Mg ha^{-1} Dec^{-1}) under irrigation for Hist, RCP4.5 and RCP8.5 scenarios, respectively.
- Impact of CC on SOC was higher for rainfed than irrigated treatment due to higher rate of SOC decomposition facilitated by availability of soil moisture.

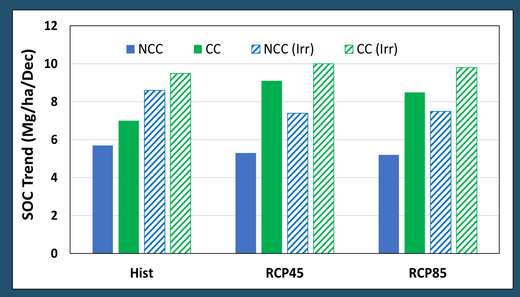


Figure 5: Rate of SOC accumulation (Mg/ha/Decade) for rainfed/irrigated corn with CC/NCC under historical, RCP4.5 and RCP8.5 scenarios

CONCLUSION

- Climate change increased tradeoff between CC & corn productivity.
- CC biomass tripled due to climate change but its quality reduced (i.e., high C:N) due to accelerated growth.
- Corn yield reduction can be minimized by adopting longer maturing corn hybrids.
- Early CC termination can improve biomass quality and soil moisture depletion.
- Climate change has a net positive impact on rate of SOC increase.