Impact of Cover Crops and Irrigation Scheduling Thresholds on Corn Production

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INTRODUCTION

- Increase in irrigated acreage over time in the Mississippi delta have resulted in decline in groundwater levels in the Mississippi River Valley Alluvial Aquifer (MRVAA).
- The MRVAA groundwater levels are diminishing at faster rate than it can be replenished, which necessitates the need for better water saving irrigation and crop management practices in the MS Delta.
- Irrigation scheduling using soil moisture sensors and cover crops can be potential options to conserve and/or improving soil and water resources.
- Cover crops reduce evaporation losses, increase soil water holding capacity by increasing organic matter inputs and can increase water infiltration which reduces irrigation runoff and water use resulting in higher water use efficiency (Irmak, 2020; Spencer et al., 2018).

OBJECTIVE

- Evaluate the impact of cover crops and sensor thresholds for irrigation scheduling on corn production and soil properties in the Mississippi Delta Region.

MATERIALS & METHODS

Field Experiment

- Site: National Center for Alluvial Aquifer Research, Leland, MS
- Initiation: Fall 2019
- Experimental design: randomized complete block with four replications
- Irrigation treatments:
  a) no irrigation
  b) Irrigation initiation at -40 kPa
  c) Irrigation initiation at -90 kPa
- Watermark soil moisture sensors were installed in each plot at 15, 30, 60, and 91 cm.
- Irrigation was started when the weighted average of the sensors reached the required treatment thresholds.
- Cover crop treatments:
  a) No cover crop
  b) Cereal rye (*Secale cereale* L.)
  c) Hairy vetch (*Vicia villosa* L.)
  d) Wheat (*Triticum aestivum* L.)-radish (*Raphanus sativus* L.)-turnip (*Brassica rapa* L.) mix

Measurements

- Bulk density and penetration resistance measurements were taken before planting cover crops (fall 2019), as well as after termination of cover crops (spring 2020) .
- Infiltration measurements were taken in December 2019 using Cornell Sprinkle infiltrometer.
- Cover crop biomass data was collected before the termination of cover crops in spring 2020. The collected biomass was oven-dried at 65°C, weighed, ground, and analyzed for C and N content to determine cover crop biomass, its C/N ratio, and N uptake.
- Corn was harvested using a plot combine (Kinkaid, Haven, KS) in year 2020 and yields were adjusted to 155 g kg^{-1} moisture content before data analysis.
- The GLIMMIX procedure of the SAS statistical software was used to analyze all the collected data.

RESULTS & DISCUSSION

- The soil properties including bulk density, infiltration rate, and penetration resistance were not significantly affected by the cover crops and irrigation treatments during the first year of our study (data not presented).
- Averaged over irrigation treatments, wheat-radish-turnip mix (3,869 kg ha^{-1}) had 1,590, 1,885, and 3,229 kg ha^{-1} greater biomass production than cereal rye, hairy vetch, and no cover crop treatments, respectively, in spring 2020 (Table 1).
- The weeds in the no cover crop treatment had lowest CN ratio whereas the cereal rye had 3 to 11.2 units higher CN ratio than all other cover crops, when data was averaged over irrigation treatments (Table 1).
- Inclusion of cover crops reduced the corn yield by 9 to 27% compared to no cover crop treatment in 2020 possibly due to reduction in corn emergence in cover crop treatments which reduced plant population.
- The no cover crop treatment had 1.6 to 12.9 units higher water productivity at -90 kPa irrigation scheduling treatment than all other treatments, however it was not significantly different from no cover crop treatments under no irrigation and -40 kPa as well as for cereal rye cover crop under no irrigation.

Table 1. Mean values of cover crop biomass production, their CN ratio, and N uptake, corn silage biomass, plant population, corn yield, and water productivity during the 2020 growing season. Means followed by the same letter within a column are not statistically different (α = 0.05). A dash (-) between two letters represent all letters for an alphabetic series (example c-h =cdefgh).

Irrigation Thresholds	Cover crop	Cover Crops			Corn					
		Biomass Production	N-Uptake	CN Ratio	Plant Population	Silage Biomass production	Silage N-Uptake	C/N Ratio	Grain Yield	Water Productivity
		-------- kg ha^{-1} -------			plants ha^{-1}	-------- kg ha^{-1} --------			Mg ha^{-1}	kg ha^{-1} mm^{-1}
No Irrigation		2,345	57.8	13.1	76,471	20.4	271.9	30.4	12.0	23.1 a
-40 kPa		2,204	44.8	14.6	66,599	19.9	273.6	29.2	12.3	19.7 b
-90 kPa		2,030	41.0	13.3	70,714	20.6	280.0	29.8	12.3	23.6 a
	No cover crop	640 c	11.1 c	7.9 d	78,342	20.9	273.4	31.0	13.8 a	26.4 a
	Cereal rye	2,279 b	40.7 b	19.1 a	69,295	20.9	300.8	27.9	12.7 b	21.2 b
	Hairy vetch	1,984 b	54.7 b	11.4 c	65,771	21.0	277.9	30.2	10.9 c	18.7 c
	Wheat-radish-turnip mix	3,869 a	84.4 a	16.1 b	71,636	18.4	248.0	30.04	11.6 c	22.2 b
No Irrigation	No Cover crop	522	10.2 f	7.8	84,842	19.2	246.5	32	13.5	25.9 ab
No Irrigation	Cereal Rye	1,994	32.3 def	19.7	72,227	21.3	300.0	29.8	13.2	25.4 ab
No Irrigation	Hairy vetch	2,359	70.8 b	10.9	74,568	21.4	286.2	30.0	10.1	19.4 d
No Irrigation	Wheat-radish-turnip mix	4,503	117.9 a	13.9	74,245	19.5	255.0	30.9	11.2	21.6 cd
-40 kPa	No Cover crop	729	14.0 ef	8.1	65,691	22.2	286.1	31.5	13.4	25.7 ab
-40 kPa	Cereal Rye	2,477	42.9 c-f	20.2	70,210	20.6	293.4	28.5	12.5	14.8 e
-40 kPa	Hairy vetch	1,873	55.0 bcd	11.4	60,687	20.7	282.9	29.0	11.1	14.6 e
-40 kPa	Wheat-radish-turnip mix	3,738	67.1 bc	18.2	69,806	16.0	232.1	27.7	12.3	26.6 bc
-90 kPa	No Cover crop	667	10.8 f	7.6	84,494	21.1	287.7	29.5	14.3	27.5 a
-90 kPa	Cereal Rye	2,365	46.6 bcd	17.4	65,449	20.7	309.2	26.4	12.2	23.4 bc
-90 kPa	Hairy vetch	1,721	38.3 c-f	11.9	62,059	21.0	264.6	31.7	11.5	22.1 cd
-90 kPa	Wheat-radish-turnip mix	3,365	68.0 bc	16.3	70,856	19.9	256.7	31.5	11.1	21.5 cd

CONCLUSION

- Cover crops did not show any changes in soil properties, and reduced corn grain yield and water productivity in first year of our study. It is possible that long term use of cover crops might improve soil health resulting in increasing corn yields and improving water productivity. Therefore, the research will be continued for more years to provide strong recommendation about use of cover crops and irrigation scheduling on corn production in MS delta.

REFERENCES

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