OPTIMIZING IRRIGATION AND NITROGEN FERTILIZATION TO ENHANCE POTATO GROWTH, YIELD, NITROGEN USE EFFICIENCY, AND MINIMIZE LEACHING ON SANDY SOILS

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INTRODUCTION

- Potato is one of the most important crops in Florida, which are vital to the state's economy and holds its national importance by supplying spring high-quality potatoes to the nation.
- As a result of significant water quality issues and coarse-textured soil with low water retention capacities, the potato industry in Florida is facing many challenges.
- In Florida, potatoes are typically cultivated under seepage irrigation, which is the dominant irrigation method. The irrigation system used in these systems consumes a high amount of water, has a very low efficiency, and is prone to nutrient leaching.
- In potato production, nitrogen (N) is important factor. The more application of Nitrogen fertilizer leads to leaching; however, the principal cause of N leaching is water, which moves nitrate beyond the rootzone of the plants.

OBJECTIVES

1. Quantifying the effect of irrigation and nitrogen application rates on plant height, Leaf Area Index (LAI) and tuber yield under sprinkler irrigation.
2. Evaluate the effect of irrigation and nitrogen on tuber quality of potato.
3. Evaluate the effect of irrigation and nitrogen management on Crop water use efficiency and Nitrogen Use efficiency.

STUDY SITE

Location: This study was conducted at North Florida Research and Education Center – Suwannee Valley, Live Oak, Florida

Soil type: Blanton-Foxworth-Alpin complex, Chipley-Foxworth-Albany, and Hurricane, Albany, and Chipley soils

Elevation: 32m/ 105 ft Lat/Long: 30.29, -82.98

Climate data of the site:

- Annual Average Temperature: 68ºF/ 20ºC
- Average annual precipitation: 51 inches/ 1314 mm
- Annual average humidity: 75 %

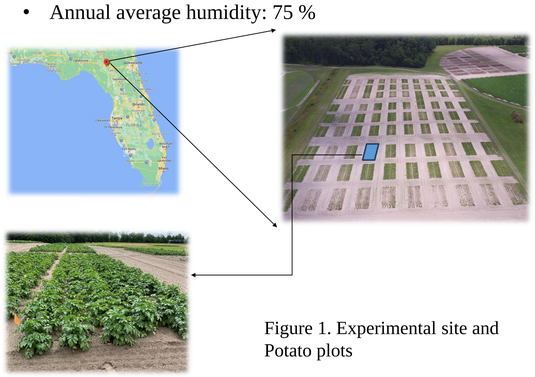


Figure 1. Experimental site and Potato plots

MATERIALS AND METHODS

Experimental Design: Randomized Complete Block Design

- Main treatments: Irrigation (Full irrigation - FIT, 75%-Full irrigation – 75% FIT, Control – No Irrigation).
- Subplot treatment: Eight nitrogen treatments (six conventional nitrogen and two controlled-release fertilizer (CRF) treatments), ranging from 112 kg/ha to 392 kg/ha.
- Split nitrogen fertilizer application with the fertilizer timing set to match the application timing commonly used by growers in Suwannee Valley.

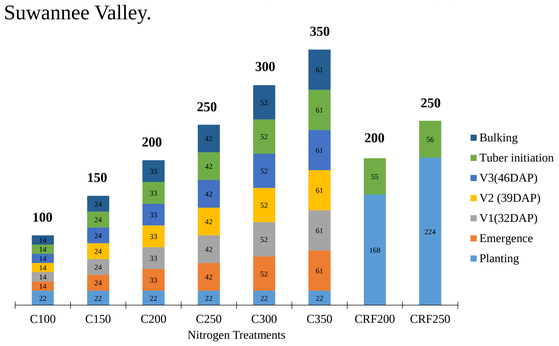


Figure 2. Split nitrogen application during each crop growing season.

- Data collected: Pre-plant soil samples, soil sampling throughout the growing season, plant height, LAI, Biomass, tissue samples, yield, and quality parameters
- Plot size: 6 m×12 m

Figure 3. Potato planting using Six row potato planter during Spring-2023

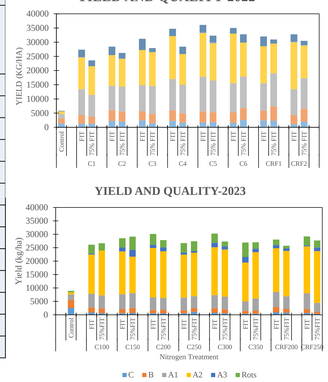
Figure 4 a) Pre-plant soil sampling in potato field; 4 b) Soil moisture probe installation in the potato field; 4 c) Plant height measurement in potato field; 4 d) Biomass sample collection at tuber initial stage; 4 e) Harvested tubers from the potato field; and 4 f) Grading of subsampled Potato tubers at UF/IFAS Extension, Hastings, FL, USA

RESULTS

Table 1. Growth, Yield, ET, water use efficiencies and Nitrogen uptake efficiency of Potato for the growing year 2022 and 2023.

Treatments	Average Plant height (cm)	Average LAI	Total N uptake (Kg/ha)	Tuber Yield (kg/ha)	ETc (mm)	IWUE (g /m² mm)	CWUE (g /m² mm)	NUE (kg/ kg of N)
Nitrogen Treatment								
Control	19^{e}	1.1^{d}	52^{c}	9767^{c}	242	-	-	-
C100	26^{d}	1.8^{c}	81^{b}	27142^{b}	387	17	8^{b}	82^{a}
C150	27^{bcd}	1.9^{c}	101^{b}	28145^{b}	382	16	8^{b}	70^{ab}
C200	27^{cd}	1.8^{c}	103^{ab}	31401^{ab}	382	20	10^{a}	59^{ab}
C250	27^{bcd}	1.9^{bc}	131^{a}	33036^{ab}	383	21	10^{a}	60^{ab}
C300	30^{abc}	2.1^{abc}	124^{a}	35594^{a}	383	22	10^{a}	44^{ab}
C350	30^{abc}	2.9^{ab}	103^{ab}	37550^{a}	383	24	11^{a}	31^{b}
CRF200	31^{ab}	2.0^{abc}	124^{a}	35012^{a}	370	22	10^{a}	68^{ab}
CRF250	32^{a}	2.4^{a}	100^{b}	35560^{a}	376	23	11^{a}	43^{ab}
Irrigation Treatment								
Control	19^{b}	1.1^{b}	52^{b}	9767^{b}	242	-	-	-
FIT	29^{a}	2.0^{a}	130^{a}	33039^{a}	343	16	9^{a}	58^{a}
75%FIT	28^{a}	2.0^{a}	136^{a}	32820^{a}	341	25	10^{a}	56^{a}

Tuber Grades of Potato



Nitrate in soil, UAV based NDVI and other relationship graphs

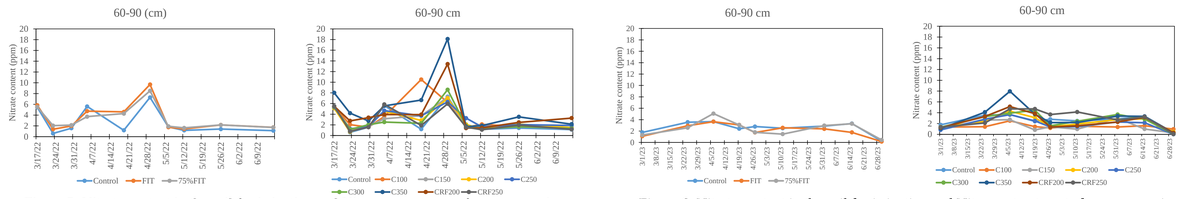


Figure 5. Nitrate content in the soil for irrigation and Nitrogen treatments for crop growing season 2022

Figure 6. Nitrate content in the soil for irrigation and Nitrogen treatments for crop growing season 2023

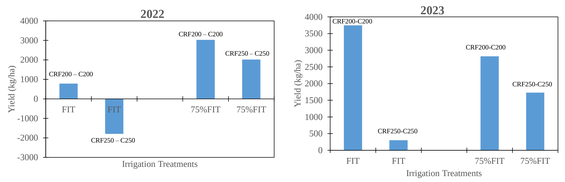


Figure 7. Yield difference for corresponding CRF and conventional treatments

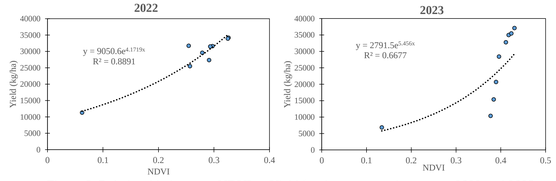


Figure 8. Relationship between NDVI vs Yield for the crop growing season 2022 and 2023

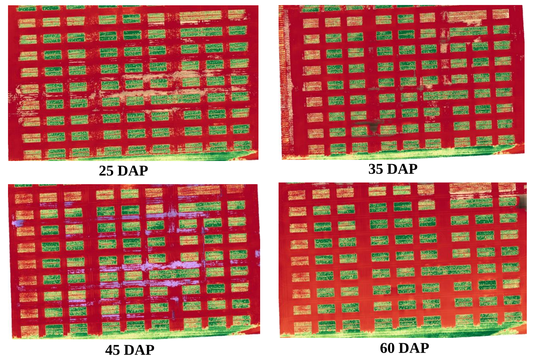


Figure 9. Spatial variation of UAV-based NDVI at different crop growth stages for 2023 crop growing

CONCLUSION AND FUTURE LINE OF WORK

- Irrigation and nitrogen management significantly affected plant height, LAI, and tuber yield in potato plants
- In high nitrogen treatments, the amount of nitrate in the soil depth of 60-90 cm, which is not accessible to roots, was high
- The water use efficiency of deficit irrigation treatment was consistently higher during each growing season. As the application rate increases, nitrogen use efficiency decreases
- SUBSTOR modeling to determine the leaching dynamics in potato fields after a combination irrigation and nitrogen application
- Leaf Nitrogen Content and yield estimation from the UAV based vegetative health indices such as NDVI, GRVI, SAVI, VARI, and GLI.

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