Empowering Young Scholars in Nitrogen Management for Organic Ratoon Rice

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Introduction

Organic ratoon rice production in Texas represents a sustainable farming approach that avoids synthetic agrochemicals, emphasizes organic inputs, and improves soil health. Practices like cover cropping and organic amendments are used to enhance soil fertility, farm productivity, and biodiversity. While US organic rice acreage has grown nearly six-fold since 1995—primarily in Texas and California, which together account for over 76% of the nation's organic rice production—domestic supply still falls short of increasing market demand. Enhancing ratoon cropping offers a significant opportunity to reduce dependence on imports and support economic growth for US rice farmers.

Nitrogen (N) availability is a critical factor in organic rice productivity, as it is often the most limiting nutrient. In organic systems, N must be derived from natural sources like soil organic matter, organic amendments, and cover crops. The challenges associated with N availability necessitate careful management to ensure a timely supply, optimize yields, and promote sustainability. While there is substantial research and practical guidance available on N management for the organic rice main crop, there is a notable gap in recommendations for the ratoon crop in organic systems. This gap is critical as ratoon crops can have different nutrient dynamics and requirements than the main crop. Understanding how N availability and dynamics are influenced by various factors, such as rice cultivar selection, crop rotation practices, and the rate and type of organic fertilization, is key to developing effective and sustainable N management practices for ratoon rice. Addressing these knowledge gaps will help optimize N use, reduce environmental impacts, and enhance the economic viability.

This Young Scholar Grant aims to enrich undergraduate STEM students' education by focusing on organic rice production and N management. This grant will provide hands-on experience in optimizing N availability and its benefits, empowering students to innovate and advance sustainable agriculture.

Objectives

- Assess the effects of rice cultivars, crop rotation including cover crops, and organic amendments rates on soil N availability for rice ratoon cropping.
- Enhance undergraduate STEM students' knowledge and research experience in N management for organic rice ratoon production.

Material and Method

A field trial was initiated at The Texas A&M AgriLife Research Center in Beaumont, Texas, USA, to assess the impact of different rice cultivars, crop rotations, and N rates on N availability and overall rice productivity. The experiment included two rice cultivars: an inbred variety, 'Presidio,' and a hybrid variety, 'XP753.' To evaluate the effects of crop rotation on soil N availability, two rotation treatments were established: cover crop (CC) and winter fallow (WF). Additionally, five nitrogen (N) rates (0, 30, 60, 90, 120 lb/ac) were applied to the ratoon crop, using an organic nitrogen source, Nature Safe (13-0-0). All treatments were replicated four times. Due to challenges in establishing a cover crop in the fall, alfalfa hay (*Medicago sativa*) was used as an alternative to simulate the effects of a leguminous cover crop. This substitution was applied at a rate of 6,614 lb/acre, aimed at mimicking the nitrogen-fixing benefits and organic matter contribution typically associated with leguminous cover crops. In 2023, rice was planted on March 31st, and the fields were flushed on April 1st to ensure proper seedbed moisture for germination. A permanent flood was established on April 25th. On May 4th, all plots of the main crop received 145 lb/acre of nitrogen, also supplied through Nature Safe. The main crop was harvested on July 27-28th. Following this, N treatments for the ratoon crop were applied on August 7th, and reflooding of the fields was established on August 8th. The ratoon crop was harvested on October 25th.To monitor soil nitrogen availability throughout the growing season, soil samples were collected periodically at predetermined dates corresponding to key physiological growth stages of the rice. Filed moist soil samples (0-25 cm) from rice root zone were collected and extracted with 0.5 K_2SO_4 to measure soil ammonium content (NH_4^+). The soil extract was used to measure NH_4^+ using a discreate analyzer (AQ300, Seal Analytical, Inc. Wisconsin). Field moist samples were also analyzed for moisture content and then soil NH_4^+ content was expressed on dry soil weight basis.

Result and Summary

Table 1: Generalized mix model analysis of variance showing effects of cover crop, variety and ratoon crop N rate on soil ammonium availability at active tillering and panicle initiation stage

Source	Probability			Source	Probability		
	08/22	09/25	10/20		08/22	09/25	10/20
Rotation (RT)	**0.0039**	**<0.0001**	**0.0218**	RT x CV	0.4582	0.7381	0.7254
Cultivar (CV)	**<0.0001**	**<0.0001**	0.3883	RT x N	**0.0249**	0.8318	0.4357
Nitrogen rate (N)	**<0.0001**	**<0.0001**	**0.0060**	CV x N	0.6614	0.1327	0.2832
				RT x CV x N	**0.0311**	0.7454	0.8264

- At the beginning of ratoon growth (08/22/2023), the mean effects of rotation, cultivar, and N rates significantly influenced soil N availability. Among the interaction effects, RT x N and RT x CV x N were significant.
- For the mid-growing stage (09/25/2023) and at harvest (10/20/2023), rotation and N rates were significant. However, only cultivar was significant at the mid-growing stage in influencing soil N availability. No interaction effects were significant at these two stages.

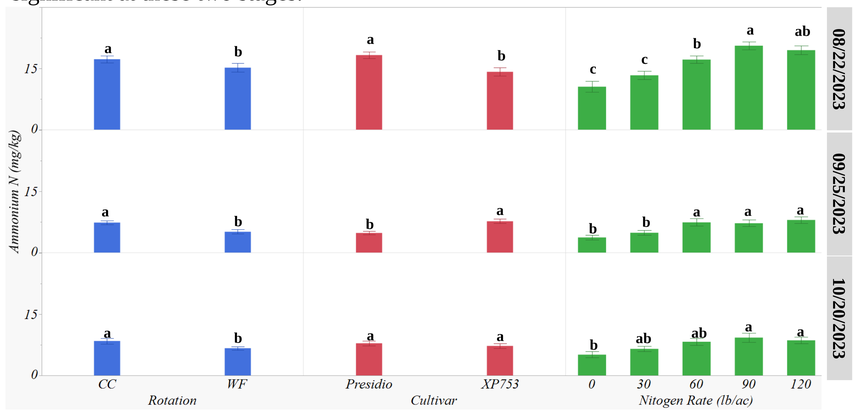

Figure 1: Soil available ammonium N (NH_4^+) as influenced by rotation, cultivar, and nitrogen rates at three different sampling dates during ratoon rice growth. Bar graphs within each section followed by the same letters are not significantly different at P < 0.05. (CC-Cover crop, WF-Winter fallow)

- For all three sampling events, cover crop had greater soil N availability compared to winter fallow.
- At the early growth stage (08/22/2023), soil N availability under Presidio was greater than under XP753. However, this trend reversed at the mid-growing season on 9/25/2023, when XP753 had greater soil N availability than Presidio. At harvest, there was no difference between the two cultivars.
- Soil N availability generally increased with higher N rates. However, for all sampling dates, 90 and 120 lb N/ac had similar N availability. A noticeable trend is that overall soil N content decreased as the growing season progressed.
- Student interns developed skills in soil sampling, processing, and measuring soil available N for ratoon rice management. They gained practical experience in assessing soil N dynamics and its impact on rice productivity.

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