The Effects of Early Season Soil Flooding-Drying Cycles on N Dynamics and Agronomic Productivity in California Rice Systems

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Introduction

- Many California rice growers are changing early season water management to facilitate use of newer herbicides.
- Fields are drained within 1-2 weeks following seeding, and once dry enough, herbicides are applied by ground.
- Shortly following herbicide application, fields are reflooded.
- This wetting and drying of soil can potentially alter N dynamics, lead to N losses, and affect rice growth and yield.

Objective

- Compare a continuously flooded rice system to one subjected to wetting and drying in the early season, by identifying and quantifying key points in the drain / reflood cycle where N loss or plant stress might occur.

Experimental Design (2006 & 2007)

- 2 side by side fields each year (1 with burned the other with incorporated straw).
- 2006 - Live Oak, CA. 2007 -Gridley, CA.
- 2 treatments, 3 blocks, RCBD, 12 plots (rings) / field in 2006 and 27 plots (rings) / field in 2007.

- 1st treatment (*Drained*): farmer practice of draining field within 2 weeks after seeding, a period of drying, followed by herbicide application, and finally reflooding.
- 2nd treatment (*Undrained*): the flood water was maintained throughout the early season.
- Treatments imposed in fields by forcing metal rings (76cm diameter x 20cm height) into soil, creating seal so water could be kept in or out of rings.
- N application rate (kg/ha) –
  - 2006 - 118 subsurface, 31 surface, 29 topdress = 178 total.
  - 2007 – 135 subsurface, 30 surface, 28 topdress = 193 total.
- Plant and soil samples taken from rings at several points during the drain-reflood cycle and at harvest.

Forcing rings into soil

Rings set in field

Maintaining flood in Undrained treatment rings

2006 Results

Table 1. 2006 yield and total N uptake by rice (kg/ha) in Drained (D) and Undrained (U) treatments, in fields with either burned or incorporated straw.

Year	Field Location	Straw Management	Treatment	Yield (kg/ha)	p value	Total N Uptake (kg/ha)	p value
2006	Live Oak, CA	Burned	Drained	9631 ± 137	0.067	138 ± 4	0.041
			Undrained	10297 ± 305		158 ± 8	
		Incorporated	Drained	10192 ± 39	0.068	139 ± 3	0.003
			Undrained	10289 ± 123		154 ± 3	

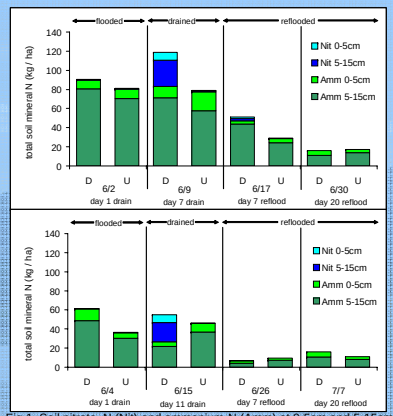

Fig 1. Soil nitrate–N (Nit) and ammonium-N (Amm) at 0-5cm and 5-15cm depths (kg/ha) from Drained (D) and Undrained (U) treatments. Fig 1A field had incorporated straw and Fig 1B field had burned straw. Samples were taken at key points in the draining-reflooding cycle.

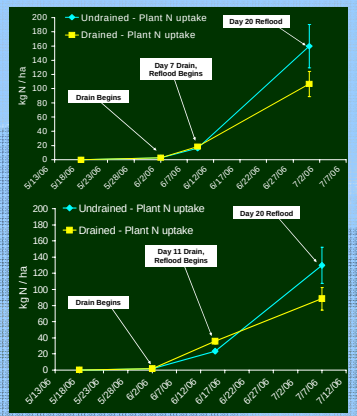

Fig 2. Total N uptake (kg/ha) in Drained (D) and Undrained (U) treatments. Fig 2A field had incorporated straw and Fig 2B field had burned straw.

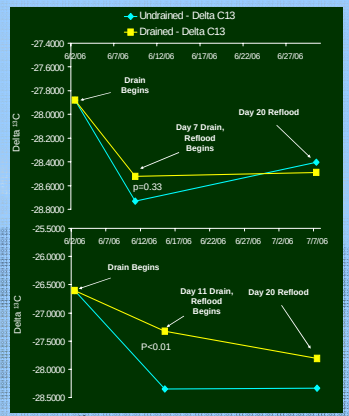

Fig 3. Delta ^{13}C in Drained (D) and Undrained (U) treatments. Fig 3A field had incorporated straw and Fig 3B field had burned straw.

2007 Results

Table 2. 2007 yield (kg/ha) in Drained (D) and Undrained (U) treatments, in fields with either burned or incorporated straw.

Year	Field Location	Straw Management	Treatment	Yield (kg/ha)	p value	Total N Uptake (kg/ha)	p value
2007	Gridley, CA	Burned	Drained	11615 ± 870	0.091	Data Not Yet Available	Data Not Yet Available
			Undrained	11319 ± 355			
		Incorporated	Drained	12017 ± 739	0.471		
			Undrained	11647 ± 498			

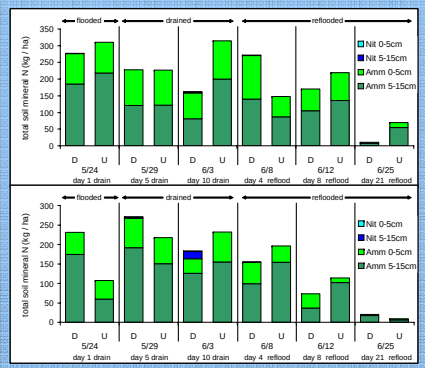

Fig 4. Soil nitrate–N (Nit) and ammonium-N (Amm) at 0-5cm and 5-15cm depths from Drained (D) and Undrained (U) treatments. Fig 4A field had incorporated straw and Fig 4B field had burned straw. Samples were taken at key points in the draining-reflooding cycle.

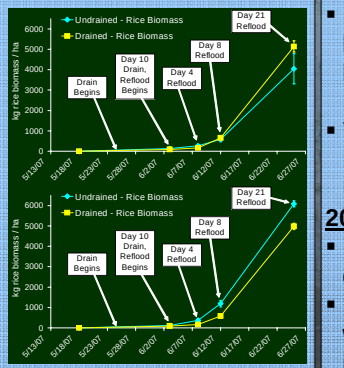

Fig 5. Total biomass accumulation (kg/ha) in Drained (D) and Undrained (U) treatments. Fig 5A field had incorporated straw and Fig 5B field had burned straw.

2006 Conclusions

- Nitrate accumulated (22-34 kg/ha) during drain in both fields, and disappeared by 20 days after reflooding (Figs 1A & 1B).
- Draining led to drought stress in both fields as evidenced by higher Delta ^{13}C values in Drained treatment.
- Yield and N uptake (Table 1, Figs 2A & 2B) were higher in Undrained treatment.

2007 Conclusions

- Less nitrate accumulated during drain in 2007 (Figs 4A & 4B).
- Biomass in Drained treatment was lower in burned but higher in incorporated (Figs 5A & 5B), but yield was higher in both (Table 2).
- Results varied across years.

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