Water Management Effects on Rice yields, Rice Water Weevil Infestation and Drainage Water Phosphorus Concentrations

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Soil & Water SCIENCE

Introduction

- Soil loss due to oxidation of organic matter is a concern in the Everglades Agricultural Area in South Florida. Growing flooded rice can help mitigate losses by maintaining anaerobic conditions of flooded fields throughout the growing season (Schueneman & Snyder 2000).
- Slowing down the oxidation process along with plant uptake can possibly alleviate phosphorus (P) enrichment of water in the EAA.
- Flooded rice production requires more water than other crops; for this reason, new techniques for conserving water and reducing pumping costs is valuable.
- Rice water weevil, *Lissorhoptrus oryzophilus* Kuschel, is the most destructive insect pest of rice in the United States (Stout et al. 2002). However, there are water management practices such as "single midseason drawdown" and "shallow flood level" that can be helpful in controlling the infestation.
- Different water managements can also affect nutrient availability and drainage water quality, as well as rice grain yields.

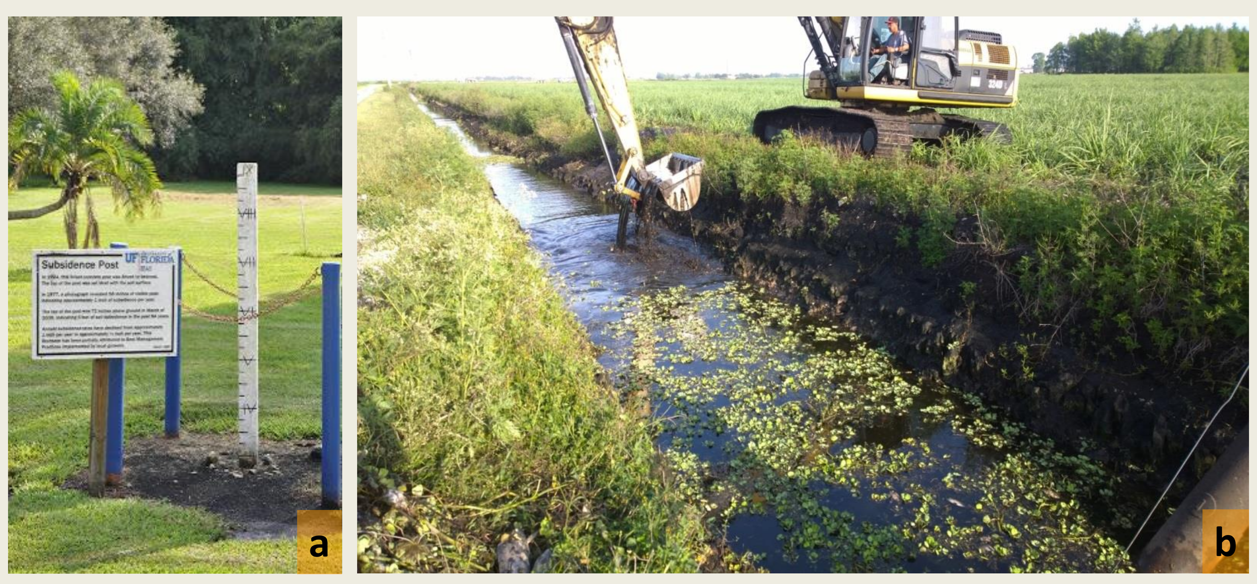

Figure 1. a) Soil Subsidence and b) aquatic vegetation in canals.

Objectives

To test the hypotheses that lowering the water table and introducing a midseason drawdown will:

- **Reduce irrigation pumping costs**
- **Reduce rice water weevil infestation**
- **Increase rice crop N and P uptake**
- **Increase rice grain yield**
- **Improve on-farm water quality**

Methodology

- A strip-plot experiment was designed with four water level treatments and four replications (Fig.3).
- Treatments were: 15 cm midseason drawdown, 5 cm midseason drawdown, 15 cm continuous flood, 5 cm continuous flood.
- In each subplot two predominant EAA rice cultivars were planted: Cheniere and Taggart.
- Preparation methods: Disc tillage followed by dry-seeding in 20 cm rows.

Action	Days After Planting
Flooding	21
Plant Sampling	56
Water Sampling	35,49,60,72,84,98
RWW Sampling	58,79,85
Drawdown	60
Reflood	71
Flag Leaf Sampling	78
Harvest	109

Figure 2. Project timeline.

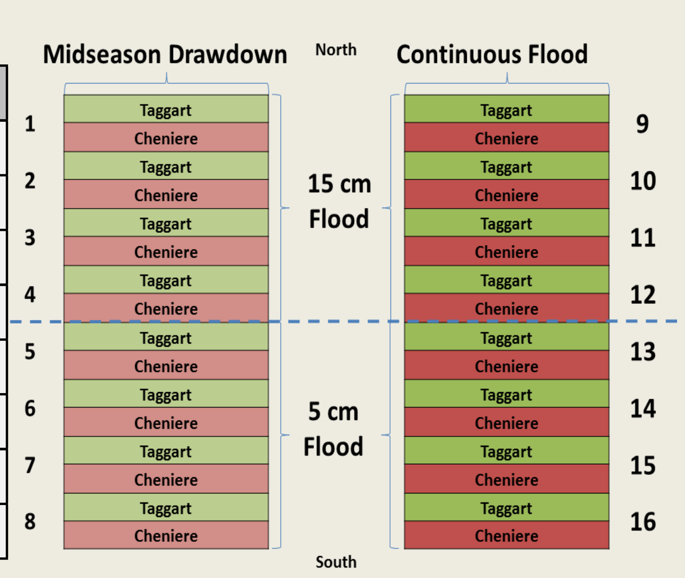

Figure 3. Experimental plot design.

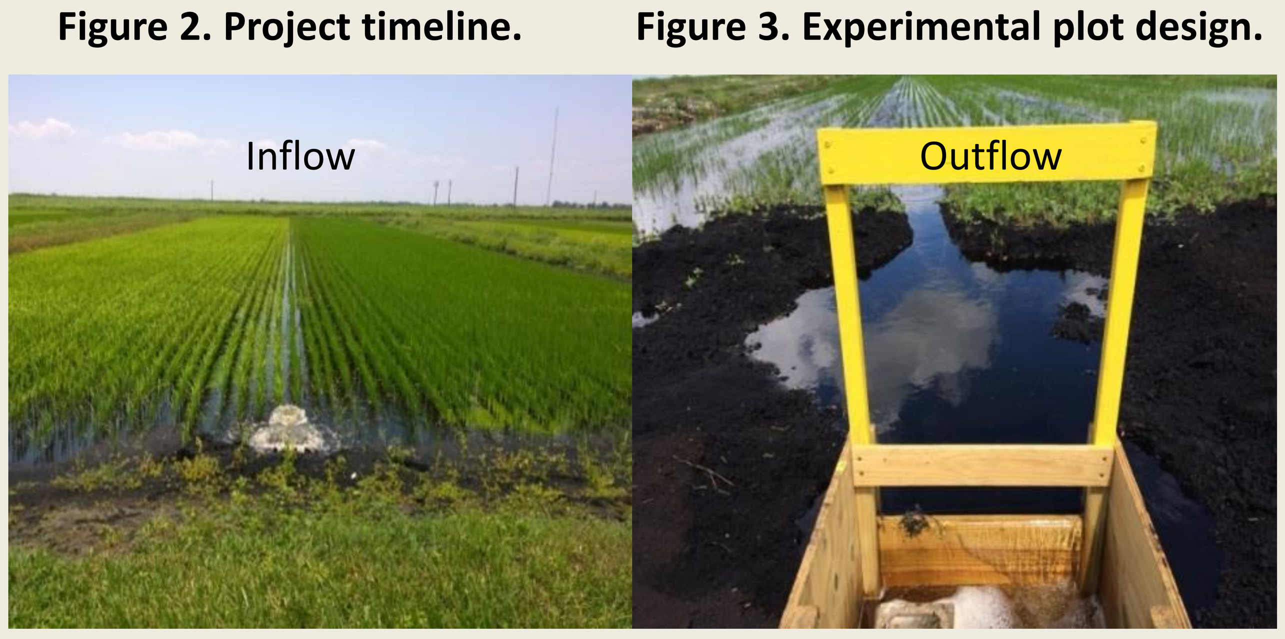

Figure 4. Early season inflow and outflow water structures.

Results & Discussion

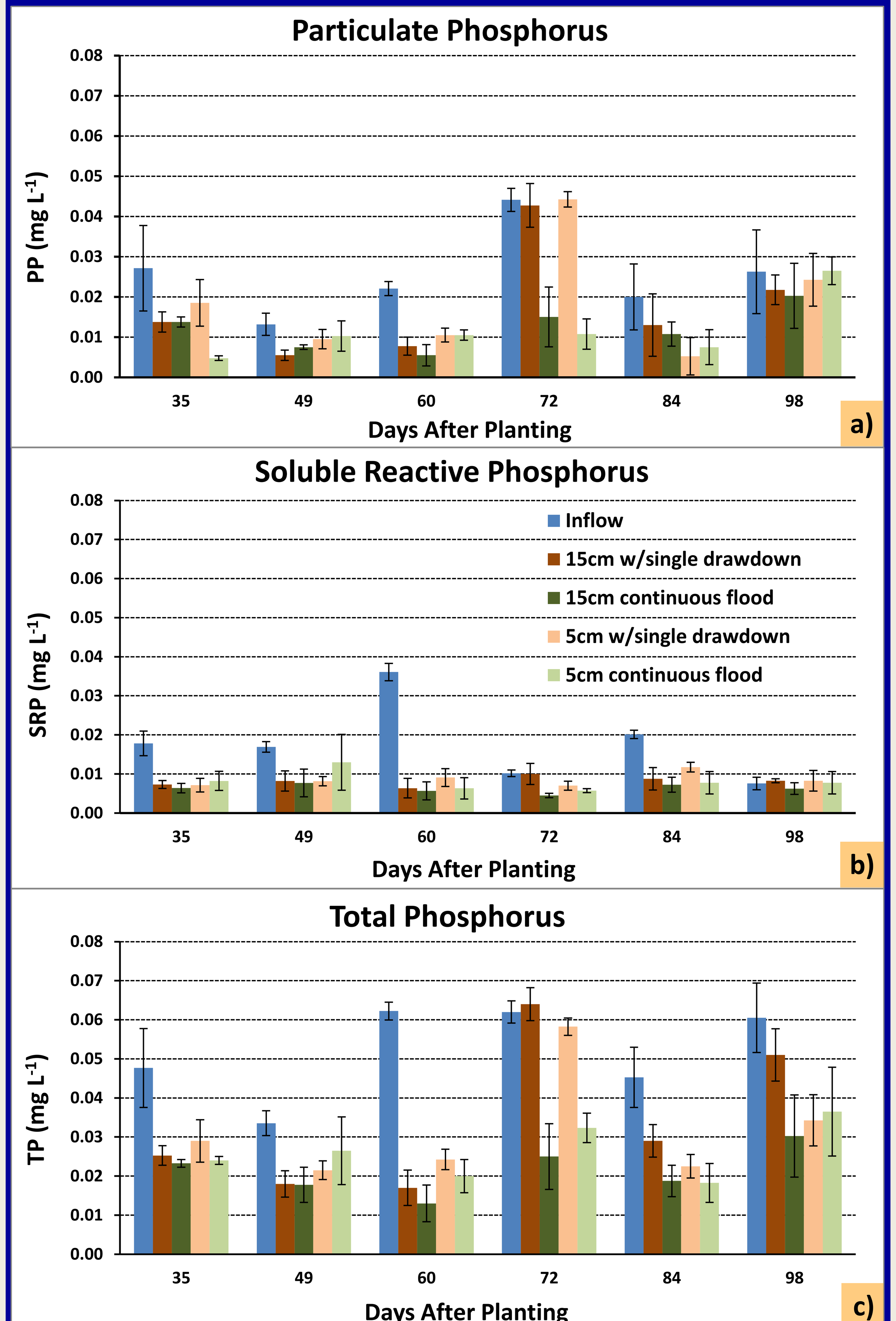

Figure 5. a) Total Phosphorus (TP), b) Soluble Reactive Phosphorus (SRP), and c) Particulate Phosphorus (PP) concentrations from inflows and outflows for 6 sampling times during the growing season.

- Phosphorus concentration reduction was highest in 15 cm continuous flood at 58% and lowest in 5 cm midseason drawdown, with an overall reduction of 46% on average.

Table 1. Percent reduction of TP, TDP, SRP and PP in drainage waters by treatment.

%Reduction	TP	TDP	SRP	PP
15cm Midseason Drawdown	40.5	38.1	51.1	50.2
5cm Midseason Drawdown	**39.4**	56.3	47.7	31.4
15cm Continuous Flood	**58.2**	67.0	53.4	56.1
5cm Continuous Flood	47.5	52.2	40.8	31.6

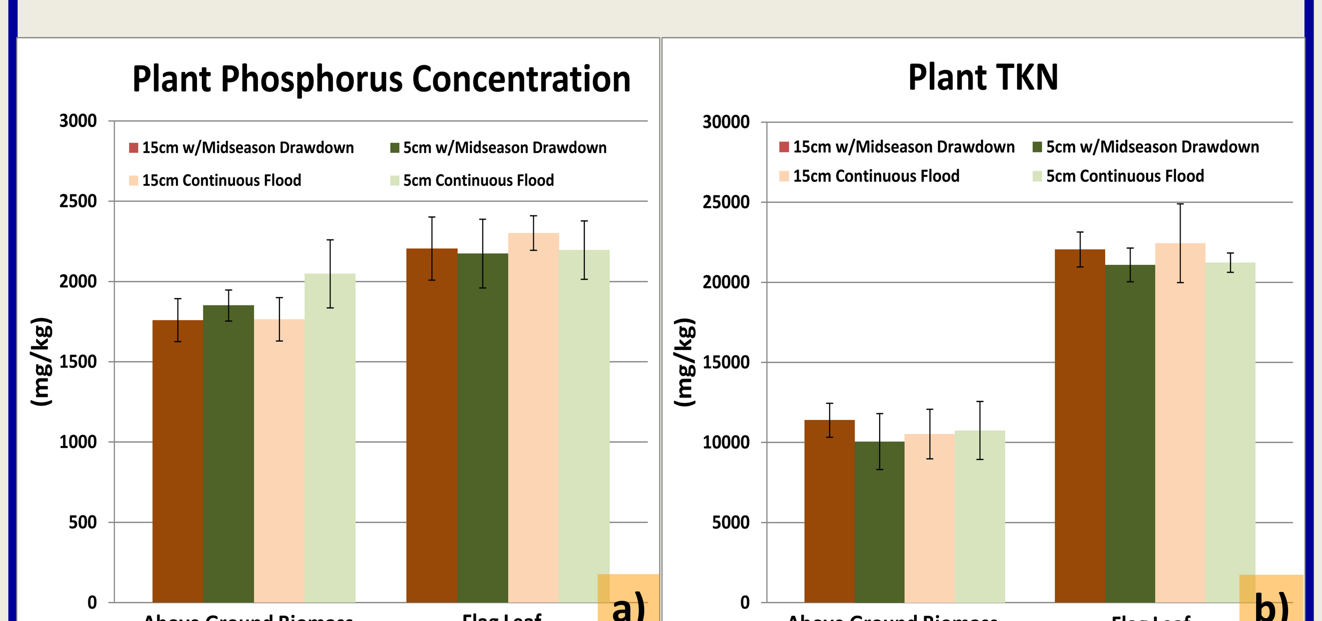

Figure 6. a) Phosphorus concentration and b) Total Kjeldahl Nitrogen (TKN) in above ground biomass and flag leaf samples.

- At 56 days after planting, Cheniere cultivar N and P uptake was significantly higher than Taggart.

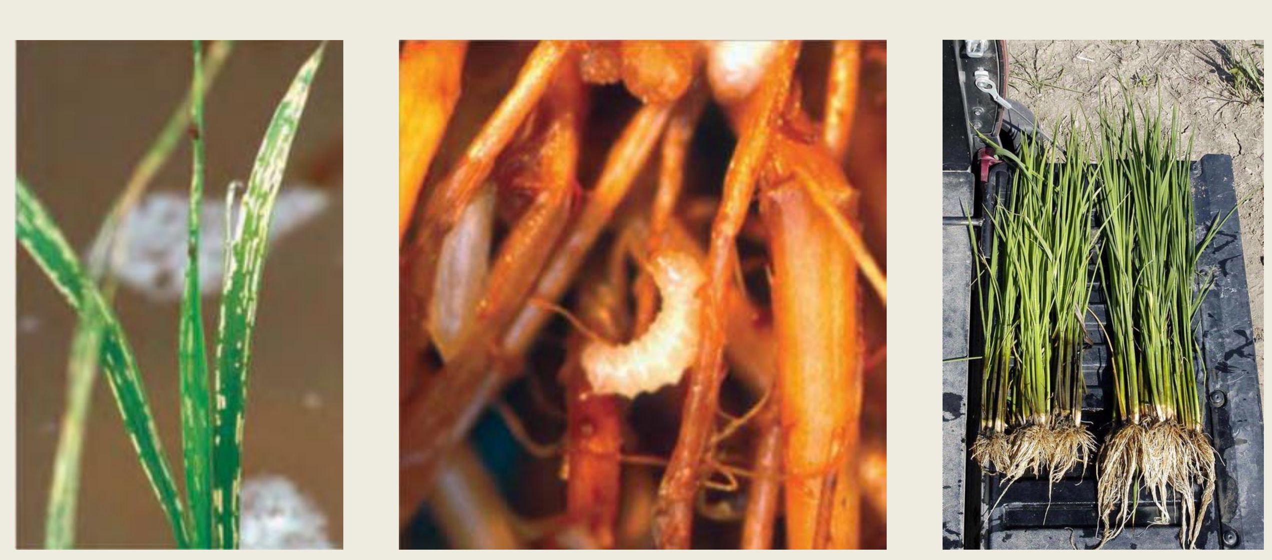

Figure 8. Rice Water Weevil Larvae and its feeding effect on rice root.

Results & Discussion

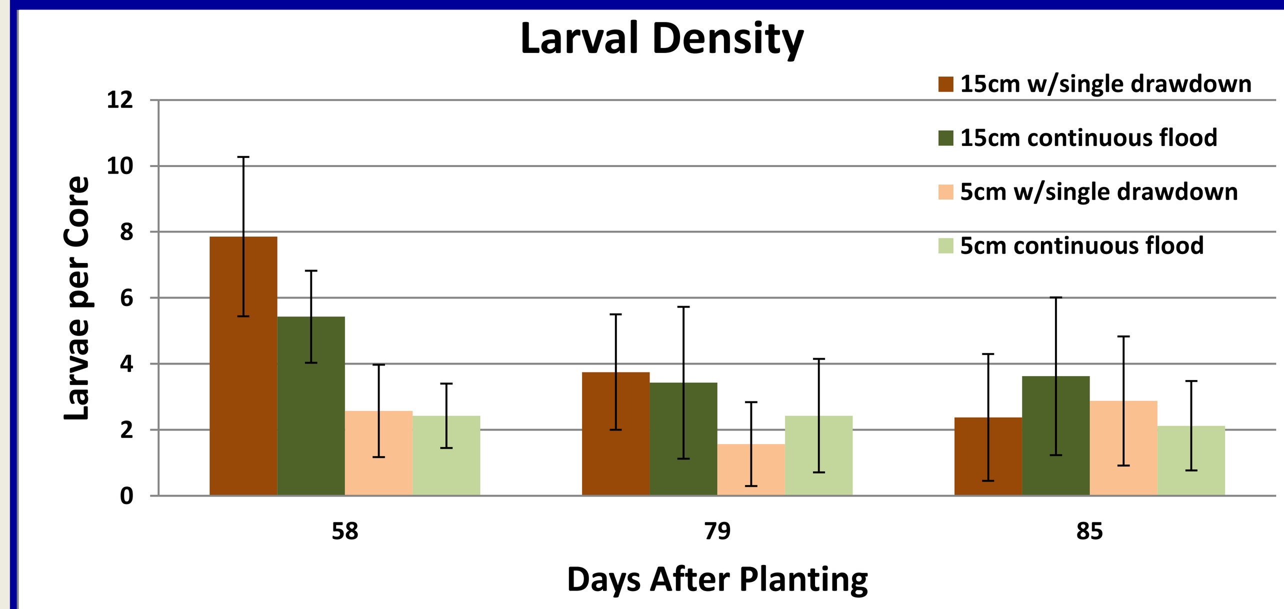

Figure 9. a) Number of Larvae per core, from each treatment for 3 sampling times during the growing season.

Table 2. ANOVA for Larval Density, Treatment, Date.

Source	DF	Type I	Mean	F Value	Pr > F
Treatment	3	81.9	27.3	3.87	**0.0126**
Date	2	89.6	44.8	6.36	**0.0029**
Treat*Date	6	48.6	8.1	1.15	**0.3428**

- Rice water weevil larval density in the 15 cm flood was significantly higher (39%) than 5 cm flood.

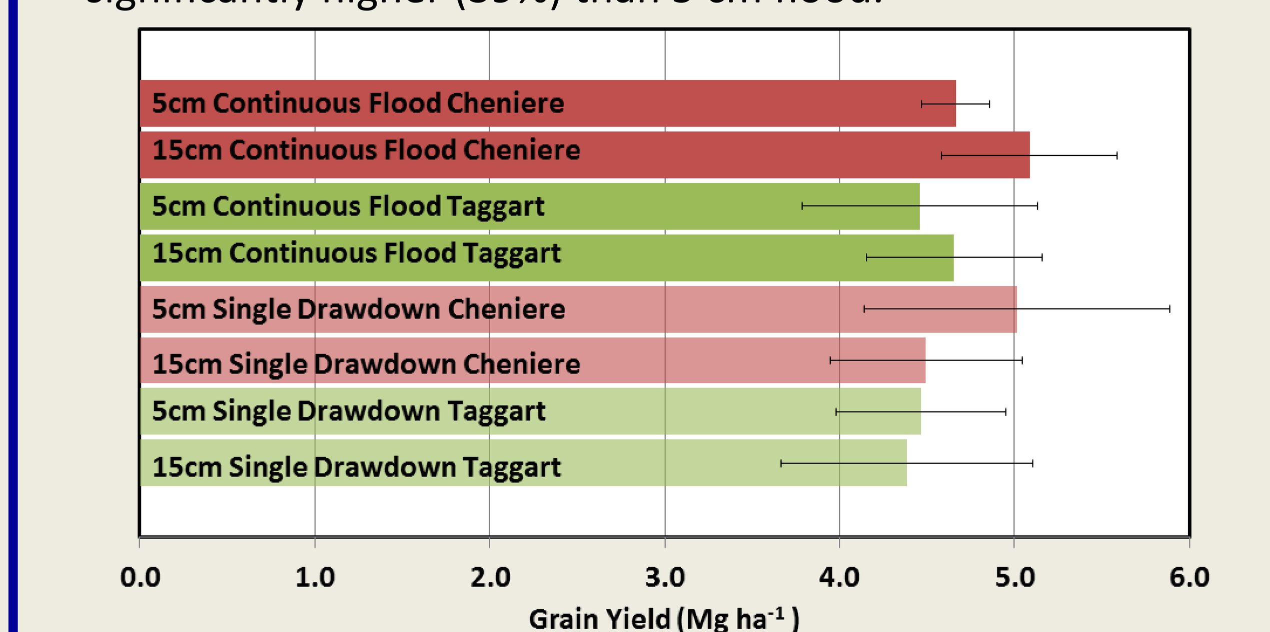

Figure 7. Rice grain yield from each treatment.

- Highest grain yields were observed in "15 cm Continuous Flood" (5.1 Mg ha^{-1}) and "5 cm Midseason Drawdown" (5.0 Mg ha^{-1}) but they were not significantly different.
- Single midseason drawdown was practiced for half of the field (1.2 ha) and in 11 days, total of 444800 m^3 of inflow water was conserved.

Conclusions

- Total phosphorus concentration in rice drainage water can be reduced through rice plant and associated aquatic vegetation uptake.
- Shallow flood water level appears to be an effective cultural method for controlling rice water weevil infestation.
- Midseason drawdown has the potential to reduce the costs of pumping and conserve 3600 m^3 ha^{-1} of water per day.
- Grain yields were almost the same in all different treatments; Cheniere cultivar had a better grain yield in each flood level.
- Drawdown did not show any significant effect on nutrient uptake by plants but also did not reduce the grain yield.
- Total phosphorus reduction in drainage water was slightly higher in the 15 cm flood than the 5 cm flood.

Ongoing Related Research

- Assessment of the total N and P total uptake by submerged aquatic vegetation and rice crop in the differing water depths and drawdown treatments.
- Gaseous fluxes from a rice field under different flood levels and conditions
- Weed incidence and yield effects on rice with the different flood levels.
- Rice ratoon crop as a cash/cover crop in the Everglades Agricultural Area

Acknowledgement

This project was funded by EAA Rice Council, a special organization composed of rice growers from within the EAA Basin. The council was created for the purpose of funding research to improve the economics, production, and sustainability of rice in the EAA.

References

T. J. Schueneman & G. H. Snyder. 2000. Water-Use Considerations for Florida-Grown Rice. SS-AGR-87. Agronomy Department, Florida Cooperative Extension Service, Institute of Food and Agricultural.

M. J. Stout et al. 2002. Flooding Influences Ovipositional and Feeding Behavior of the Rice Water Weevil (Coleoptera: Curculionidae). J. Econ. Entomol. 95(4): 715-721 Entomological Society of America.