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Water-Use Considerations for Florida-Grown Rice[1]

T. J. Schueneman and G. H. Snyder[2]

Introduction

The land south and south east of Lake Okeechobee in southern Florida is designated the Everglades Agricultural Area (EAA). Part of the historic everglades, it was progressively drained beginning in the late 1800's to provide land for homes and farms. Environmental concerns and water supply were not the issues, only drainage. With the extensive urbanization of the adjoining region and the designation of the Everglades National Park and other preserves, water policies have changed in focus from drainage issues to water quality and supply issues.

The rainy season in south Florida stretches from mid-spring to late-fall, roughly six months. Rain-water is conveyed into ditches and canals and stored in Lake Okeechobee and Water Conservation Areas until needed, during the dry half of the year. Agricultural lands in the EAA are a major collecting site for rainy season water and any restriction on this water flow is open to public scrutiny.

Historically, cattle and vegetable farms, and more recently sugarcane, vegetable, and sod farms, have covered the EAA. Twenty percent of the sugarcane land, and all of the vegetable farms lie fallow during the summer months.

Two major agricultural concerns have led to the introduction and expansion of rice production in the area. These are both related to the 50-90% organic matter content of the native soils. First, in order to improve soil tilth and seed-bed properties, some vegetable growers began planting rice as a soil conditioning crop during the summer fallow periods.

Second, a major regional concern is the loss of the organic soil mass, called subsidence. When these soils were drained, the land surface began falling for a number of reasons: loss of bouyancy, peat shrinkage, fires, wind erosion, and most importantly, aerobic microbiological decomposition (oxidation).

Subsidence caused by oxidation is a common occurrence when organic soils are

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2. T. J. Schueneman, Extension Agent IV, Palm Beach County-Belle Glade and G. H. Snyder, Soil Scientist, Everglades Research and Education Center-Belle Glade, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611. The use of trade names in this publication is solely for the purpose of providing specific information. It is not a guarantee or warranty of the products named and does not signify that they are approved to the exclusion of others of suitable composition.

drained. As these carbon-based soils decompose, their constituent parts vaporize as carbon and nitrogen products, dissolve and are moved into ground water and canals by fluctuating water tables, and are lost by water and wind erosion.

The University of Florida has shown, and recommended for years, that summer-fallow fields be kept flooded to reduce all of these causes of soil loss. This practice is highly visible and, since it restricts the normal drainage and subsequent water flow, comes under public scrutiny, especially during periods of drought.

Fallow flooding, by itself, has a positive economic benefit by reducing soil-borne pest pressure on subsequent crops, thus reducing significant pest management costs.

However, fallow flooding incurs considerably more operating costs than the practice of dryland fallow. Fields to be flooded must be closely managed, completely enclosed by a berm that must be constructed and maintained for 6-12 weeks, then removed. Pumping costs to maintain water levels may be substantial. To defray these costs, it was only a small additional step to establish milling facilities for the rice grain already being grown on fallow-flooded fields destined for vegetables and sugarcane.

Environmental Factors that Promote South Florida Rice Production.

The topography of the southern third of the Florida peninsula is nearly level and poorly drained. The climate for most of the year is temperate to sub-tropical. Long day-length and a high level of solar energy during the ripening period contribute to favorable rice yields in the region. Warm temperatures that favor seed germination and plant growth are the norm. Rainfall is abundant during the summer growing season and sea breezes help to reduce the negative effects of high humidity. High rainfall coupled with level topography facilitate water management in flooded rice paddies.

Rice Doesn't Actually Need to be Flooded to Produce a Crop

We usually see rice plants being produced under flooded conditions because rice is well adapted to a semi-aquatic habitat. As with many water inhabiting/tolerating plants, rice stems contain a specialized type of tissue called aerenchyma cells. These specialized cells facilitate air movement from the leaves to the roots by forming hollow tubes within the plant. However, rice can be grown “upland” without being flooded. Certain varieties do better than others under non-flooded conditions. However, upland grown-rice produces significantly lower yields than paddy rice and requires abundant moisture at frequent intervals. For commercial rice production, paddy rice is the preferable method.

Water Requirements of Rice and Other Crops

Growing paddy rice as a summer cash/cover crop has addressed both the soil conditioning and the soil mineralization concerns in the EAA. However, is its water requirement greater than other crops grown in the area? Are we wasting water growing rice?

The reason for rice growth enhancement under flooded conditions has been pondered by many scientists, but has not been fully resolved. Some have suggested that flooding is needed mainly for weed control, or to maintain plant available levels of iron or phosphorus, or to support nitrogen fixing algae. However, the flood culture is not needed to supply unusually large amounts of water to the plant. Over 35 years ago the plant physiologist Lin pointed out that “there is no evidence that throughout its growing period the rice plant has a water requirement especially higher than that of dryland plants." This conclusion is born out by data collected in Florida on the combined evaporation from the soil surface and the evaporation from the leaf surfaces (transpiration), a combination called evapo-transpiration (ET) (Table 1).

Perennial crops such as citrus, pasture, and sugarcane have a large biomass in the field throughout much of the year and, therefore, high rates of ET.

Because rice is an annual it requires relatively little water during the months when it has relatively low biomass. Rice ET is greatest for a 5 to 6-week period beginning with the initiation of the reproductive phase and concluding several weeks before the grain is ready to harvest. Only during the months of June and July is the rice ET requirement greater than five inches of water.

Rice planting begins in February and continues through May. Only about 120 days elapse from seeding to harvest, and a second “ratoon” crop (regrowth of the first crop) can be obtained in another 70 days. Fortunately, the rice plant's period of highest water requirement usually coincides with the summer rainy season in Florida. Thus, the water requirement falls below normal monthly precipitation. Furthermore, rice ET almost always is below that of the native sawgrass that once covered the Everglades, and still predominates in some water storage areas.

Summary

In addition to the obvious benefits accruing from rice production such as increased summer employment, a local food supply, and a general enhancement of south Florida's economy, there are some important environmental benefits as well. Rice uses less water to produce a crop than sugarcane, citrus, pasture, or even the native sawgrass. In most months its evapo-transpiration requirement is less than all other crops grown in the area.

The richest, most productive soils in the state, the organic soils of the Everglades Agricultural Area, were formed under a flooded condition. As stated earlier, these soils are being lost by biological oxidation that accompanies drainage. The flood culture used for rice stops this loss of soil. It also stops the formation of nitrate – nitrogen that results from oxidation – which reduces the problem of nitrate enrichment of surface and ground waters.

Flooding is a biological means of controlling nematodes and soil borne insects, which reduces the need for pesticides on crops following rice. A significant yield increase is often seen in these crops after rice.

Rice is grown in the summer, a time when excess water is the usual problem. Permanent water storage capacity is nearly expended and additional areas are needed to prevent fresh water releases into the ocean. Rice paddies increase south Florida's water storage capability and reduce the immediate need to transport and store water following rainfall events.

Finally, rice, more than any other crop, brings back the “river of grass” landscape for which the Everglades was once known.

Table 1. Evapo-Transpiration Data for Various Crops Grown in South Florida.

Month	Citrus[1]	Pasture or home lawn[2]	Sugarcane[3]	Sawgrass[4]	Rice[5]	Rainfall[6]	Pan evaporation[6]
Inches of Water							
Jan	2.09	2.01	1.42	5.61	–	1.97	3.39
Feb	2.60	2.52	1.10	4.93	–	1.97	4.00
Mar	3.58	3.35	2.52	6.24	–	3.21	5.70
Apr	4.49	4.21	3.39	7.53	1.63	2.96	6.54
May	5.31	5.20	4.80	9.64	3.07	4.74	7.06
Jun	4.41	4.25	5.98	7.05	5.82	9.08	6.24
Jul	4.88	4.80	6.50	9.95	8.43	8.58	6.36
Aug	4.80	4.80	6.69	8.80	3.05+ (2.00)	8.21	6.12
Sep	4.02	3.86	5.12	8.93	(5.00)	8.82	5.31
Oct	3.59	3.43	5.20	7.60	(3.00)	5.65	4.82
Nov	2.72	2.48	3.19	4.14	–	1.74	3.71
Dec	2.09	1.93	2.59	3.62	–	1.80	3.19
Total	44.58	42.84	48.50	84.04	22.00 (10.00)	58.73	62.44

[1]Data from Dr. Dave Calvert, Soil, Water, Atmosphere, and Plant Relationships Program, Ft. Pierce Indian River Research and Education Center, University of Florida (unpublished).

[2]Stewart, E. H. and W. C. Mills. 1967. Effect of depth to water table and plant density on evapotranspiration rate in southern Florida. Trans. ASAE 10:746-747. Mean monthly values averaged over 5 years (3 years Tifway bermudagrass and 2 years St. Augustinegrass) and over water table depths of 12, 24, and 36 inches maintained in lysimeters at Ft. Lauderdale, FL. These turfgrass evapotranspiration values are assumed to be valid for pastures adequately supplied with water.

[3]Shih, S. F. and G. J. Gascho. 1980. Water requirement for sugarcane production. Trans. ASAE 23:934-937. Data averaged over the water table depths of 12, 24, and 36 inches.

[4]From Table 13, Clayton, B. S., J. R. Neller, and R. V. Allison. 1942. Water control in the peat and muck soils of the Florida everglades. University of Florida Agricultural Experiment Station Bulletin 378. The data are for one year only. The sawgrass was not flooded but a 1-foot water table was maintained.

Table 1. Evapo-Transpiration Data for Various Crops Grown in South Florida.

[5]Shih, S. F. 1981. Rice-Water Relationships. P. III-1 to III-5 in Belle Glade AREA Research Report EV-1981-3 "Fourth Annual Rice Field Day." Assuming planting data of April 15th which is approximately the middle of the planting season. Values in parenthesis are estimates for a ratoon crop. (Rice is not always ratoon cropped.) Months with no values are periods when an April planted crop is not present in the field.

[6]Belle Glade weather records, University of Florida-AREA, PO Box 8003, Belle Glade FL 33430.