SL 208

UF UNIVERSITY of FLORIDA
IFAS Extension

Subirrigated Caladium Tuber Production and Water Use as Affected by Water Table Level[1]

C.D. Stanley and B.K. Harbaugh[2]

Most of the commercial caladium tuber production in the United States occurs in a small geographic area in central Florida near Lake Placid. Production is common on organic soils with a typically high natural water table, although some production does occur on sandy soils with deep water tables in the same geographical area. This area is ideal for growing this tropical plant which originated in the wet humid conditions of the Brazilian Amazon River basin. Much of past research on field production management has dealt with nutritional problems (Harbaugh and Overman, 1983; Wilfret and Harbaugh, 1988; Harbaugh, 1986) or control of pests and weeds (Overman and Harbaugh, 1983; Harbaugh, et al., 1988; Gilreath and Harbaugh, 1985) but because of the unique growing conditions, little work has been done to understand water management of this crop. Water management has historically not been an issue of much concern until recent years when other cultural problems have occurred which may be linked to deficit or excessive soil moisture conditions.

Typically, for production on organic soils, surface water from nearby Lake Istokpoga is released through a network of canals for use by agriculture as needed. Caladium producers are self-regulating with respect to when, where, and how much water is directed into production fields. Mole drains are used to attempt to distribute water uniformly throughout a production field during an irrigation period and to drain the fields when excessive rainfall occurs. The target water table level to maintain in the field is approximately 60 cm below the soil surface. The common practice is to raise or lower the water level in rim ditches surrounding the production areas in order to achieve the target water table level and avoid extended periods of time when the water table is too high (because of rainfall) or too low. There is evidence that the practice may have little or no effect on the resulting water table level in the field, since in a preliminary field study, no relationship between rim ditch water level and field water table level was detected for an entire season (Stanley and Harbaugh, unpublished data). Since few caladium producers monitor water table position in their production fields, they are usually unaware of what is happening in the field. Also, since there seems to be very little control over the field water table level, the target

1. This is document SL 208, a publication of the Soil and Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Published October 2003. Please visit the EDIS Website at http://edis.ifas.ufl.edu.
2. C.D. Stanley, professor, Soil and Water Sciences and B.K. Harbaugh, professor, Environmental Horticulture, Gulf Coast Research and Education Center, Bradenton, Florida Cooperative Extension Service, IFAS, University of Florida, Gainesville, FL 32611.

water table level may not be appropriate, as evidence shows that it isn't being controlled at that level. This results in two primary issues to be addressed: 1) the need to determine what target water table level best suits caladium tuber production, and 2) the need to develop improved in-field water distribution and water table level control. Because of this situation, a study was conducted to determine what the target water table level should be for optimum tuber production. Once this is determined, improved water management to maintain this level in the field should result in higher and more consistent tuber yields.

Materials and Methods

A study was conducted over two growing seasons (April/May to November/December) in 1998 and 1999 at the Gulf Coast Research and Education Center in Bradenton, Florida. Two different caladium cultivars were used in the study, 'White Christmas' in 1998 and 'Florida Cardinal' in 1999. A field-located lysimeter installation was used to allow improved control of water table level treatments of 30, 45 and 60 cm depths. The facility consists of 16 independently controlled experimental units. Fifteen units were used for this study (three water table level treatments and five replications). Each experimental unit consisted of four growing tanks (58 cm diameter and 76 cm deep) connected by a manifold (mounted at the bottom of the tanks) which is connected to a water table level controller and reservoir tank. An organic soil mix was used in the growing tanks to simulate the common organic muck soil conditions in the geographic areas of central Florida where caladiums are commonly grown. As the water table level in an experimental unit declined due to water uptake by the plants, a float-controlled valve opened to allow water to flow into a tank connected to the manifold until the water level was equilibrated at the desired level, after which the valve closed. Additional amounts of water added because of rainfall events were also taken into account. After rainfall events, treatment water table levels were checked and reestablished if necessary by removing and recording necessary amounts of water if target water table levels were exceeded. The total amount of water needed to maintain the target water table levels (including that added from the reservoir tank and rainfall and subtracting any amounts removed) for a specific time period was assumed to be the evapotranspiration which occurred for that specific period.

Caladium seed pieces were planted in two rows, 18 cm apart with 20 seed pieces in each row (10 cm apart) for a total of 40 plants per experimental unit. All seed pieces were hot-water treated for disease prevention and dusted with dolomite. Planting dates were 29 April 1998 and 12 May 1999 for 'White Christmas' and 'Florida Cardinal', respectively. A slow-release fertilizer formulated for 100-day release (Nutricote 10-10-17) was applied at a rate of 5 gm plant^{-1}. All border areas between lysimeter units and within the facility were planted with buffer plants to simulate plant density and foliage coverage under actual field conditions. These plants were microirrigated so that none of the applied water would interfere with the water table level treatments.

Harvest dates for 'White Christmas' and 'Florida Cardinal' were 17 Nov 1998 and 8 Dec 1999, respectively. Caladiums tubers were graded into size classes (Mammoth, Jumbo, #1, #2, and #3) with numbers and tuber weights measured. A production index which integrated the relative value of different tuber size classifications was used (Harbaugh and Overman, 1983) to assimilate all yield data into distinct value and provide an overall description of relative harvest value. This production index (PI) was determined by: PI = a+ 1.5b + 3c + 6d + 9e, where a, b, c, d, and e were the numbers of tubers in the No. 3, No. 2, No. 1, Jumbo and Mammoth size grades, respectively.

Yield data were statistically analyzed and water table level treatment mean separation were determined using Duncan's multiple range mean separation procedures. In addition, these yield data were analyzed with respect to specific water use data using regression procedures to determine if any significant relationship existed.

Results and Discussion

Table 1 contains the tuber yield data for each cultivar as affected by water table level treatments. Results for 'White Christmas' showed significant mean separation among water table level treatments for the numbers of jumbo and mammoth tubers and for the production index. Significant differences were detected for total tuber weight among all water table level treatments. The results for 'Florida Cardinal' showed similar results, except that there was no difference between the 30 and 45 cm treatments with respect to total tuber weight or production index, while both treatments were still significantly higher than the 60 cm treatment. These yield results indicate that the water table level influences caladium tuber production, likely by influencing the soil moisture content in the rooting zone.

Since crop water use could be estimated for each individual replication within each water table level treatment, a comparison of total tuber production for each experimental unit to the corresponding water use was made using regression analysis. This analysis procedure treated each experimental unit independently regardless of its imposed water table treatment while recognizing that the water use was influenced by the water table level treatment. Figure 1 graphically shows the results of these analyses for each cultivar. While both linear and quadratic models were significant for 'White Christmas', only the quadratic model is shown because the coefficient of determination (r^2) was significantly higher. The quadratic model for Florida Cardinal did not improve the r^2 significantly over the linear model, thus only the linear model is shown. Both cultivars show a very significant relationship between water use and tuber production (r^2=0.82 and 0.92 for 'White Christmas' and 'Florida Cardinal', respectively. Since water use is directly influenced by the availability of water to the plant and subsequent plant mass production, it is logical that the higher the water table, the more water would be available leading to less potential for plant water stress to occur and allow for maximum plant mass production. Even though a water table level 30 cm might be considered excessively high for most crops, it was not the case for caladiums in this study. This trend in tuber production with respect to water use is consistent with results from a greenhouse pot study where tuber weights increased with increased irrigation rates (Overman and Harbaugh, 1988).

Conclusions

It is apparent from these results that caladiums are a crop which thrive under high soil moisture conditions, which is understandable given the origin of the plant species. The comparison between water use tuber production indicate more tuber weight is produced when more water is available. Since it is known that waterlogged conditions can cause aeration and tuber problems, a proper balance between drainage and irrigation must be maintained. However, from these results, it appears that a higher target water table level (30 cm) might be warranted to maximize tuber production as long as the ability exists to drain the field of excessive amounts of water from rainfall.

References

Gilreath, J. P. and B. K. Harbaugh. 1985. Chemical weed control in caladiums. HortScience 20(6):1056-1058.

Harbaugh, B. K. 1986. Visual nutrient deficiency symptoms in *Caladium* x *hortulanum* Birdsey. J. Amer. Soc. Hort. Sci. 111(2):248-253.

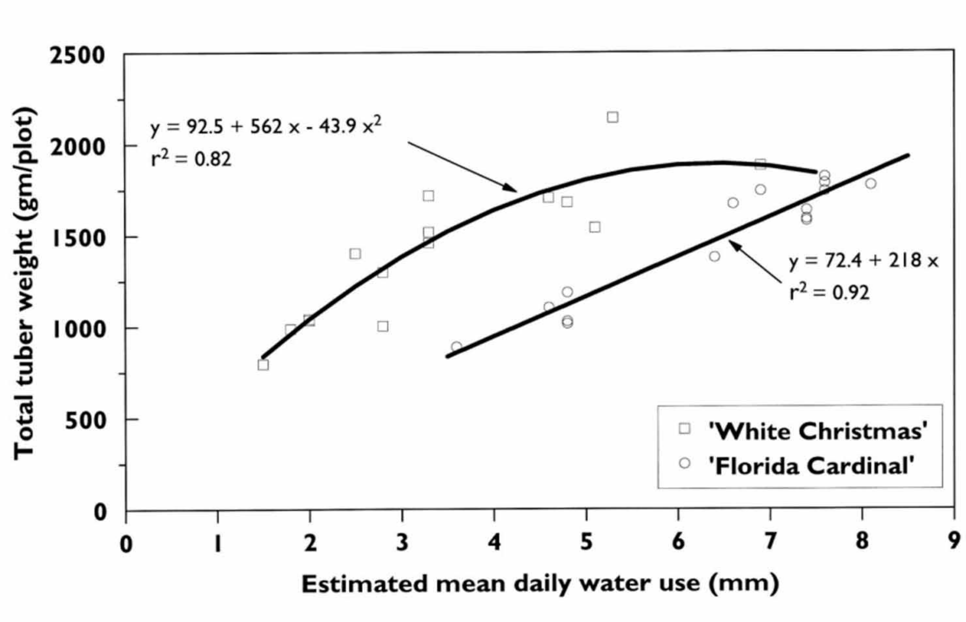
Harbaugh, B. K. and A. J. Overman. 1983. Evaluation of fertilizer types and rates on *Caladium* x *hortulanum* Birdsey Candidum tuber production in muck and sandy soil management systems. Proc. Fla. State Hort. Soc. 96:250-254.

Harbaugh, B. K., G. J. Wilfret, and A. J. Overman. 1988. Tissue cultured stock history and hot water treatment affect caladium tuber production on sandy soils. Proc. Fla. State Hort. Soc. 101:305-307.

Overman, A. J. and B. K. Harbaugh. 1983. Soil fumigation increases caladium tuber production on sandy soil. Proc. Fla. State Hort Soc. 96:248-250.

Overman, A. J. and B. K. Harbaugh. 1988. Relationship of caladium tuber size to water use in production. Proc. Fla. State Hort. Soc. 101:311-312.

Wilfret, G. J. and B. K. Harbaugh. 1988. Propagule spacing and nutrition influence production of caladium tubers. Proc. Fla. State Hort. Soc. 101:307-310.



y = 92.5 + 562 x - 43.9 x2
r2 = 0.82
y = 72.4 + 218 x
r2 = 0.92
'White Christmas'
'Florida Cardinal'
Total tuber weight (gm/plot)
Estimated mean daily water use (mm)
2500
2000
1500
1000
500
0
0 1 2 3 4 5 6 7 8 9

Figure 1.

Table 1. Mean caladium tuber size class, weight and numbers, and production index for each water table level treatment for 1998 ('White Christmas') and 1999 ('Florida Cardinal').

Year	W.T.[z] Level (cm)	Total tuber Weight (g)	Mean number of tubers No. 3	No. 2	No. 1	Jumbo	Mammoth	PI[y]
1998	30	1791 A[x]	1.6 a	5.8 a	21 a	15 a	1.4 a	43 a
	45	1400 B	1.4 a	6.6 a	20 a	13 ab	1.2 a	41 a
	60	1052 C	1.6 a	7.2 a	23 a	8 b	0.4 b	32 b

Year	W.T.[z] Level (cm)	Total tuber Weight (g)	Mean number of tubers No. 3	No. 2	No. 1	Jumbo	Mammoth	PI[y]
1999	30	1741 A	0.12 a	0.5 b	3.9 a	5.5 a	5.2 a	94 a
	45	1601 A	0.46 a	0.9 ab	3.9 a	5.9 a	4.4 a	88 a
	60	1044 B	0.46 a	1.5 a	5.9 a	5.8 a	1.5 b	69 b

[z] W.T. Denotes water table level treatments.
[y] PI denotes production index.
[x] Means followed by different letters within columns indicate significant statistical differences (p = 0.05).