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The Effect of Three Sediment Types on Tuber Production in Hydrilla [*Hydrilla verticillata* (L. f.) Royle]

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ABSTRACT

Production of tubers by hydrilla [*Hydrilla verticillata* (L.f.) Royle] was studied for plants grown in outdoor aquaria in three different soil types. Sand, marl, and potting mix were used. The results show that the instantaneous rate of tuber production is an intrinsic property of the plant and independent of soil type. The number of tubers produced and sustained is a function of soil fertility. It is hypothesized that soil fertility influences the initiation of tuber production.

Key words: Hydrilla, tubers, growth, production, analysis of covariance.

INTRODUCTION

Significant management problems are caused by the submersed aquatic weed hydrilla in many Southeastern water bodies. It was introduced to Florida around 1960. By 1980, it infested approximately 327,000 ha of the larger public lakes and rivers (Tarver et al. 1980). The only known mode of reproduction of hydrilla in Florida is vegetative, either by plant fragments or turions. Turions are dormant, compact apices in which food reserves are stored. They detach from the parent plant and serve as propagules for new growth. One type of turion, formed at the tip of a rhizome growing in the sediment, is known as a tuber. Tubers are particularly troblesome since they can serve as a source of regrowth in areas in which above ground material has been controlled by chemical or mechanical methods. Up to 10 million tubers per hectare have been reported (Mitchell 1974). Even with the most effective herbicides, knowledge of the factors which influence tuber production are essential for the development of sound long term management practices. The work of Van et al. (1978) has shown that daylength and temperature are two factors which influence tuber production and preliminary work we did indicated that sediment type is another. This study was designed to evaluate how different types of sediments influenced tuber production.

MATERIALS AND METHODS

Hydrilla was grown under ambient conditions in outdoor aquaria in three soils of differing texture and fertility at the University of Florida Research and Education Center, Ft. Lauderdale, Florida. Twelve cement aquaria were used, each 0.77 m wide and 2.19 m long and filled with pond water to a depth of 0.55 m resulting in a volume of 927 L. Aluminum trays, 30.5 cm on a side and 15.0 cm deep were filled with one of three different soil types. These were planted with five, 15 cm apical fragments of hydrilla. Twelve trays were placed in each aquarium. After the plants were established they were harvested at four-week intervals. Eight trays of each sediment type (two randomly assigned trays from each of four aquaria) were removed at each harvest. Above ground plant material was harvested, rinsed, and oven dried at 60 C to constant weight. Tubers were collected and counted by passing the sediment through a screen of small mesh.

The experiment was initiated in December 1981 and continued for 28 weeks. Aquaria were flushed weekly and brought to volume with pond water. The first harvest was done eight weeks after initial planting. Sediments used were commercially available builder's sand, calcareous marl, and a potting soil mix of 30% sand and 70% muck. Sediments were analyzed for nutrients and organic matter following procedures outlined in Allen et al. (1974).

Tuber data for each sediment and harvest date were examined using analysis of covariance. In order to satisfy the homogeniety of variance assumption of the statistical methods, a natural log transformation of the counts were used. Computations were performed using the Statistical Analysis System (SAS Institute Inc. 1982) on an IMB 4033 computer.

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RESULTS AND DISCUSSION

Based on the chemical analysis of the soils (Table 1), sand was the least fertile sediment, followed by marl and then potting mix. The above ground standing crop harvests are presented in Table 2. Sand supported the least amount of biomass. The lack of increase, or in fact the loss of standing crop in the infertile sand indicates the nutrient stress experienced by these plants. Standing crop in the other two sediments was variable on a temporal basis but similar in range and magnitude throughout the study.

Data for the average number of tubers per tray for each soil type over time are presented in Table 3. They show that the number of tubers increased for each sediment through the sixteenth week, after which the number stabilized. However, the stabilization level was different for each soil type.

Due to this non-linear trend, the data were divided into two groups for the analysis of covariance. The first group contained data for weeks eight through sixteen inclusive. These showed a significant slope for the relationship between log tuber counts and weeks for each sediment. Slopes of these lines were equal for all sediments and represented the instantaneous rate of tuber production.

TABLE 1. ORGANIC MATTER AND NUTRIENT VALUES FOR THE VARIOUS SOILS USED IN THE EXPERIMENT. ALL VALUES ARE EXPRESSED ON A PERCENT DRY WEIGHT BASIS.

	SAND	MARL	POTTING MIX
Organic matter	0.085	2.820	9.400
N	<0.001	0.141	0.308
P	0.003	0.025	0.048
K	0.000	0.007	0.014

TABLE 2. ABOVE GROUND STANDING CROP (GRAMS AT 60 C/TRAY) OF HYDRILLA FOR EACH SAMPLE DATE. THE VALUES ARE THE MEAN STANDARD ERROR OF THE MEAN (IN PARENTHESES) FOR EIGHT REPLICATES. THE EXPERIMENT WAS INITIATED IN DECEMBER 1981 AND TERMINATED IN JULY 1982.

WEEKS POST-PLANTING	SAND	MARL	POTTING MIX
8	1.25(0.08)	3.80(0.34)	2.95(0.49)
12	1.11(0.14)	7.00(0.91)	5.23(0.66)
16	1.00(0.35)	11.20(1.21)*	7.10(1.09)
20	0.70(0.29)	6.60(1.05)	7.18(0.44)
24	0.64(0.18)	8.20(0.69)	8.53(0.54)
28	1.08(0.19)	25.30(3.72)	23.19(3.38)

*These values were for n = 6.

The number of tubers for the first harvest (week eight) was different for each sediment. The combination of different initial numbers and equal slopes resulted in an increasing disparity in the actual number of tubers for each of the sediments with time; similar to compound interest accounts which begin with different initial deposits.

The difference among sediments in numbers of tubers present at the first harvest could be caused by one of two factors. First, the time of onset of tuber production could differ among sediments, or production may start at the same time for all sediments, but the rates of production could differ prior to the eighth week. Since we found equal instantaneous rates of production in our study, we hypothesize that the difference is due to varying dates of onset. Additional experiments are needed to evaluate this hypothesis.

In the second time period, weeks twenty through twenty-eight, the slopes of the regression lines were not significantly different from zero. Differences were observed in the level at which tuber numbers stabilized for the three sediments. This value represented the ability of each soil type to sustain a tuber population. The implication was that the more fertile the sediment the greater the population of tubers.

Our results indicate that at least two sets of factors, intrinsic physiological and external environmental factors influence tuber production. The instantaneous rate of production was independent of soil type and appeared to be regulated by some sort of inherent mechanism. The fact that the slopes were equal for each of the two time periods, regardless of sediment-type, supports this conclusion. The significant differences among soil types for the number of tubers produced and the inferred differences in initiation of tuber production indicated the influence of external factors.

There was no increase in tuber numbers after twenty weeks. Several hypotheses could explain this phenomenon. One would be that no more tubers were produced since the carrying capacity of the plant's environment was reached. Another would concern the effect of daylight in controlling tuber production. For the latitude of the study location, there was a photoperiod of 12.7 hours sixteen weeks after the initiation of the experiment. This was slightly less than the 13 hours suggested as the critical daylength for cessation of tuber production by Van et al (1978). A third possibility could be that the rate of new tubers being formed was equalled by those lost due to decay, resulting in a net gain of zero.

In the management of any weed problem the ultimate goal is for the predictable control of the target species. This

TABLE 3. MEANS AND 95% CONFIDENCE INTERVALS FOR THE NUMBER OF TUBERS PER TRAY. VALUES BASED ON BACK-TRANSFORMED NATURAL LOG DATA.

	WEEKS AFTER PLANTING					
SOIL TYPE	8	12	16	20	24	28
SAND	2.4 (1.4-4.2)	5.3 (4.0-7.1)	8.8 (7.5-10.2)	7.7 (5.9-10.0)	8.3 (6.4-10.7)	8.4 (6.4-11.0)
POTTING MIX	3.2 (1.6-6.5)	13.1 (8.4-20.5)	22.0 (15.9-30.5)	20.2 (14.1-28.9)	21.2 (18.4-24.5)	22.7 (19.8-26.1)
MARL	7.8 (5.1-12.0)	26.0 (17.2-39.2)	40.4 (25.8-63.2)	42.0 (33.4-52.9)	46.7 (34.2-63.9)	42.7 (34.7-52.5)

goal is rarely met and other aspects of a management program become important, for example, the ability to predict the efficacy of a herbicide under different conditions or the potential severity of an infestation. The results of this study indicate that elimination of tuber production cannot be obtained by altering the nature of the sediments since the rate of production was independent of soil type and even in the most infertile soil tubers were still produced. However, our study showed that predicting the severity of tuber infestation might be possible if sediment fertility characteristics for a water body were known.

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