Some Characteristics Of Hydrilla Tubers Taken From Lake Ocklawaha During Drawdown[1]

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ABSTRACT

Subterranean propagules (tubers) of hydrilla (*Hydrilla verticillata* [L.f.] Royle) were harvested from five different water depths at Lake Ockalawaha (Rodman Reservoir) during the drawdown in January 1975. Increases in tuber size and number per square meter were correlated with increases in water depth. When tubers were sprouted either in continuous light or darkness, the highest sprouting percentage was observed in tubers harvested at 0.6 to 1.2 m depths. When tubers were sprouted under various light, nitrogen, and air regimes, only light was found to have a stimulatory effect on hydrilla tuber sprouting. Light quality had no effect on tuber sprouting. Starch was found to be the main carbohydrate stored in the tuber, while crude protein, sucrose, lipid, and reducing sugars occurred in much lesser amounts. Ca and K were the predominant minerals present.

INTRODUCTION

Problems associated with the control of hydrilla are greater than those associated with the control of other aquatic macrophytes. This plant has become a primary nuisance, and defies effective control measures through its ability to multiply profusely and produce large standing crops under a variety of environmental conditions (4, 7, 8, 10). Haller and Sutton (4) reported that competition from other plants is almost negligible because of the presence of millions of hydrilla propagules per hectare and the dense canopy produced. Tubers are considered to be the primary mode of hydrilla reinfestation. Mitra (6) reported that once tubers begin to germinate, only 12 to 14 days are required for formation of a fully developed plant.

Tuberization of hydrilla will occur at any depth of water in which rooted canopy grows. The purposes of these studies were to define some of the chemical and physical characteristics of tubers and to determine if there are sprouting differences among tubers formed at five different depths in Lake Ocklawaha.

METHODS AND MATERIALS

Hydrilla tubers were collected from the Kenwood area of Lake Ocklawaha during drawdown in January 1975. The lake is located in north central Florida, about 40 miles southeast of Gainesville. Mature tubers were taken from water depths of 0.3 to 1.5 m. The tubers were located 8 to 20 cm below the hydrosoil. When possible, 1.0 m^2 by 15-cm-deep blocks of hydrosoil were excavated; however, when deeper samples were required, hydrosoil was ob-

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tained with a core sampler. The excavate was washed on a screen to separate tubers from hydrosoil. The tubers were then stored in the dark at 24 C in plastic bags containing moist peat.

Tubers were incubated in Petri dishes under either continuous darkness or light (12 μEinsteins$\cdot m^{-2}\cdot sec^{-1}$) at 28 C for 14 days. Four replicate dishes of 15 tubers each were prepared for every depth and light/dark treatment combination.

A second experiment was conducted to observe the effect of light quality on tuber sprouting. Four replicates of 15 tubers each were placed in each of four wooden boxes topped with blue, red, green, or white light filters. Resulting light intensities were 30, 17, and 10 μEinsteins$\cdot m^{-2}\cdot sec^{-1}$, respectively. Sprouting was recorded on the 7th day of treatment.

In the third experiment, tubers were subjected to aerobic and anaerobic conditions. Tubers were placed at 28 C under either continuous light or darkness in 250-ml Erlenmeyer flasks containing two sheets of filter paper and 10 ml water. Four replicates of 15 tubers each were prepared for each treatment. Anaerobic-treatment flasks were flushed with N_2 and sealed with lanolin-coated stoppers. Plastic wrap used to cover the stoppers was secured with rubber bands. Aerobic-treatment flasks remained open.

Tuber carbohydrate content, including starch, sucrose, and reducing sugars, was determined by the method of Carter et al (3). Nitrogen was determined by salicylic acid modification of the micro-Kjeldahl technique (5), and protein was calculated from nitrogen data. Lipids were measured by the method of Official Analytical Chemists (1). University of Florida Analytical Research Laboratory analyzed dried tubers for mineral composition by means of atomic absorption spectroscopy and flame emission spectrophotometry, the latter being used to estimate K and Na.

RESULTS AND DISCUSSION

Number of tubers per square meter and average tuber fresh weight increased significantly with increases in depth of water above the harvest site (Table 1). In contrast, Mitra (8) found greater numbers of tubers in the shallow areas of a pond than in the deeper parts. Doubtless, these contradictory observations result from differences in the climate and soils of the sampling areas.

TABLE 1. DISTRIBUTION, FRESH WEIGHTS, AND LIGHT- AND DARK-SPROUTING OF HYDRILLA TUBERS FOUND AT VARIOUS WATER DEPTHS.[1]

Depth (m)	Tubers/m^2	Tuber weight[2] (mg fresh wt)	Percent sprouting	
			light	dark
0.3	293	188 a	43.3 a	10.0 a
0.6	326	230 b	86.7 b	61.7 b
0.9	605[3]	236 b	63.3 ab	46.7 b
1.2	—	273 c	68.3 ab	25.0 a
1.5	—	290 c	45.0 a	13.3 a

[1]Sprouting was conducted at 28 C in either light (12 μEinsteins$\cdot m^{-2}\cdot sec^{-1}$) or darkness. Sprouting was observed for 14 days following tuber harvest.
[2]Average tuber weight was calculated from the fresh weights of 120 randomly-selected individual tubers. Values in the same vertical column followed by different letters are significantly different from one another according to the Duncan multiple range test, $p = 0.05$.
[3]Calculated from 9-cm diameter core samples.

The increase in tuber weight with depth of water may be explained in several ways. The tubers may have remained attached to the plant for longer periods of time, thus accumulating greater amounts of metabolic reserve materials. Alternatively, the plant canopy of plants rooted at greater depths may be more efficient in the production and translocation of assimilate. Also, the hydrosoil environment at greater depths may restrict tuber respiration significantly more than in the case of shallow water tubers. The presence of large numbers of mature non-sprouted tubers at greater depths may be due to high concentrations of CO_2 in the tubers, water, and hydrosoil. Observations made in this laboratory confirm that CO_2 is effective in inhibiting tuber sprouting. The concentrations of CO_2 in the hydrosoil would increase with depth (9).

Depth of water above the tubers had a significant effect on tuber sprouting after harvest. In general, tubers harvested from 0.6 to 1.2 m depths sprouted more successfully in either light or darkness than did those from 0.3 m and 1.5 m depths. Sprouting percentages of light-treated tubers from 0.3 m and 1.5 m were similar and the lowest observed for tubers sprouted under the continuous light regime. These sprouting percentages were significantly lower than the sprouting percentage observed for tubers harvested from the 0.6 m depth. Maximum tuber sprouting was observed in tubers from 0.6 m. The same general results were obtained when the tubers were sprouted in continuous darkness, except that in all cases sprouting percentages were reduced. The reductions in sprouting response in darkness compared to light treatment were 76.9, 63.4, and 70.4% for tubers harvested from 0.3, 1.2, and 1.5 m, respectively. Sprouting percentages of tubers from 0.6 m and 0.9 m were 28.8% and 26.2% lower in darkness than in continuous light.

Mitra (8) observed that when a nursery pond filled with hydrilla was cleared of significant amounts of the canopy vegetation, within 10 days numerous small plants appeared from sprouting turions. It was not specified whether these turions were subterranean (tubers) or aboveground propagules (winter buds). In adjacent ponds where no vegetative material was removed, sprouting turions were found to occur in much fewer numbers. It was suggested that either sunlight promoted sprouting or sprouting resulted from the providing of increased space for early growth of the turions. The data reported in the present study (Table 1) clearly show that light has a stimulatory effect on the sprouting of subterranean turions of hydrilla, and that this response is achieved at very low light levels (12 μEinsteins$\cdot m^{-2}\cdot sec^{-1}$). Haller and Sutton (4) examined the penetration of light through open water and hydrilla and vallisneria communities. In open water, approximately 18% of the light impinging on the water surface reached a depth of 2.0 m (360 μEinsteins$\cdot m^{-2}\cdot sec^{-1}$). This radiation would be sufficient to stimulate the sprouting of turions and tubers located on or near the hydrosoil surface, especially if portions of tubers became uncovered. The presence of hydrilla canopy drastically reduced light

penetration (4). At a depth of 0.33 m below the surface of a hydrilla canopy, the radiation level was found to be only 70 μEinsteins$\cdot m^{-2} \cdot sec^{-1}$, and below 1.66 m depth there was virtually no light. Light stimulation of turion and tuber sprouting beneath a dense vegetative canopy would be much less than in instances where the canopy was removed. The importance of light to the growth of sprouted hydrilla propagules has been recognized (2).

The sprouting of hydrilla tubers was not significantly affected by light quality. Sprouting percentages of 98 to 100% were observed for tubers exposed to blue, red, green, and white light at photon flux densities of 10 to 30 μEinsteins$\cdot m^{-2} \cdot sec^{-1}$. Under natural conditions red light penetrates turbid water farther than other wave lengths and may have a prominent role in stimulating propagule sprouting.

Light stimulated sprouting under both aerobic and anaerobic conditions (Table 2). Sprouting percentages of light-treated tubers were similar regardless of anaerobic or aerobic treatment, as were percentages of dark-treated tubers in the two regimes. However, sprouting percentages of light-treated tubers were significantly greater than those of dark-treated tubers under both aerobic and anaerobic conditions. Thus, oxygen level may not be a critical factor regulating sprouting in the hydrosoil.

Starch was found to be the major carbohydrate form present in hydrilla tubers, followed by sucrose, with trace amounts of reducing sugars (Table 3). Crude protein, nitrogen, and lipids were present at 5.3, 0.9, and 1.0% of tuber dry weight, respectively. The organic composition of hydrilla tubers is similar to that of white potato. Ca and K were the chief mineral components (Table 4). Mg, Fe, Na, Si, Zn, Cu. Al, Mn, Cr, and Pb were present, also, in lesser amounts. Tubers were analyzed for Co, Ti and Ni as well, but levels of these were not detectable.

In summary, presence of light, water depth at tuber origin, and CO_2 concentration were found to influence sprouting percentages, tuber density, and tuber weight. Of these factors, light appeared to have the most well-defined regulatory effect. Starch was the main carbohydrate storage form, and Ca and K were the principal mineral components.

TABLE 2. EFFECT OF LIGHT ON HYDRILLA TUBER SPROUTING UNDER AEROBIC AND ANAEROBIC CONDITIONS.[1]

Regime	Percent sprouting[2]
light + N_2	96.7 a
Light + air	93.3 a
Dark + N_2	58.3 b
Dark + air	63.3 b

[1]Sprouting was conducted in 250-ml Erlenmeyer flasks in a germinator at 28 C. Anaerobic flasks were purged with N_2 gas and stoppered, while aerobic flasks remained open. Each flask contained 15 tubers, and percent sprouting was recorded on the 14th day after study initiation.

[2]Values are the averages of four replicates. Figures followed by different letters are significantly different from one another according to the Duncan multiple range test, $p = 0.05$.

TABLE 3. ORGANIC COMPOSITION OF HYDRILLA TUBERS.

Composition	Tissue content (% of dry wt)
Starch	46.80
Sucrose	4.17
Reducing sugars	0.39
Crude protein	5.30
Nitrogen	0.86
Lipids	1.00

TABLE 4. MINERAL CONTENT OF HYDRILLA TUBERS

Mineral	Tissue content (mg/g dry wt)
Calcium	3.64
Potassium	3.38
Magnesium	0.73
Iron	0.61
Sodium	0.51
Silicon	0.05
Zinc	0.04
Copper	0.04
Aluminum	0.01
Manganese	0.01
Chromium	0.01
Lead	0.01
Cobalt	<0.01

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