Carbohydrates and Agronomic Characteristics of *Miscanthus × giganteus* as Affected by Cold Storage, Rhizome Age and Size, and Plot Age

Ping Huang[1] and R. Dewey Lee[2]

[1]Department of Plant Pathology, Auburn University, Auburn, AL;

[2]Department of Crop and Soil Sciences, University of Georgia, Tifton, GA.

Introduction

Miscanthus × gigantaeus, a sterile triploid hybrid of Miscanthus sinensis and Miscanthus sacchariflorus, has been extensively evaluated as a dedicated cellulosic energy crop in the United States and Europe, with very favorable results, such as high yield with low fertilizer and pesticide inputs. Since M. × gigantaeus is sterile, it must be propagated vegetatively from stem cuttings or rhizome pieces, or by micro-propagation. Compared to stem-propagation and micro-propagation, rhizome-propagation is less susceptible to environmental changes. The identified factors that are critical to successful M. × gigantaeus establishment from rhizome in Europe and North American included rhizome size, planting depth, and storage prior to planting. However, there is no data available on these parameters under the southeastern USA growing conditions, where has a long growing season with reasonable rainfall that is ideal for growing cellulosic energy crops such as miscanthus for biomass feedstocks production. This research was aimed to evaluate effects of cold storage, rhizome length, rhizome age, and plot age on establishment of M. × gigantaeus in the southeastern USA, and to determine the relationship between rhizome carbohydrates and shoot emergence rate.

Fig. 1 Miscanthus

Fig. 2 Miscanthus rhizome

Procedure

In late February 2013, dormant rhizomes were harvested from 12-, 18-, and 44-month old plots at New Energy Farm in Tifton, Georgia. Rhizome clumps with soils were placed in plastic bags and stored at 4 ^{o}C and 75% humidity. All experiments were conducted in a growth chamber. Conditions within the growth chamber were set at a 12h day/night cycle, with supplemental lighting at the rate of 700 W m^{-2} and temperature of 27^{o}C during the day and 23^{o}C at night. On March 29, 2013 (cold storage time of 0 day), rhizomes were taken out of the cold storage room, washed, and cut into lengths of 5 cm, 10 cm, 15 cm and 20 cm. The experimental design at each cold storage time was a RCB with a split-plot restriction on randomization of rhizome length (n=3). Ten rhizomes of each length were randomly selected and placed into a smaller experimental unit within an aluminum tray, 5 cm below the surface of the potting mix (Sta-Green, N-P-K: 0.14-0.11-0.08), watered, and placed in the growth chamber. Thereafter, approximately once a month for three months (April 30, May 30, and July 11, 2013, corresponding to cold storage times of 33, 64, and 106 d, respectively) rhizomes were washed, cut, and then placed in aluminum tray and in the growth chamber.

Before each cold storage experiment, three pieces of rhizome cuttings from each treatment were taken for measuring carbohydrates using High Performance Liquid chromatography. After growing three weeks in the growth chamber, agronomic traits of miscanthus including shoot emergence rate and culm bud number per rhizome cutting were measured. Data were analyzed by using SAS PROC GLIMMIX and PROC REG procedures.

Results

Within each storage time, shoot emergence rate of 1-year-old rhizomes tended to increase as rhizome length increased up to 15 cm (Fig. 3). Shoot emergence rate for 5-cm long rhizomes maximized after storing for 2 months, while little change in emergence rate over storage time was observed for rhizomes with 10, 15 and 20 cm long (Fig. 4). Rhizome age and mother-plot age did not affect shoot emergence rate for all rhizome length levels except for 5-cm long rhizomes (Figs. 5&6).

Like emergence rate, longer rhizomes formed more culm buds than shorter rhizomes (Fig. 7). Unlike emergence rate, culm bud formation was affected by mother plot age. One-year old rhizomes dug from 12-month old plot formed highest number of culm bud, followed by rhizomes dug from 18- and 44-month old plot for all rhizome length levels except for rhizomes with 5-cm long (Fig. 8). Culm bud number of rhizomes dug from 44-month old plot did not vary very much among different ages (Figs. 9&10). Rhizomes stored under cold condition for about 2 months formed higher culm bud number when compared to other cold storage treatments(Fig. 11).

Emergence rate for 5-cm-long rhizomes dug from 12-month-old mother plot increased as the decrease in carbohydrate contents, whereas emergence rate for rhizomes dug from 44-month-old mother plot tended to increase as the increase in carbohydrate contents reached to certain levels (Figs. 12&13).

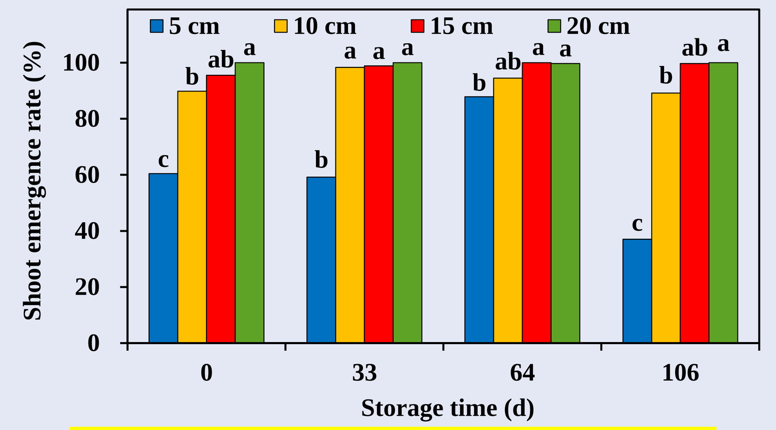

Fig. 3 Shoot emergence rate of 1-year old rhizomes under each cold storage time across rhizome length.

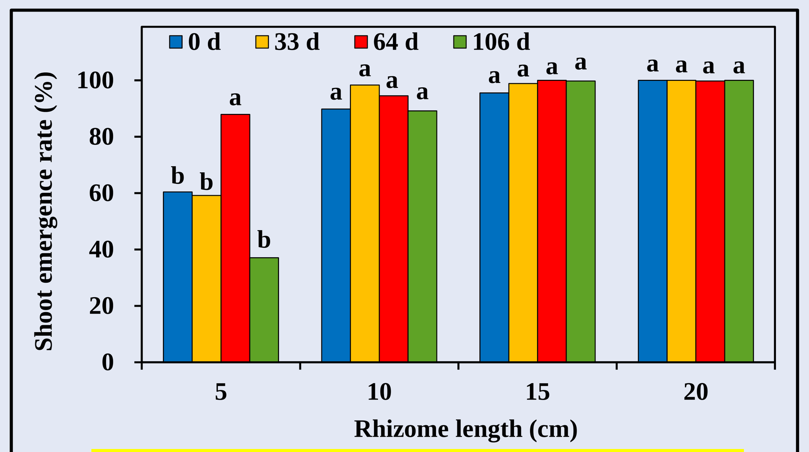

Fig. 4 Shoot emergence rate of 1-year old rhizomes under each rhizome length across cold storage time.

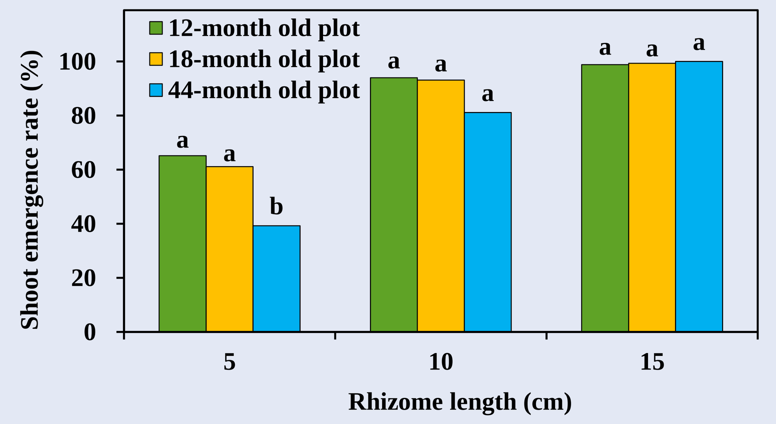

Fig. 5 Shoot emergence rate of 1-year old rhizomes under each rhizome length across mother-plot age.

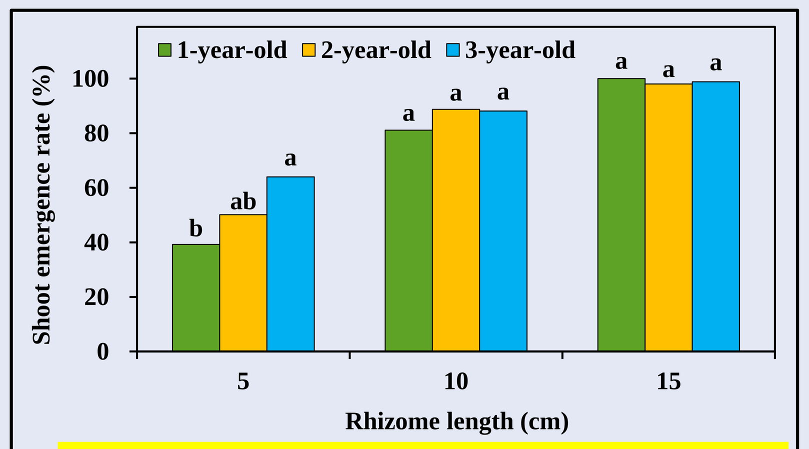

Fig. 6 Shoot emergence rate of rhizomes dug from a 44-month old plot under each rhizome size across rhizome age.

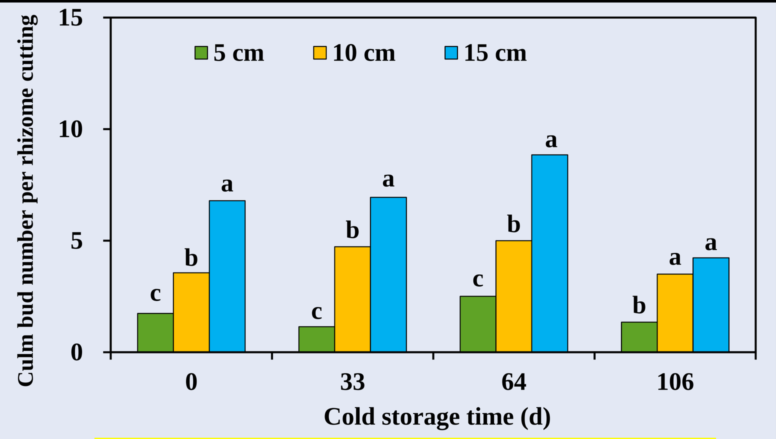

Fig. 7 Effect of rhizome length on culm bud formation of 1-year old rhizomes.

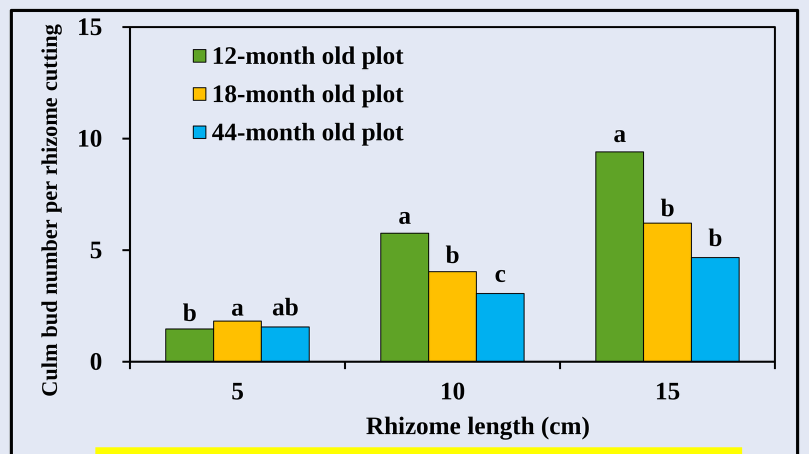

Fig. 8 Effect of mother-plot age on culm bud formation of 1-year old rhizomes.

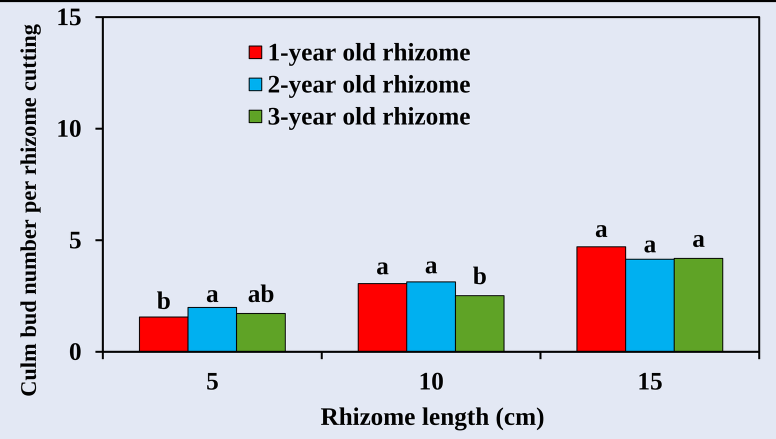

Fig. 9 Effect of rhizome age on culm bud formation of rhizomes dug from 44-month old plot.

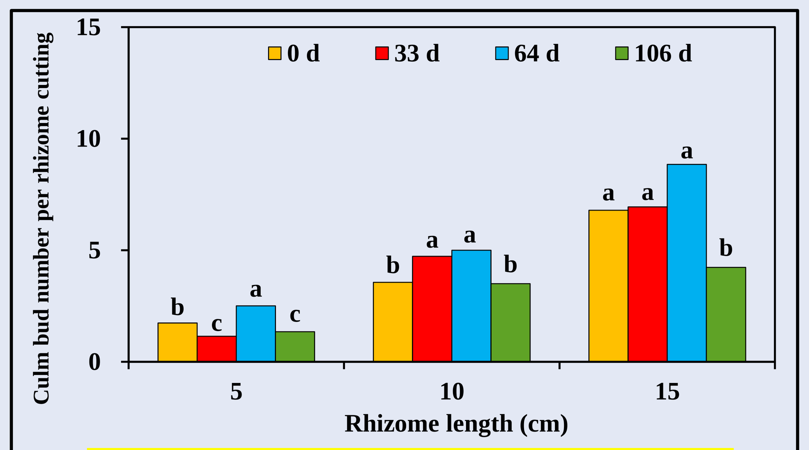

Fig. 10 Effect of cold storage on culm bud formation of 1-year old rhizomes.

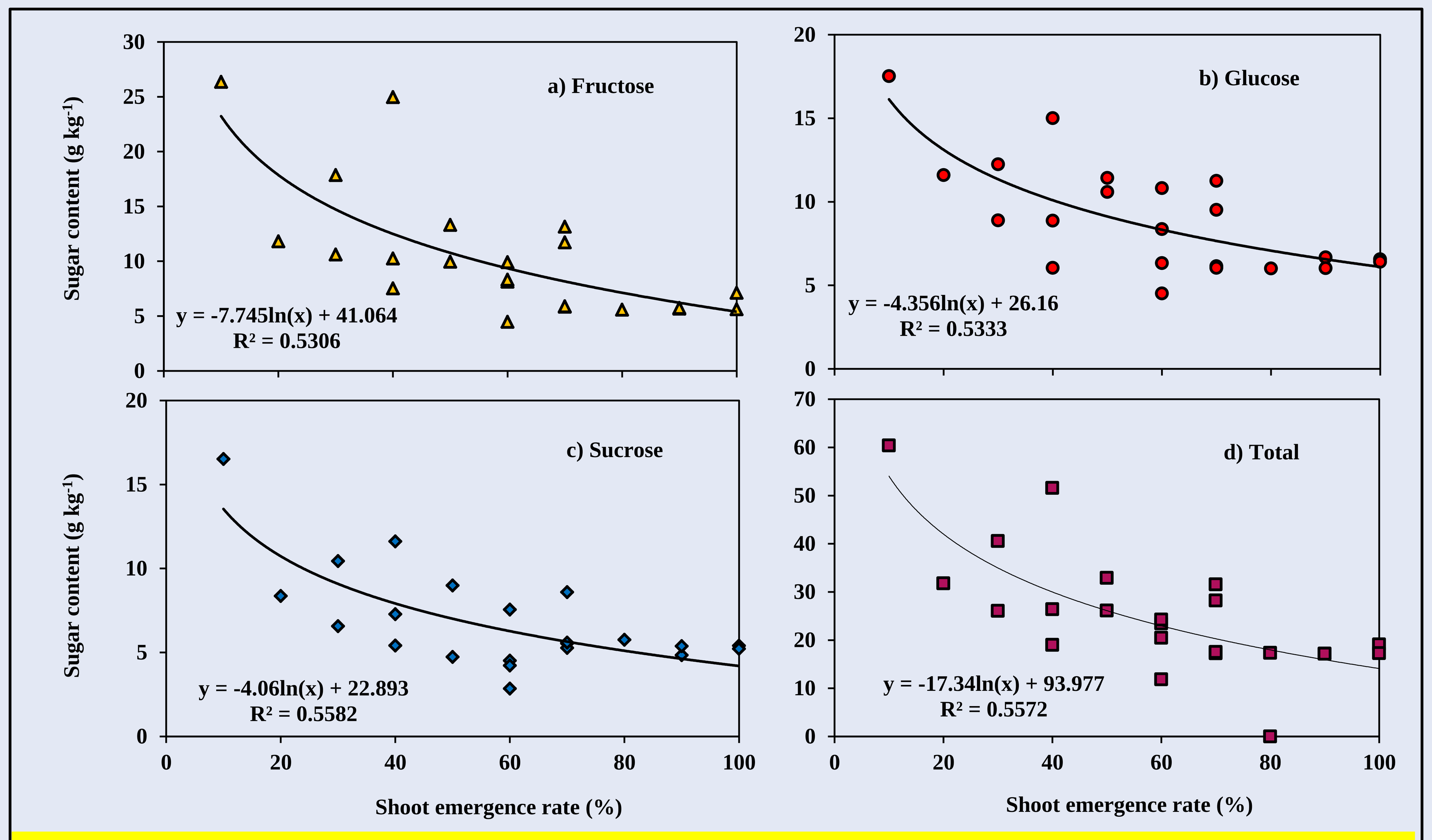

Fig. 12 Relationship between carbohydrates and emergence rate of 1-year old rhizomes with 5-cm long dug from 12-month and 18-month old plots

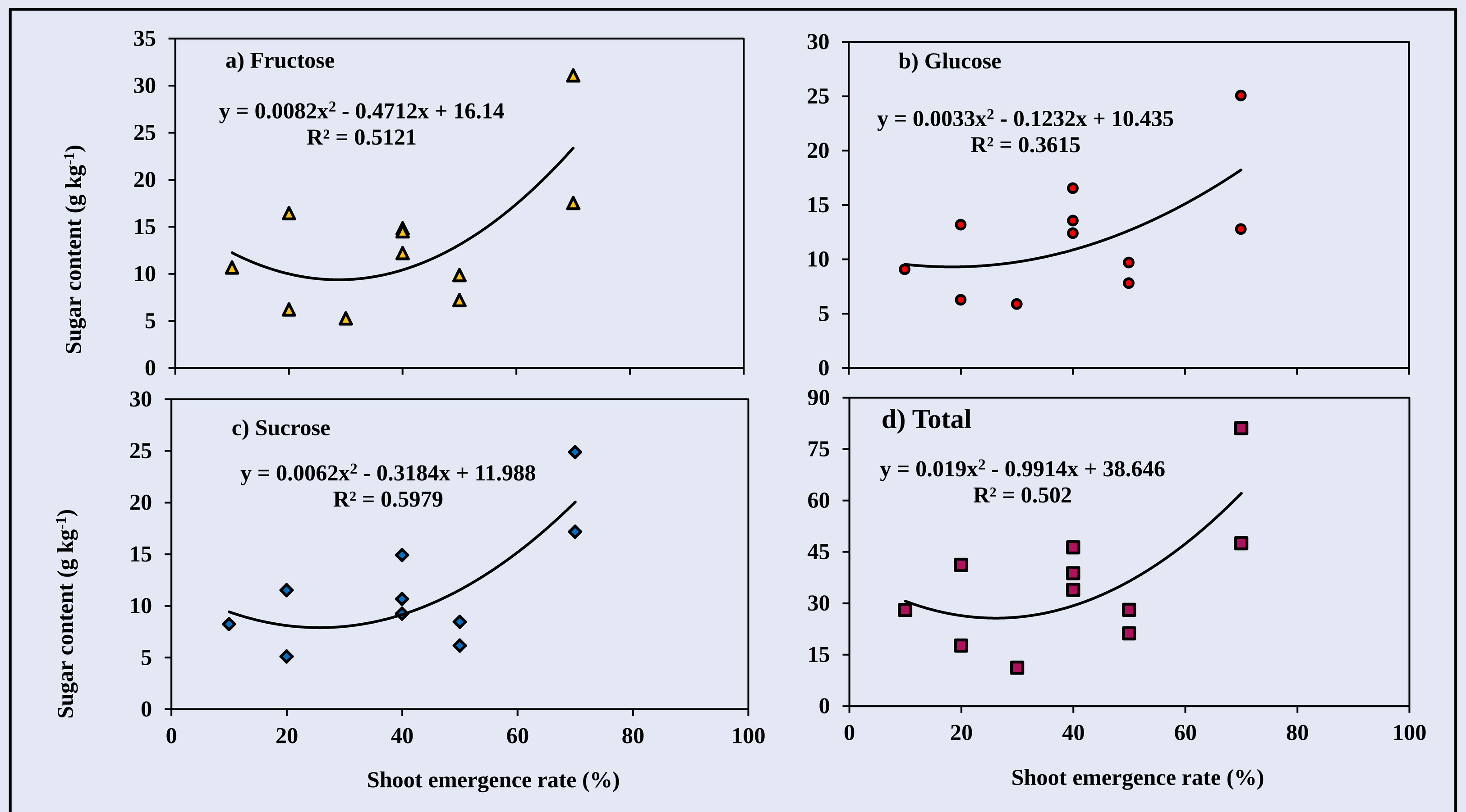

Fig. 13 Relationship between carbohydrates and emergence rate of 1-year old rhizomes with 5-cm long dug from 44-month old plots.

Conclusions

- Shoot emergence rate increased as the rhizome length increased up to 15 cm;
- Rhizome length of 10 cm would be considered long enough to ensure an acceptable emergence rate of 85-94%;
- Mother-plot age did not affect shoot mergence rate of all rhizome length levels except for 5-cm-long rhizomes, for which dug from older plots tended to have lower emergence rate;
- Shoot emergence rate for the 5-cm-long rhizomes was maximized when stored under cold condition for about 2 months;
- Emergence rate for 5-cm-long rhizomes dug from 12-month-old mother plots was negatively related to the carbohydrate contents, whereas positively related for the 5-cm-long rhizomes dug from a 44-month-old mother plot.

Acknowledgments

The University of Georgia, Department of Energy, and Mr. Robert Pippin and Ms. Susan Sladden were acknowledged for their support and assistance in this project.