PROCEEDINGS

OF THE

33rd ANNUAL MEETING

6-12 July 1997

Proceedings Edited
by
Nelson Semidey and Lucas N. Aviles

Published by the Caribbean Food Crops Society

Proceedings of the Caribbean Food Crops Society. 33:396-400. 1997

SCREENING SWEETPOTATO GENOTYPES FOR SEMI-DWARF CHARACTERISTICS UNDER CONTROLLED ENVIRONMENT

P. P. David, C. K. Bonsi, A. A. Trotman, W.A. Hill and P.A. Loretan. Center for Food and Environmental Systems for Human Exploration of Space. G.W. Carver Agricultural Experiment Station, Tuskegee University, Tuskegee AL 36088, USA.

ABSTRACT. Studies were conducted in an environmental growth chamber to evaluate sixteen sweetpotato genotypes for dwarf characteristics that may be adaptable for advanced life support systems. Plants were grown from vine cuttings (15 cm long) of the selected genotypes and planted in 0.15 x 0.15 x 1.2m growth channels using a closed nutrient film technique system. Nutrients were supplied in a modified half strength Hoagland's solution with a 1:2.4 N:K ratio. Plants were grown for 120 days. Upon termination of the study, vine length, yield and biomass data were taken. Results showed significant differences among genotypes for all parameters measured. Storage root yield ranged from 47.25- 531.2g/plant. Generally, genotypes with semi-dwarf morphology showed the highest percentage root dry mass accumulation; however, foliage biomass was lowest for these genotypes. Four genotypes were identified based on height and canopy morphology as possessing semi-dwarf characteristics that will be suitable for advanced life support systems.

INTRODUCTION

The sweetpotato is a major staple crop across the globe with production found in China, tropical America, and Africa and to a lesser extent in the United States. Currently, sweetpotato is grown in about 10 million ha in the world and 443,000 ha in the United States (Horton, 1988). Generally sweetpotato production in the United States is limited to three major Southeastern States partly due to their ideal climatic conditions. Like most of the other sweetpotato growing regions in the world, these states have also seen a decline in production over the past decade. According to Collins (1980) there is no clear distinct reason as to why sweetpotato production is decreasing, however, as stated by Hill et al (1980) the creation of new and innovative marketing tools to remove the negative imagine associated with sweetpotato consumption may overcome this stereotype. Such is the case with the recent selection of sweetpotato by National Aeronautics and Space Administration (NASA) as a candidate crop for advanced life support systems (ALS), the goal of which is to produce food for long-termed manned space missions. With this selection comes new areas of research for the adaptability of sweetpotato to such an environment.

Much work has been accomplished with sweetpotato for ALS in the areas of environmental conditions (Bonsi et al., 1992; Mortley et al., 1994 and Loretan et al., 1994), nutrition (David et al., 1996; Grant et al., 1992; Mortley et al., 1996) and cultural practices (David et al., 1995; Mortley et al., 1991). However, as with any growing system, crop adaptability through breeding and selection must be achieved in order to select the most productive cultivars for those systems. Previous studies have identified several sweetpotato genotypes that contain high root dry matter content of 25-40% (David et al., 1994), as well as those adaptable to hydroponic culture for controlled environment (Bonsi et al., 1992; Hill et al., 1992; Mortley et al., 1991). This present study seeks to identify sweetpotato genotypes with dwarf characteristics that may be adaptable for ALS.

METHODOLOGY

Sweetpotato vine cuttings, each 15 cm long, from each of the sixteen genotypes were placed in a recirculating nutrient film technique (NFT) system as described by Hill et al., (1984) and Morris et al., (1989). Vine cuttings from the genotypes W263-6/18DO, W265-LO, W235-LO-635, W155-666-DO, W294-622, -LO, W285-6/3-DO, W235-636-LO, W263-630-LO, W265-DO, W294-LO-623, W263-DO, W323-645-LO, W255-656-DO, W278-664-DO, W294-624-LO and the control, TU-82-155, were planted 25 cm apart in 0.15 x 0.15 x 1.2 m growth channels. Each channel contained four plants of the same genotype. Growing vines were held in place in the growth channels by a flat plate assembly (Morris et al., 1989).

Nutrient solution of modified half-Hoagland strength (Hoagland and Arnon, 1950) with a 1:2.4 N:K ratio was supplied at a volume of 273.6-liters. Solution was pumped to the opposite end of each growth channel by a submersible pump (Teel Model 1p680 A 2 horse power; Dayton Electric, Chicago) and spread across each channel (1% slope) in a thin film as it flowed back into the container. Nutrient solution flow rate was set at 1 liter/min using a bypass line to each container with a control valve. Nutrient solution protocol consisted of daily water replenishment to maintain the above volume. Nutrients were replenished as needed when the EC of the nutrient solution fell below 1200 mhos/cm. Solution pH was adjusted to 6.0 by adding (1 N) HCl or NaOH at the time of planting and allowed to fluctuate between 6.0 and 4.0. Plants were grown in an environmental growth chamber for 120 days at ambient CO2 levels, a diurnal temperature cycle of 28/22 oC, 70% relative humidity, and irradiance between 400-500 µmol m-2 s-1.

Plants were grown for a total of 120 days. At harvest, plants were weighed for fresh mass of foliage and storage roots. Vine length was measured from the base of the stem to the terminal portion of the vine. Foliage was dried at 70oC for 72 h and weighed. Similarly a 25g random sample of storage roots was dried and weighed.

The design used was a complete randomized design with four one-plant replicates. Analysis of variance was conducted and where F test warranted, least significant differences at the 5% level of probability was calculated.

RESULTS AND DISCUSSION

Results showed significant variation among genotypes for all the parameters measured (Table 1). Storage root mass ranged from 47.25-531.28g/plant, while foliage fresh mass range from 25.0-755.0g/plant. The genotype W263-6/18-DO was the highest storage root producer, yielding 34% more storage roots than our control genotype, TU-82-155. Typically, highest storage root mass was associated with genotypes that produce the highest foliage mass, suggesting the production of more photosynthates by genotypes with greater photosynthetic surface as a result of greater foliage mass-produced. Genotypes, W323-645-LO, W255-656-DO and W285-6/3-DO accumulated significantly higher root dry mass than W-278-664-DO, W294-624-LO, W263-6/18-DO or the control genotype TU-82-155.

Table 1. Storage root yield performance of selected sweetpotato genotypes

Genotype	Storage FW	% Root DW
W263-6/18DO	531.28a	17.2b
TU-82-155	395.15ab	17.6b
W265-LO	316.2bc	20.7ab
W235-LO-635	294.33bcd	22.6ab
W155-666-DO	268.55bcde	22.2ab
W294-622-LO	232.93bcdef	19.7ab
W285-6/3-DO	204.75bcdef	25.0a
W235-636-LO	122.98cdef	21.1ab
W263-630-LO	120.13cdef	20.3ab
W265-D0	119.58def	21.4ab
W294-LO-623	112.2def	22.0ab
W263-DO	108.23def	22.1ab
W323-645-LO	105.15def	25.4a
W255-656-DO	83.70ef	26.6a
W278-664-DO	50.63f	16.68b
W294-624-LO	47.25f	17.6b

Means within column with the same superscript are not significantly different according to the Duncan's Multiple Range Test. P<.05

Vine length was measured as a means of identifying genotypes with semi-dwarf characteristics as well as visual observations of canopy growth was done to determine compactness of the canopy (Table 2). Based on these two parameters four genotypes: W255-656-DO, W278-664-DO, W265-DO and W265-LO were identified as possessing semi-dwarf characteristics that will be suitable for ALS. Vine length for all four genotypes did not exceed that of 100cm/plant throughout the growing period while canopy showed much compactness as a result of shorter internode length, less secondary branching and limited vine spread. Generally, genotypes with semi-dwarf morphology showed greater % root dry mass accumulation than genotypes that were more vining in morphology.

To determine the relationship, if any, between semi-dwarf morphology and root production Pearsons correlation analysis was conducted. While no correlation was found between vine length and root dry mass accumulation ($r=0.19$), a significant correlation was found between vine length and root yield ($r=0.39$). This indicates that careful attention must be made in the selection of semi-dwarf genotypes that posses not only short statureness but that these plants operate at a higher photosynthetic rate such that yield may be comparable to those of plants with more foliage production.

Table 2. Foliage yield performance of selected sweetpotato genotypes.

Genotype	Foliage FW	Line Length
W263-6/18DO	611.8abcd	290.45a
TU-82-155	541.7abcde	241.33ab
W265-LO	173.5fg	100.13de
W235-LO-635	531.8abcde	201.75bc
W155-666-DO	384.5cdef	192.38bc
W294-622-LO	505.5abcde	295.0a
W285-6/3-DO	525.8abcde	168c
W235-636-LO	755.5a	275.75a
W263-630-LO	301.3def	246.00ab
W265-D0	155.ofg	94.74e
W294-LO-623	567.3abcde	186.33bc
W263-DO	708.5abc	178.05bc
W323-645-LO	440.0abcdef	182.67bc
W255-656-DO	25.0g	47.4e
W278-664-DO	260.0efg	94.75e
W294-624-LO	421.3bcdef	162.5cd

Means within column with the same superscript are not significantly different according to the Duncan's Multiple Range Test. P<.05

REFERENCES

Bonsi C.K., P.A. Loretan, W.A. Hill and D.G. Mortley. 1992. Response of sweetpotatoes to continuous light. HortScience 471-472.

Collins, W.A. 1988. Variability in sweetpotato germplasm for food quality characteristics., p.579-583. In: R.H. Howeler(ed.). Proceedings of the Eighth Symposium of the International Society for Tropical Root Crops, Bangkok, Thailand.

David, P.P., A.A. Trotman, D.G. Mortley, C.K. Bonsi, P.A. Loretan and W.A. Hill. 1995. Foliage removal influences sweetpotato biomass in hydroponic culture. Hortscience 30(5):1000-1002.

David, P.P., C.K. Bonsi, O.C. Clarke and D.Z. Douglas. Screening sweetpotato germplasm for high dry matter. Proceedings Caribbean FoodCrops Society Meeting. July 1-August 5, 1994. US Virgin Islands. pp146-149.

Hill, W.A., D.G. Mortley, C.L. Macowiak, P.A. Loretan, T.W. Tibbitts, R.M. Wheeler, C.K. Bonsi and C.E. Morris. 1992. Growing root, tuber and nut crops hydroponically for CELSS. Adv. in Space Res. 12(5):125-131.

Hill, W.A., P.A. Loretan and C.K. Bonsi (Eds.) 1984. The sweetpotato for space missions. Carver Research Foundation Inc. of Tuskegee University and George Washington Carver Agricultural Experiment Station, Tuskegee, Al.

Horton, D.E. 1988. Underground Crops. Winrock International, Morilton, Arkansas, USA. p.132.

Morris, C.E., P.A. Loretan, C.K. Bonsi and W.A. Hill. 1989. Movable root contact pressure plate assembly for hydroponic system. United States Patent Number, 860,490. 29, Aug. 1989.

Mortley, D.G., P.A. Loretan, C.K. Bonsi, C.E. Morris, and W.A. Hill. 1991. Plant Spacing influences yield and linear growth rate of sweetpotatoes grown hydroponically. Hortscience 26:1274-1275.

Mortley, D.G., C.K. Bonsi, P.A. Loretan, C.E. Morris, W.A. Hill and C.R. Ogbuehi. 1991. Evaluation of sweetpotato genotypes for adaptability to hydroponic systems. Crop Science 31:845-847.

ACKNOWLEDGMENTS

This research was funded by grants from the United States Aeronautics and Space Administration: NAGW-2940 and the Department of Agriculture: ALX-SP-1