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Yield Performance of Sweet Potato as a Specialty Crop in Delaware

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Abstract: Organic products have been popular in the local food system of Delaware. Underserved farmers are switching to growing specialty crops organically to capitalize on this niche opportunity. However, underserved farmers still face challenges becoming organic growers due to a lack of knowledge and information to find a suitable specialty crop. The objective was to grow sweet potato (*Ipomoea batatas*) in Delaware with minimum inputs. Four sweet potato genotypes were evaluated during the 2012-2014 growing season at the Outreach and Research Center (ORC) of Delaware State University in Smyrna, DE, 19901. Field experiments were conducted in a Randomized Complete Block Design with four sweet potato genotypes and three replications on a clay loam soil with a pH of 6.8 and constant agronomic practices: regular visiting plots; pulling weeds; maintaining adequate soil moisture through drip irrigation, were maintained throughout the growing season. In comparing the ungraded storage root yield, the purple-fleshed “Birmingham” showed the highest yield (34833 kg (76793.5lb) ha^{-1}) as the control, followed by “creamy fleshed” TUI-001 (31847 kg (70210.5lb) ha^{-1}), “light creamy fleshed” A-193-217 (28935 kg (63790.6lb) ha^{-1}), and “white fleshed” TI-6008 (26481 kg (58380.5lb) ha^{-1}), respectively. The results suggest that these sweet potato genotypes have shown enormous potential to be good specialty crops in the Delaware climate without adding chemicals in synthetic fertilizers and pesticides.

Key words: Underserved farmers · *Ipomoea batatas* · Genotypes

INTRODUCTION

There is an increased interest among the mid-Atlantic region’s consumers for locally grown foods, including organic produce and specialty or ethnic’ vegetables. Some farmers seek to fill the demand created by these niche markets. However, most of the underserved farmers in Delaware are still lagging in capitalizing on their opportunities due to a lack of knowledge of organic farming. Environmental quality and public health concerns about using chemicals in conventional agriculture have driven a significant increase in demand for organic food [1]. North American consumers are more interested in the sweet potato partly because of its nutritional value: it is a reliable source of beta-carotene and dietary fiber. It has a low glycemic index [2, 3]. The organic sector grew from $3.2 billion (about $10 per person in the U.S.) in 2008 to $5.5 billion (about $17 per person in the U.S.) in 2014, demonstrating that there is increased demand for organic products and opportunities for growth [4]. Although growers have obtained higher prices and seen growth in demand for organic products, many farmers are reluctant to convert to organic agriculture because of perceived risks of lower yields and challenges in managing pests [5-7]. Moreover, minority farmers in Delaware fear losing existing crops during the three-year transition to becoming organic-certified farmers. Sweet potato has the potential for low input or organic production to supply local markets because of low nitrogen (N) fertilizer requirements [8] compared with many other vegetables and because it currently has few diseases and pests in regions where sweet potato is not widely grown [16].

Sweet potato is one of the most important crops worldwide [3], with China being the largest producer. Because sweet potato requires a minimum frost-free period of 110 to 150 days (about five months), large-scale sweet potato production has been limited to the Southeast and California in the continental U.S. [9]. Sweet potato is a cheap source of calories even under adverse production conditions because of the plants’ characteristics to resist drought. Thus, most sweet potato consumed in Canada and the northern tiers of the United States are shipped long distances to reach these northern markets. Indeed, 70% of U.S. sweet potato exports to

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Canada [10]. Consumption of sweet potato in North America has increased over the past decade. In the United States, per capita consumption has increased from 4.7 lb in 2003 to 6.4 lb in 2011 [11]. However, there is limited research on sweet potato production during the transition to organic farming. Therefore, this research was designed to evaluate four non-traditional sweet potato genotypes for growth under Delaware climatic conditions.

MATERIALS AND METHODS

Study Site: Field planting was carried out on June 12th of 2012, 2013, and 2014 at the Outreach and Research Center (SORC) of Delaware State University located at 884 Smyrna of Delaware. The soil type at the site (lat. 390.28'N and long750.58'W) was a sandy loam with a pH of 6.5. The crimson clover was planted as a cover crop and plowed under before planting, and the land was followed for six years prior. Cultural practices were like conventional production, except that no chemical fertilizers and pesticides were applied.

Experimental Design and Land Preparation: The experiment was conducted on a randomized complete block design with three replications. The field was plowed and disked in late spring, and plots were (1.5m x 10m). Plots were mulched with black polyethylene film (# RB436), and drip tapes for irrigation were laid before mulching. Slips of 0.22 m to 0.25 m developed from the eyes of sweet potato storage roots were planted 0.30m apart on each bed. The four genotypes of sweet potato were: A-193-217 (T1), Birmingham (T2), TI-6008 (T4), and TUI-001(T6), where T2 served as a control since it was liked by most of the visitors and audiences as it is purplish color both skin and flesh with many antioxidants (Table 4). The varieties were accessed from the Tuskegee University breeding program and were planted as non-traditional cultivars like orange flesh.

Slip Multiplication and Planting Preparation: Storage roots of sweet potato were the source of slips, which were grown in a greenhouse during the early spring and transplanted into high tunnels in early May for rapid multiplication and early growth before being transplanted into field plots in June. The sweet potato slips were transplanted into openings in the black plastic mulch at 0.3 m apart. Slips from each genotype were planted in single rows on 10 m x 1.5 m beds. Production followed all cultural practices recommended for organics. Weeding between the rows was done twice mechanically in late June and early July and two or three times manually in late July and early August once sweet potato vines had spread enough to prevent mechanical weeding.

Harvesting and Data Collection: All the storage roots were harvested manually for 120 days (about four months) after planting using forks and shovels and weighed fresh. All the vines were cut at ground level prior to harvest.

Statistical Analysis of variance was done using Proc GLM [12], with mean separation using LSD (0.05). Analysis of variance showed significant treatment x year interactions for all variables; therefore, data were analyzed separately by year.

RESULTS AND DISCUSSION

Table 1 shows the yields of ungraded storage roots for 2012, 2013, and 2014 where genotype T2 was the control group. However, all storage roots were marketable quality but not graded as the USDA (United States Department of Agriculture) rule. Genotype T4 showed the

Table 1: Ungraded means yield of four sweet potato accessions in 2012, 2013 and 2014.

	Mean yield (kg ha^{-1})			
Genotypes†	2012	2013	2014	Average yield (kg ha^{-1})
(T1)	31934ab	32168ab	22702c	28935ab
(T2)	22910b	39138a	42453a	34833a
(T4)	44157a	17852b	17436c	26481b
(T6)	26837b	32662a	36043ab	31847ab
LSD	13204	14329	15919	7201
CV	21	23.5	26.8	23.8†

T1, A-193-217; T2, Birmingham; T4, TI-6008; T6, TUI-001.

Means yield followed by the same letters in a column are not significantly different at P≤0.05 probability.

Note: Only t4 showed poor yield during the growing season of 2013 in comparison to all other varieties. This season received more rainfall than other years.

	May	June	July	August	Sept.	October	Nov.
2012	0.81	2.42	1.47	3.61	4.35	9.98	1.18
2013	3.67	11.78	8.09	4.7	1.43	4.13	2.89
2014	4.56	5.03	3.67	4.6	2.32	3.46	4.95

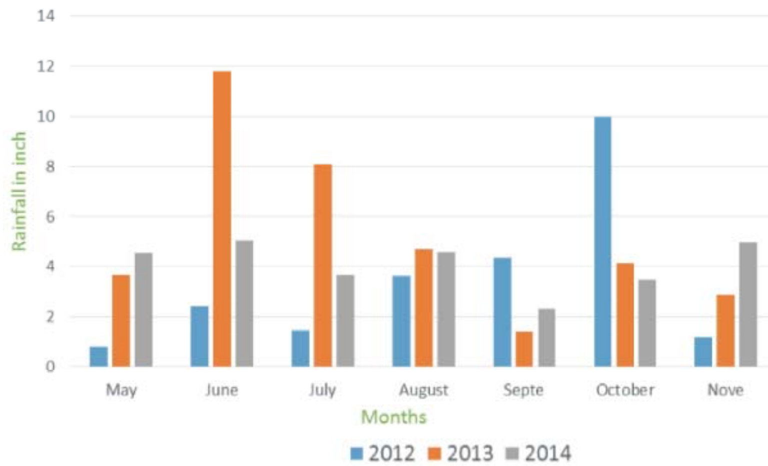

Fig. 1: Rainfall distribution in Smyrna during Sweet potato growing season of 2012, 2013, and 2014

Table 2: ANOVA in year wise analysis

			Years					
			2012		2013		2014	
Source of variance	df	Mean sq	F	Pr>F	F	Pr>F	F	Pr>F
Model	5	178318624	4.08	0.05	3.01	0.10	3.87	0.06
Rep	2	61957612.5	1.42	0.31	0.47	0.64	0.16	0.85
Accessions	3	255892631	5.86	0.03	4.7	0.05	6.34	0.02
Error	6	43677602						
Total	11							

Table 3: ANOVA in combined analysis

Source of variance	df	Mean sq	F	Pr>F
Model	17	171351274	3.24	0.0087
Yr	2	9772335	0.18	0.83
Rep(yr)	6	32165611	0.61	0.72
Accession	3	117572097	2.22	0.12
Yr*var	6	391286171	7.4	0.0004
Error	18			
Total	35			

Table 4: Phenotypic characters of sweet potato genotypes

Genotype	Clone Name (ID)	Skin color	Flesh color
T1	A-193-217	Red	Creamy
T2	Birmingham	Purple	Purplish
T4	TI-6008	White	Whitish
T6	TU-I-001	Red	Creamy

highest yield in 2012 among all genotypes and was 92% higher than that of T2. During 2013 and 2014, genotype T2 had the highest yield and T1 had the lowest yield in 2013, and T4 showed the lowest yield in 2014. On average, for all years, genotype T2 showed the highest yield, and T4 showed the lowest [15]. Analysis of variance showed that year-wise treatments performed significantly different at a 5% level of significance (Table 2), and interaction between treatments and year was observed highly significantly different (Table 3) [14]. Results are shown year-wise since year treatments interaction was significantly different [17]; however, the average yield for all years is given just for comparison (Table 1). This research showed that sweetpotatoes perform well without any chemical inputs; although genotypes have shown different performances in different years may be due to different environment genotype interactions [13]. The most abundant weeds observed in 2011 were lamb's quarters (*Chenopodium album*), red root pigweed (*Amaranthus retroflexus*), barnyard grass (*Echinochloa crusgalli*), and field bindweed (*Convolvulus arvensis*). In 2012, in addition to the previous species, purslane (*Portulaca oleracea*) and large crabgrass (*Digitaria sanguinalis*) were observed. Removing field bindweed was particularly problematic as it often became entwined with sweet potato vines.

CONCLUSIONS

- Sweet potato can be a suitable specialty crop in a short growing season.
- Yields depend on varieties and further studies are needed to determine the best planting space and date.
- Additional varieties of sweet potato need to be evaluated to evaluate their suitability in Delaware climate.

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REFERENCES

1. Dorais, M., 2007. Organic production of vegetables: State of the art and challenges. Can. J. Plant Sci., 87: 1055-1066.
2. Bovell-Benjamin, A.C., 2007. Sweet potato: A review of its past, present, and future role in human nutrition. Adv. Food Nutr. Res., 52:1-59.
3. Lebot, V. 2009. Tropical root and tuber crops: Cassava, sweet potato, yams and aroids. CAB Intl., Wallingford, UK.
4. NASS (National Agriculture Statistics Service), 2015. Organic production survey by USDA. Accessed at organic farming research foundation. 17 October 2017. <http://ofrf.org/organic-faqs>.
5. Beveridge, L.E. and R.E.L. Naylor, 1999. Options for organic weed control - What farmers do. 1999 Brighton Crop Protection Conference-Weeds. British Crop Protection Council, Brighton, United Kingdom. pp: 939-944.
6. Hanson, J., R. Dismukes, W. Chambers, C. Greene, and A. Kremen, 2004. Risk and risk management in organic agriculture: Views of organic farmers. Renewable Agr. Food Systems, 19: 218-227.
7. Oberholtzer, L., C. Dimitri and C. Greene, 2005. Price premiums hold on as U.S. organic produce market expands. U.S. Dept. Agr., Econ. Res. Serv., Resources Econ. Div., VGS- 308-01.
8. OMAFRA (Ontario Ministry of Agriculture, Food and Rural Affairs), 2010. Vegetable production recommendations 2010-2011. Ontario Ministry Agr. Food Rural Affairs Publ. 363.
9. Adam, K., 2005. Sweet potato: Organic Production. ATTRA (Appropriate Technology Transfer for Rural Areas) Publication.
10. U.S. Department of Agriculture (USDA). 2011a. U.S. sweetpotato statistics. Economic Research Service. 16 June 2014. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1492>.
11. U.S. Department of Agriculture (USDA). 2011b. Vegetable and melon yearbook. Economic Research Service. 16 June 2014. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1212>.
12. SAS Institute Inc. 2009. SAS/STATH 9.2 User's guide SAS (Statistical Analysis System) Institute Inc. Cary, NC.
13. Mostafa, L. and Samia S. Hosney, 2021.Evaluation of Some Avocado Cultivars under El-Nubaria Region Conditions, 13(2): 98-105.
14. Ahmed, R., Amani H.A.M. Gharib and S.M. Rizk, 2021. Shortening of Taro (*Colocasia esculenta*) Life Cycle by Using Plug Planting System. Journal of Horticultural Science & Ornamental Plants, 13 (2): 185-196.
15. Arafat, I., Abdelaziz Ahmed El-Taweel and Mohamed Hassan Abdelaziz Mosa, 2020. Evaluation of Some Genotypes of Guava Trees (*Psidium guajava* L.) for Yield and Fruits Quality in Dakahlia Governorate, Egypt. Journal of Horticultural Science & Ornamental Plants, 12(1): 40-46.
16. Mohamed, A., Ayman A.M. Ali, Hala N. Nassar and Ahmed M. Elsawy, 2020. Performance of Manfalouty and Wonderful Pomegranate Cultivars under Four Egyptian Climate Regions. Journal of Horticultural Science & Ornamental Plants, 12(3): 169-181.
17. Taherlou, A. and Atilla Dursu, 2019. Evaluation of Leaf Yield of Rocket (*Eruca sativa* Mill.) for use as Salad Vegetable in Iran. Journal of Horticultural Science & Ornamental Plants, 11(1): 01-06.