Variability in 42 Orange-Fleshed Sweet Potato Hybrids for Tuber Yield and Carotene & Dry matter Content

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Abstract

Forty two orange-fleshed sweet potato hybrids were evaluated for storage root yield, β-carotene and dry matter content along with a control variety 'Sree Kanaka' in upland and lowland situations. In the upland condition, the root yield ranged from 3.0 – 20.0 t ha^{-1} and in lowland, from 3.0 – 30.0 t ha^{-1}. Three hybrids yielded above 20 .0 t ha^{-1} in the upland condition and 7 hybrids yielded above 20.0 – 25.0 t ha^{-1} in the lowland condition and one hybrid, 30.0 t ha^{-1}. The β-carotene values of the hybrids varied between 1 – 14 mg/100g.f.w. Majority of the hybrids (22) possessed a β-carotene value of 10 – 15 mg/100g.f.w. Two

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hybrids (106427-10 and 106035-9) possessed highest β-carotene value (14.37mg/100g.f.w). The dry matter content of the hybrids varied from 18.5 - 29.2%. In both the locations, dry matter content was negatively associated with carotene content.

Key words

Orange-fleshed sweet potato, β-carotene, RHS colour chart, tuber yield, dry matter

Abbreviations

VAD-: Vitamin A deficiency

OFSP-: Orange-flesh sweet potato

RBD-: Randomised Block Design

FW-: Fresh weight

Introduction

Sweet potato *(Ipomoea batatas* (L.) Lam) is an important tuber crop grown in over more than 166 countries of the tropics, sub-tropics and warm temperate regions of the world. The flesh colour varies from white, cream, yellow to dark-orange and purple depending upon the pigment. It is a rich source of provitamin A, vitamin B1 (Thiamin) and vitamin C (Huang, 1999). The roots are used as a source of carbohydrate and dietary fibre which has the potential to reduce the incidence of a variety of diseases including colon cancer, diabetes, heart diseases and digestive disturbances (Palmer, 1982; Ustimenko and Bakumovsky, 1982; Villareal, 1982). The major carotenoid pigment present in the orange-fleshed sweet potato is β-carotene which is a precursor of vitamin A and is an essential micronutrient for normal immune function of the body. Recent studies associated with the consumption of carotenoid rich food showed the decrease of the incidence of certain cancers in human beings (Gester, 1993) and Orange-Fleshed Sweet Potato (OFSP) forms an important source of carotene rich food (Woolfe, 1992; Jalal, 1998).

The objective of the present study was to find out the yield variability within the selected 42 orange-fleshed sweet potato hybrids and to identify high yielding hybrids with high β-carotene and dry matter content.

Materials and methods

At Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram, a preliminary yield trial was conducted with the seedling population of 220 hybrids originating formerly from an orange-fleshed, nutritionally rich, ‘Jewel variety’. From these, 42 hybrids of 27 cross combinations were selected for the advanced yield trial. Sree Kanaka, a released orange-fleshed variety from CTCRI was the control. The experiment was planted in Randomised Block Design (RBD) with 2 replications at upland and lowland conditions. Each plant/replication was planted on 10 mounts with 4 vine cutting per mount. The spacing followed was 90 x 90 cm within and between the rows. The recommended dose of 5 t ha^{-1} farmyard manure was broadcasted in the field before the preparation of mounts as per the package and practices standardized by CTCRI (2004). Half the dose of nitrogen (N) and full dose of Potassium (K) was applied on the mounts at the time of planting. Half N was applied one month after planting. The soil analysis showed that the available Phosphorous (P) content in the soil of Central Tuber Crops Research Institute (CTCRI) was higher than the required amount. Hence, P was not applied in the soil. Intercultural operations like weeding and earthing up were also carried out during the application of second dose of fertilizer. Both the trials were harvested at 90 days after planting. Storage root weight of each hybrid was recorded at the time of harvest. β-carotene value was recorded as per the RHS colour chart developed by Burgos *et al* (2009) from CIP, Lima, Peru. For the determination of dry matter, 20g triplicate samples of raw and peeled storage root were cut into small pieces and dried to a constant weight in a hot air oven at 50^0C for 24-48h till constant weight attained and percentage of dry matter was calculated. Statistical analysis for all the parameters was carried out using one way analysis of variance of Genstat DE (2008).

Results and discussion

The storage root is the commercial part of the sweet potato plant and root yield is said to be a variable quantitative character (Jones, 1977). The data on storage root yield, β-carotene value and dry matter content are given in table 1. Wide range of variability was observed for root yield, β-carotene value and dry matter content. In upland condition, the root yield ranged from 3.0 – 20.0 t ha^{-1} and in lowland, from 3.0 – 30.0 t ha^{-1}. Majority of the hybrids possessed a yield of 5.1 – 10 t ha^{-1} (15) and 10.0 – 15.0 t ha^{-1} (16) in the upland. The yield of 5 hybrids was between 15.1 – 20.0 t ha^{-1}. Only 3 hybrids recorded yield of above 20.0 t ha^{-1}. The lowest yield in upland was observed in three hybrids (< 5 t ha^{-1}). However, in the lowland, 7 hybrids yielded 20.0 – 25.0 t ha^{-1} and 1 hybrid, 30.0 t ha^{-1}. The low yield (<5 t ha^{-1}) was observed in 2 hybrids. 10 hybrids had a yield of 5.1 – 10.0 t ha^{-1}. 13 hybrids yielded 10.0 – 15.0 t ha^{-1}. The control variety ‘Sree Kanaka’ gave a yield of 9.0 – 11.0 t ha^{-1} at both the locations.

In the present study, the flesh colour as per the RHS colour chart value ranged from 13 to 30. Majority of the hybrids (25) had higher chart value of 25 to 30 and only 15 hybrids had 10 to 15. The corresponding β-carotene values of 42 hybrids were found to vary between 1 – 14 mg/100g.f.w. Of the 42 hybrids, 22 hybrids possessed a high value of 10 – 15 mg/100g.f.w and 9 hybrids had 5.1 – 10.0 mg/100g.f.w β-carotene. Some hybrids (11) had less than 5 mg/100g.f.w. The hybrids- 106427-10 and 106035-9 had maximum colour chart value (30) and also possessed highest β-carotene value (14.37 mg/100g.f.w) which is significantly higher than the control. Sree Kanaka possessed RHS colour chart value of 26 and the β-carotene

carotene content was 7.76mg/100g.f.w. The results showed that there was no difference between the carotene content of the hybrids planted at the two sites. In this study, it was observed that β-carotene content was associated with storage root flesh colour as reported by Zhang and Xie (1988) and Lin *et al* (1989). In the hybrid progeny the dry matter content varied from 18.5 - 29.2%. It was found that the intensity of the orange-flesh colour was negatively related with dry matter content which is in confirmation with the observation of Hernandez *et al* (1967); Simonne *et al* (1993). The results of the present study also showed that the two hybrids which possessed highest β-carotene value (14.37 mg/100g.f.w.) recorded low dry matter content (18 – 19%). There was not much difference observed in the value of dry matter content from both the locations. The average dry matter content in sweet potato is approximately 30% and also found to vary widely depending on the factors such as cultivar, location, climate, day length, soil type, incidence of pests, diseases and cultivation practices (Bradbury & Holloway, 1988).

In the lowland condition, the prevalence of high soil moisture content could have favoured the production of high yield compared to the storage root yield of upland condition. Even though, irrigation was provided at both the locations, the evaporation of water at upland condition was higher than at lowland which resulted in the low yield. Wilson (1970) has proposed that storage root weight per plant was a measure of total tuber sink capacity. The present studies indicated that, the variation in root yield in different hybrids may be either due to the difference in the number of storage roots per plant or size of individual roots or difference in bulking rate as reported by Lowe and Wilson (1975).

In general, the storage root yield was higher at lowland than at upland conditions which could have resulted from differences in the available moisture in the soil as well as the genetic variability between the hybrids. No significant difference was noticed in the β-carotene values at both sites indicating that it is a stable character which is in confirmation with the studies conducted by Vimala *et al* (2011). The studies showed that 8 hybrids possessed β-carotene value of 7.73 – 14.37 mg/100g.f.w. and recorded high yield of 20 -30t/ha. The promising hybrids could be cultivated in the rural areas to improve the food security and for the production of value added sweet potato products. The study showed that the orange-fleshed hybrids with high yield can be popularized as an excellent source of β-carotene to control vit A deficiency which affects millions of children in the developing countries since β-carotene is a precursor of vit A.

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Reference

Bradbury JH and Holloway WD (1988). Chemistry of Tropical Root Crops: Significance for Nutrition and Agriculture in the Pacific, Australian Centre for International Agricultural Research, Canberra. 53-77.

Burgos G, Carpio R, Sanchez C, Sosa P, Porras E, Espinoza J and Gruneberg W (2009). Guide for using the RHS colour chart for selecting for high β-carotene sweetpotato. ISTRC, Lima, Peru.

CTCRI (2004). Agro-techniques of Tuber Crops. pp 32.

Genstat (2008). Genstat Discovery Edition, DE3. SP1, VSN International Ltd.UK.

Gester H (1993). Anticarcinogenic effect of common carotenoid. International Journal for Vitamin and Nutrition Research. 63: 93-121.

Hernandez TP, Hernandez T, Constanin RJ and Kakar RS (1967). Improved techniques in breeding and inheritance of some of the characters in the sweet potato (*Ipomoea batatas*). International Symposium on Tropical Root and Tuber Crops. 1: 31-40.

Huang AS, Tanudjaja L and Lum D (1999). Content of alpha-beta- and dietary fibre in 18 sweet potato varieties grown in Hawaii. Journal of Food Composition and Analysis. 12: 147-15.

Jalal F, Nesheim MC, Agus Z, Sanjur D. and Habicht JP (1998). Serum retinol concentrations in children are affected by food resources of β-carotene, fat intake, and antehelminthic drug treatment. American Journal of Clinical Nutrition. 68: 623-629.

Jones A (1977). Heritability of seven sweet potato root traits. Journal of the American Society for the Horticultural Science. 102: 440-442.

Lin DV, Li W and Lu XY (1989). Studies on carotenoid and flesh colour of sweet potato root tubers. Acta Agriculturae Sinica. 15, pp 260-266.

Lowe SB and Wilson LA (1975). Yield and yield components of six sweet potato (*Ipomoea batatas* (L.) Lam.) cultivars. II. Variability and possible sources of variation. Experimental Agriculture. 11: 49-58.

Palmer JK (1982). Carbohydrates in sweetpotato. In: Sweetpotato. Proceedings of the First International Symposium. AVRDC. Villareal and Griggs Editors. China, pp 135-140.

Simonne AH, Kays SJ, Koehler PE and Eilenmiller RR. (1993). Assessment of B–carotene in sweet potato breeding lines in relation to dietary requirements. Journal of Food Composition and Analysis 6, 336-345.

Ustimenko CGV and Bakumovsky (1982). Plants growing in the tropics and subtropics. Mir Publishers.

Villareal RL (1982). Sweet potato in tropics: Progress and problems. In: Villareal, R.L. and T.D. Griggs (Eds.). Proceedings of the 1st International Symposium on Sweet Potato. AVRDC, Taiwan, China, pp 3-15.

Vimala B, Nedunchezhian M, Ramanathan S and Jayaprakas CA (2011). Evaluation of Orange-fleshed sweet potato for tuber yield and carotene content at different locations of Orissa. Abstracts in National Seminar on Climate Change and food Security: Challenges and Opportunities for Tuber Crops. CIG/P8. pp88.

Wilson LA (1970). The process of tuberization in sweet potato (*Ipomoea batatas* (L.) Lam). Tropical Root and Tuber Crops Tomorrow: Proceedings of the 2nd International Symposium on Tropical Root and Tuber Crops. Honolulu, Hawaii: College of Tropical Agriculture, University of Hawaii, Edt by Plucknett DL. 1: pp. 171.

Woolfe JA (1992). Sweet potato: An untapped food resource. Cambridge University Press. Cambridge, UK. pp 60.

Zhang LY and Xie YZ (1998). Inheritance of flesh colour and its correlation with other traits in sweet potato (*Ipomoea batatas*). Journal of Agricultural Sciences**.** 4: 30-34.

TABLE

Table 1. Data for variability of storage root yield, β-carotene and dry matter content of 42 sweet potato clones at upland and lowland conditions

Sl No	**Hybrids**	**Yield (t ha^{-1})**		**RHS colour chart value**	**β-carotene (mg/100g. f.w.)**	**DM (%)**	
		Upland	**Lowland**			**Upland**	**Lowland**
1	106035-9	14.69	21.11	30	14.37	18.5	19.2
2	106035-14	11.98	12.72	27	10.5	22.3	23
3	106035-24	9.01	9.75	28	11.03	22.9	24.7
4	106058-3	14.51	17.10	27	10.5	21.0	22.2
5	106064-1	14.94	18.70	24	4.61	27.5	28.0
6	106075-3	8.58	11.30	24	4.61	26.0	27.2
7	106082-4	15.12	16.23	25	7.23	27.3	28.1

8	106097-13	8.58	9.26	13	1.17	24.2	25.0
9	106098-1	9.82	10.37	28	11.03	19.8	20.4
10	106130-2	12.78	13.03	25	7.23	22.4	23.0
11	106130-3	14.26	24.57	25	7.23	24.8	25.0
12	106130-8	20.86	22.59	28	11.03	20.5	21.0
13	106130-17	7.47	24.51	25	7.23	22.1	22.9
14	106148-7	21.36	21.91	26	7.76	22.4	23.1
15	106148-22	8.21	15.93	25	7.23	20.2	21.3
16	106148-26	9.26	11.79	24	4.61	23.7	23.9
17	106160-2	11.79	15.93	26	7.76	19.8	20.6
18	106162-1	16.11	7.78	27	10.5	20.2	20.9
19	106179-10	8.89	19.07	28	11.03	19.2	20.5
20	106196-2	13.95	15.99	27	10.5	21.3	22.1
21	106203-5	3.58	7.72	29	12.39	18.5	19.8
22	106206-1	6.42	6.79	25	7.23	22.5	22.9
23	106248-1	12.59	14.01	29	12.39	19.1	20.1
24	106261-4	12.78	21.17	27	10.5	22.4	23.3
25	106285-5	11.61	13.89	28	11.03	22.0	22.9
26	106309-9	7.84	8.77	28	11.03	21.9	22.7
27	106327-16	12.72	15.00	27	10.5	22.4	23.1
28	106390-3	20.06	30.00	28	11.03	20.1	20.4
29	106427-10	18.64	9.94	30	14.37	18.5	19.6
30	106520-1	3.77	7.72	22	3.03	27.1	28.1
31	106526-7	16.61	14.38	27	10.5	24.0	24.2
32	106526-12	7.72	13.40	27	10.5	23.5	24.2

33	106526-15	10.19	15.43	28	11.03	23.9	24.6
34	106581-6	9.82	3.58	28	11.03	20.1	20.7
35	106581-9	16.98	21.11	27	10.5	19.4	20.1
36	106582-17	3.52	3.09	13	1.17	26.3	27.1
37	106582-46	11.36	10.31	24	4.61	25.1	25.7
38	106665-4	14.94	8.70	14	1.32	28.5	29.2
39	106735-10	7.59	14.38	15	1.04	27.4	28.3
40	106735-11	17.47	14.94	14	1.32	27.0	27.9
41	106735-65	7.47	6.17	24	4.61	25.1	25.4
42	Sree Kanaka	8.89	11.42	26	7.76	22.1	23.0
L.S.D		2.46	2.56	-	-	1.83	1.93