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Performance of Sweet Potato Varieties and their Nutritional Profile under Punjab conditions

Sweet potato (*Ipomoea batatas* L.) ranks seventh among the food crops of the world (Nedunchezhiyan and Ray, 2010) and is important in subsistence farming systems of Asia and Africa (Krishnan et al., 2011). The crop is gaining importance as functional food crop in developed countries (Truong and Avula, 2010). Nearly 90% of the world production is from the developing countries, with China topping the list. The roots as well as leaves are used as animal feed in China, Papua New Guinea, India and Vietnam (Woolfe, 1992), while several value added food products are made from sweet potato roots in China, Japan, New Zealand and Southern United States. Nutritionally, the roots are rich in starch, vitamins and minerals (Bouwkamp, 1985; Padmaja, 2009; Woolfe, 1992). Besides the major nutrients, sweet potatoes are a rich source of phyto nutrients like dietary fibre (Philpott et al., 2003) and antioxidants (Hayase and Kato, 1984).

In India, sweet potato is an important tuber crop that plays a significant role in food and nutritional security of poor and tribal farmers and has potential to substitute cereals owing to their high carbohydrate and calorie content. In addition to excellent nutritional value, sweet potato is remarkable for its ability to produce high yields of edible energy in a relatively short growing season (Vries et al., 1967). In India it is grown in *kharif, rabi* and summer under different ecosystems (Mukherjee and Naskar, 2012; Nedunchezhiyan et al., 2012). Among different sweet potato varieties, orange and purple fleshed are gaining importance as they are rich in β-carotene (pro-vitamin A) and anthocyanin (Nedunchezhiyan and Ray, 2010). In this background, an investigation was carried out to evaluate orange and purple fleshed sweet potatoes under Punjab conditions during early winter.

A field experiment was conducted to evaluate orange and purple fleshed sweet potatoes at Punjab Agricultural University, Ludhiana (latitude 30°54'00" N, longitude 75°51'00" E and altitude 243 m above mean sea level) during 2013-14. The soil of experimental area is sandy loam with low organic matter (0.5%) and nitrogen (225 kg ha^{-1}), while it was medium in phosphorous (16.4 kg ha^{-1}) and potassium (186 kg ha^{-1}). The soil is having pH 7.4. Five orange fleshed sweet potato varieties viz. ST-14, CIP-440127, CIP-SWA-2, Kamla Sundari and Sree Kanaka, a purple fleshed variety ST-13 and a white fleshed variety PSP-21 (local) were planted with three replications in randomized block design. Vine cuttings (20 cm length) of sweet potato were planted horizontally on ridges with the spacing of 60 cm x 20 cm. A fertilizer dose of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} was applied. At the time of planting half N and K, and full P was applied and the remaining half N and K was applied 30 days after planting (DAP). Other recommended package of practices was duly followed (Mohankumar et al., 2000). The crop was irrigated as and when required. The crop was planted on 29th September 2013 and harvested 8th January 2014 (101 days after planting).

The area is characterized by hot and dry summer during May-June followed by humid monsoon period and then severe cold during December-January. During crop growing period October and November recorded average temperature of 24.4°C and 18.6°C, respectively. The mean maximum, minimum and average temperatures during December were 19.6, 7.2 and 13.5°C, whereas in January, the mean maximum, minimum and average temperatures were 17.0, 5.1 and 11.1°C during the crop growing period. Growth, yield attributes and yield observations were recorded at harvest. Proximate analysis of tuber was carried out by standard procedures (AOAC, 2000). The statistical analysis of yield data was carried out as per the procedure given in Panse and Sukhatme (1967).

The vine length presented in the Table 1 revealed that among the varieties PSP-21 produced significantly longer vines. However, it was statistically at par with ST-14, CIP-440127 and CIP-SWA-2. Significantly shorter vine lengths were observed with ST-13, but it was statistically comparable with Kamla Sundari.

The variety CIP-440127 produced maximum number of tubers per plants (Table 1). It was followed by Kamla Sundari and CIP-SWA-2. This may be due to more translocation of photosynthates from vine to yield forming factors like number of tubers per plant. Minimum number of tubers per plant was noticed in ST-13 and it was at par with ST-14, Sree Kanaka and PSP-21. Maximum tuber yield per plant was observed with CIP-440127 and it was followed by ST-14 and Kamla Sundari. The variety PSP-21 produced lowest tuber yield per plant, however it was statistically comparable with ST-13 and Sree Kanaka. The variations in growth and yield attributes may be due to genetic factor. Nedunchezhiyan et al. (2008) also reported similar findings.

Significantly highest tuber yield was recorded with CIP-440127 compared to other varieties (Table 1). Nedunchezhiyan and Srinivasulu Reddy (2002) reported that better translocation and more tuber initiation lead to higher yield in sweet potato. This in turn leads to higher tuber yields. The variety ST-14 was the next best. But tuber yield of Kamla Sundari was at par with ST-14. The local variety PSP-21 recorded lowest tuber yield, due to sink limitation in spite of higher vine yield. The photosynthates produced were unable to convert into tuber yield.

In general, the tuber yields were very low (8.17-12.67 t ha^{-1}) except in CIP-440127. This indicated that low temperature (December-January) during tuber bulking stage affected the tuber yield in all the varieties. The variety CIP-440127 may be having cold tolerance, hence recorded moderate tuber yield of 17.67 t ha^{-1}. The vine yield recorded in all the varieties were found reasonable. Maximum vine yield was recorded with PSP-21 and it was statistically comparable with CIP-440127, CIP-SWA-2, ST-14 and Sree Kanaka (Table 1). This may be due to higher vine growth. This indicates that the above varieties were able to continue cell multiplication at higher rate during low temperature. Lower vine growth due to lower rate of cell multiplication at low temperature led to significantly lowest vine yield in ST-13.

Table 1. Growth and yield of sweet potato varieties

Varieties	Vine length (cm)	No. of tubers per plant	Tuber weight (g plant^{-1})	Tuber yield (t ha^{-1})	Vine yield (t ha^{-1})
ST-14	120	2.1	152	12.67	14.46
CIP-440127	118	3.2	212	17.67	14.82
CIP-SWA-2	112	2.6	114	9.50	14.65
Kamla Sundari	104	2.8	144	12.00	13.87
Sree Kanaka	110	2.2	108	9.00	14.32
ST-13	96	2.0	104	8.67	12.14
PSP-21	122	2.2	98	8.17	15.16
CD (0.05)	11	0.2	13	0.8	1.16

Marked variation in dry matter (%) content at harvest was noticed among the varieties (Table 2) and values ranged from 15.82-26.34%. Significantly higher amount of dry matter was found in the variety PSP-21 (local). It is a white fleshed variety with higher vine growth yield. All coloured flesh varieties had lesser dry matter. Among orange fleshed varieties, ST-14 had maximum dry matter and minimum was with CIP-440127. Purple fleshed variety ST-13 had moderate amount of dry matter (23.20%).

Starch content of the tubers varied from 13.16 to 18.30% on fresh weight basis (Table 2). Significantly higher amount of starch was observed in PSP-21 and it was followed by ST-14. The lowest starch content was noticed in CIP-SWA-2 and it was statistically at par with Sree Kanaka, CIP-440127 and Kamla Sundari.

The total sugars content was ranged from 2.44 to 4.04% on fresh weight basis (Table 2). Maximum amount of total sugars was noticed in PSP-21 and it was followed by CIP-SWA-2. The next higher level of total sugars was found in ST-13. The

Table 2. Dry matter, starch and total sugars content in tubers of sweet potato varieties

Varieties	Dry matter	Starch (% on FW basis)	Total sugars (% on FW basis)
ST-14	22.62	16.96	3.14
CIP-440127	15.82	13.48	2.44
CIP-SWA-2	18.26	13.16	3.78
Kamla Sundari	18.96	14.10	3.00
Sree Kanaka	17.38	13.30	2.80
ST-13	23.20	15.50	3.55
PSP-21	26.34	18.30	4.04
CD (0.05)	1.24	1.18	0.22

total sugars content in ST-14 and Kamla Sundari were at par and significantly higher than Sree Kanaka and CIP-440127. Significantly lower total sugar was with CIP-440127.

In general, sweet potato tuber content low amount of protein. Nitrogen (N) content indicates level of protein in the tuber. Nitrogen content varied from 118.4 to 142.6 mg 100 g^{-1} of tuber dry matter among the varieties (Table 3). Significantly higher amount of N content was noticed in PSP-21 (local) and it was on par with Sree Kanaka. Next higher level of N content was noticed in ST-14 and it was on par with Kamla Sundari, CIP-SWA-2 and ST-13. Significantly lower N content was observed in CIP-440127.

carotene was found in the tubers of ST-14 and it was followed by Sree Kanaka, Kamala Sundari and CIP-440127. ST-14 is a deep orange flesh coloured variety. Intensity of its orange colour itself indicates the higher amount of β–carotene (16.24 mg 100 g^{-1}). The lowest amount of β-carotene was observed with CIPSWA-2 (7.77 mg 100 g^{-1}). Maximum ascorbic acid content was noticed with the variety Sree Kanaka, however it was at par with all other varieties except ST-14 and CIP-SWA-2. Minimum ascorbic acid content was found in CIP-SWA-2. Among the tested varieties, only ST-13 is purple fleshed and its anthocyanin content recorded as 88.7 mg 100 g^{-1}. The variation especially in yield, dry matter, starch and micronutrients in the present study might be due to

Table 3. Minerals, vitamins and anthocyanin content in tubers of sweet potato varieties

Varieties	N (mg 100 g^{-1})	P (mg 100 g^{-1})	K (mg 100 g^{-1})	Mn (mg 100 g^{-1})	Fe (mg 100 g^{-1})	Zn (mg 100 g^{-1})	Cu (mg 100 g^{-1})	β-carotene (mg 100 g^{-1})	Ascorbic acid (mg 100 g^{-1})	Antho-cyanins (mg 100 g^{-1})
ST-14	130.5	96.8	187.9	1.80	8.40	1.40	0.43	16.24	2.98	-
CIP-440127	118.4	90.2	156.6	1.70	8.21	1.60	0.51	8.01	3.16	-
CIP-SWA-2	124.6	94.6	168.2	1.51	8.50	1.85	0.60	7.77	2.62	-
Kamla Sundari	128.9	93.1	174.8	1.70	18.00	1.40	0.52	8.60	3.32	-
Sree Kanaka	132.4	90.6	166.7	1.80	10.90	1.62	0.48	10.39	3.38	-
ST-13	121.4	98.4	172.4	1.80	10.20	1.33	0.49	-	3.26	88.7
PSP-21	142.6	92.4	176.4	1.71	10.12	1.26	0.40	-	3.20	-
CD (0.05)	11.3	4.2	8.4	0.08	0.09	0.21	0.04	-	0.32	-

Among varieties, ST-13 recorded with higher amount of phosphorus (P) content, however it was at par with ST-14 and CIP-SWA-2. Significantly lower content of P in tubers was observed in CIP-440127 and it was on par with Sree Kanaka, PSP-21 and Kamla Sundari. Maximum amount of potassium (K) content in tubers was noticed with ST-14 and minimum was with CIP-440127.

Manganese (Mn) content of ST-14, ST-13 and Sree Kanaka was comparable and significantly higher than other varieties (Table 3). Significantly lower amount of Mn was found in CIP-SWA-2. Maximum iron (Fe) content was noticed in Kamla Sundari and minimum was with CIP-440127. Significantly higher amount of Zinc (Zn) and Copper (Cu) was found in CIP-SWA-2. The variety PSP-21 recorded with lower amount of Zn and Cu, however it was on par with ST-14.

Wide variation in β-carotene content was observed among the varieties (Table 3). Highest amount of β-

their sensitivity to low temperature affecting their bulking stages and proximate composition.

Thus, the orange fleshed variety CIP-440127 and to some extent ST-14 and Kamala Sundari observed to be tolerant to cold. Translocation of photosynthates to the bulking tubers was limited by the low temperature in all other varieties in spite of good vine growth. The variety ST-14 recorded moderate amount of tuber yield with highest β-carotene, N, P, K and Mn contents. Thus, the varieties CIP-440127 and ST 14 may be recommended for cultivation during early winter under Punjab conditions.

References

AOAC. 2000. *Official Methods of Analysis*. Washington DC, association of Official Analytical Chemists.

Bouwkamp, J.C. 1985. *Sweet potato products: A natural resource for the tropics*. CRC Press, Boca Raton, Florida, 205p.

Hayase, F. and Kato, H. 1984. Anti-oxidative components of sweet potatoes. *J. Nutrn. Sci. Vitaminol.*, **30**: 37-46.

Krishnan, J.G., Padmaja, G., Moorthy, S.N., Suja, G. and Sreekumar, J. 2011. Biochemical changes in cream and orange-fleshed cured sweet potatoes cooked under different modes. *J. Root Crops*, **37** (1): 65-76.

Mohankumar, C.R., Nair, G.M., George, J., Ravindran, C.S. and Ravi, V. 2000. *Production Technology of Tuber Crops*, Central Tuber Crops Research Institute, Kerala, India, 174p.

Mukherjee A. and Naskar S. K. 2012.Performance of orange and purple fleshed sweet potato genotypes in coastal locations of Odisha. *J. Root Crops,* **38** (1): 26-31.

Nedunchezhiyan, M. and Ray. R.C. 2010. Sweet potato growth, development production and utilization: overview. In: *Sweet potato: post harvest aspects in food*, Ray, R.C. and Tomlins, K.I. (Eds.). Nova science Publishers Inc., New York, pp. 1-26.

Nedunchezhiyan, M. and Srinivasulu Reddy, D. 2002. Nitrogen management in sweet potato (*Ipomoea batatas* L.) under rainfed conditions. *Indian J. Agron.*, **47** (3): 449-454.

Nedunchezhiyan, M., Byju, G. and Jata, S.K. 2012. Sweet potato agronomy. In: *Sweet potato*, Nedunchezhiyan, M. and Byju, G. (Eds), Global Science Books, Japan, pp. 1-10.

Nedunchezhiyan, M., Byju, G. and Naskar, S.K. 2008. Performance of sweet potato (*Ipomoea batatas*) varieties under shaded and open field conditions. *The Indian J. Agric. Sci.*, **78** (11): 974-977.

Padmaja, G. 2009. Uses and Nutritional data of sweet potato. In: *The Sweet potato*, Loebenstein, G. And Thottappilly, G. (Eds), Springer Science + Business Media B.V. 2009, pp. 189-234.

Panse, V.G. and Sukhatme, P.V. 1967. *Statistical Methods for Agricultural Workers*, ICAR, New Delhi, 381p.

Philpott, M., Gould, K.S., Markham, K.R., Lewthwaite, L.S. and Ferguson, L.R. 2003. Enhanced coloration reveals high antioxidant potential in new sweet potato cultivars. *J. Sci. Food Agric.*, **83**: 1076-1082.

Truong, Van-Den. and Avula, R.Y. 2010. Sweet potato purees and dehydrated powders for functional food ingredients. In: *Sweet potato: post harvest aspects in food*, Ray, R.C. and Tomlins, K.I. (Eds.). Nova science Publishers Inc., New York, pp. 117-161.

Vries, C.A.De., Ferwerda, J.C. and Flack, M. 1967. Choice of food crops in relation to actual and potential production in the tropics. *Netherlands J. Agric. Sci.,* **15**: 241-248.

Woolfe, J.A. 1992. *Sweet potato: an untapped food resource*. University Press, Cambridge, UK, 643p.

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