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Development of Nutritionally Rich Orange-Fleshed Sweet Potato Lines: A Way to Increase Consumer Acceptance in Andhra Pradesh

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Abstract

Sweet potato is a staple food in several tropical countries. It is one of the world's highest yielding crops with the total production per unit area exceeding that of rice. Traditionally, sweet potato varieties produced and sold in Andhra Pradesh, have a pale and white coloured flesh, but new biofortified orange flesh sweet potato varieties (OFSP) have been introduced that contain high concentrations of β-carotene (pro-vitamin A). However, these varieties reportedly possess lower percentage of total sugars and dry matter content. A breeding programme was undertaken at Horticultural research station, Dr. Y.S.R Horticultural university, venkatramannagudem from 2013 to 2015 to develop new orange-fleshed sweet potato lines with high percentage of total sugars and dry matter to meet the end-users preferences. Genotypes of white and orange-fleshed sweet potato lines collected from different places were evaluated for beta carotene and total sugars. Based on the flowering habit and compatibility, parents were selected for crossing. Variety ST14 (Female parent) found to be superior in beta carotene content (8.5 mg/100 g) where as Kalinga (Male parent) was rich in total sugars (6.4%). Crossing programme was conducted between these parents and seeds were collected from the dried capsules of ST-14. Out of 55 seedling progenies, 14 orange fleshed genotypes were identified. Among the 14 F_1 orange fleshed genotypes VRSP-1 (PASP1) was found to be superior in yield (40.7 t ha^{-1}), β-carotene (6.3 mg /100 g) and total sugars (7.8 %).

Key words: Orange-fleshed sweet potato, β-carotene, dry matter and total sugars

Introduction

Sweet potato is a staple food in several tropical countries. It is one of the world's highest yielding crops with the total production per unit area exceeding that of rice and having greater food value. In India, Sweet potato is cultivated mainly in Orissa, Uttar Pradesh, West Bengal, Bihar, Karnataka, Tamil Nadu, Andhra Pradesh and Kerala. Sweet potato tubers are rich in starch, sugars, minerals and vitamins. Being rich in β-carotene, the orange fleshed sweet potato is gaining importance as the cheapest source of antioxidant having several physiological attributes like anti-oxidation, anti-cancer properties and protection against liver injury. It is a food crop to combat malnutrition in small and marginal farming community. Recent studies associated with the consumption of carotenoid rich food showed that consumption of carotene rich food decreases the incidence of certain types of cancers in human beings (Gester,1993) .

Orange-fleshed sweet potato varieties (OFSP) have been introduced to Andhra Pradesh that contains high concentrations of β-carotene (pro-vitamin A). However, these varieties reportedly possess lower percentage of total sugars and dry matter content, a challenge towards their adoption and wide-scale production by farmers in Andhra

Pradesh. Orange flesh sweet potato varieties should carry increased β-carotene and dry matter to promote their adoption and large-scale production (Cervantes-Flores et al., 2010; Mwanga et al., 2010). The sustainability and expansion of sweetpotato production depend on the availability of varieties that meet end-users preferences. Orange fleshed varieties are associated with pumpkin flavour, watery texture and orange colour while white fleshed varieties were associated with creamy colour, starchiness, and fibrous texture and sweet in taste (Tomlins et al., 2007). Hence the present research was carried out to develop new orange flesh sweet potato genotypes with high sugar content by crossing white and orange flesh sweet potato genotypes.

Materials and Methods

The experiment was conducted from 2013 -2016 at the experimental farm of the Horticultural Research Station of Dr. Y.S.R. Horticultural University, Andhra Pradesh (16°83' N latitude, 81°50' E longitude, is 34 m above mean sea level). The soil was a red sandy loam. Well matured healthy and disease free cuttings of the previous season of each genotype were used as planting material for the experiment. The cuttings of 20-30 cm in length of thirty genotypes (18 white flesh and 12 orange flesh) were planted in primary nursery at 30 x 20 cm spacing on a raised nursery bed and watered regularly. When the nursery vines reach a sufficient length, the cuttings were made and planted in the secondary nursery with same spacing. The recommended synthetic fertilizer rate of N: P_2O_5: K_2O at 50:25:60 kg.ha^{-1} was applied as urea, single-super and muriate of potash respectively. In which single super phosphate was applied prior to transplanting and urea and muriate of potash was applied one month after transplanting. The experiment was arranged in a randomized complete block design with three replications in 3.0 × 2.4 m plots. Seven-week old cuttings of at least 20-30 cm length with 3 to 4 nodes were transplanted at a spacing of 60 × 20 cm between and within rows and 5 cm depth in the main field as per the recommendations of Nedunchezhiyan et al. (2007). Ten plants of each genotype in each replication were chosen and labeled for recording observations. Single plant observations were recorded for 14 quantitative characters (vine length, vine internodal length, number of roots per plant , root length, root girth, root yield per plant, plant dry matter content, root dry matter content and root yield per hectare, β-carotene content, starch content, total sugars, reducing sugars and non reducing sugars). For each character data were recorded on five randomly selected plants from the middle two rows of each plot and expressed on per plant basis. The mean values of five plants were used for statistical analysis.

β-carotene was estimated based on the procedure described by AOAC (2000). The percentage of starch content was determined by using the method outlined by McCready et al. (1950). Total sugars and reducing sugars were determined following the method described by Lane and Eyon (AOAC, 1965). Non reducing sugars in a sample are obtained by subtracting reducing sugar from total sugars.

Based on the blooming habit and cross compatibility crossing programme was conducted between the selected white flesh genotypes with high root dry matter content and orange flesh genotypes with high β-carotene content. Hand pollination was conducted between the parental plots. Flowers to be pollinated were bagged in the evening of the day prior to pollination using butter paper bag. Pollination of bagged flower was done at morning hours. The flowers from the male parent were taken to the female parents and the paper bag was removed gently without destroying the corolla. The anther of the male parent was rubbed gently over the stigma of the female parent. In order to avoid insect visit, the corolla of the pollinated flower was closed with paper bag again. The pollinated flowers were tagged. The dried fruits were harvested from 30 to 50 days after pollination in the early morning to prevent scattering. Seeds were collected from dried capsules of the female parent and F1 seedlings were raised for further evaluation to identify the genotypes with high β-carotene and high amount of total sugars.

Results and Discussion

Out of the 30 genotypes tested, significant variation was observed among the genotypes with respect to root dry matter content which was ranged from 18.29 to 31.21 %. Maximum root dry matter content was observed in Kalinga (31.21 %) followed by S-30/17 (29.53 %), while minimum dry matter content was observed in S-30/11 (18.29 %) (Fig.1). Vimala and Hari prakash. (2011) also found similar range of 18.5 to 29.2 % root dry matter content in their studies. β-carotene content was ranged from 0.63 to 8.46 mg/100 g fresh weight.

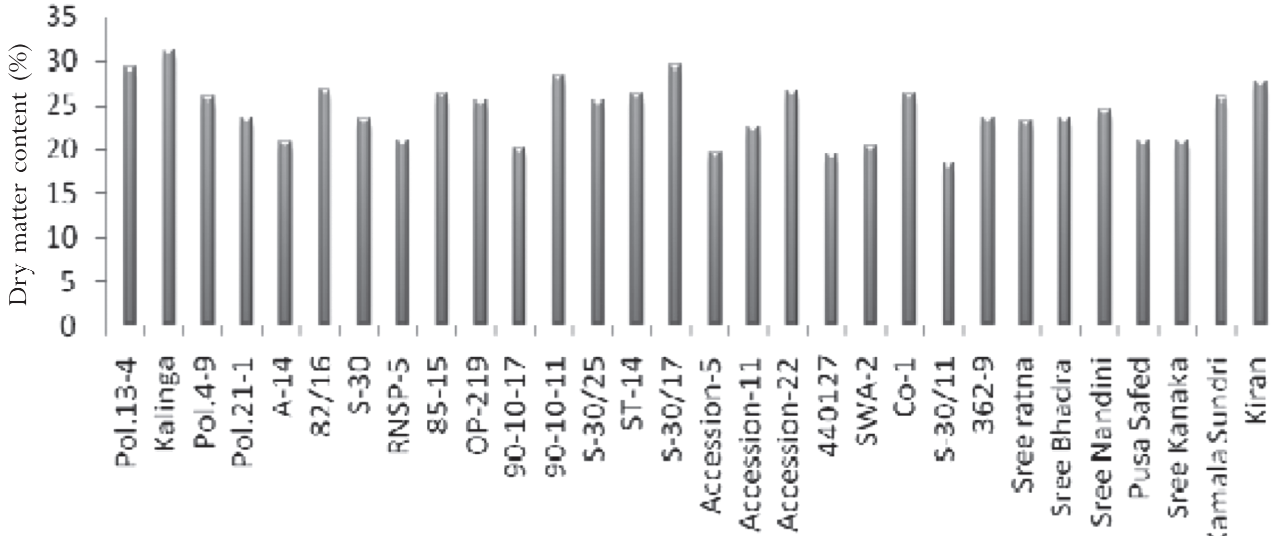

Fig.1. Root dry matter content (%) in different genotypes of sweet potato

ST-14 recorded maximum β-carotene content of (8.46 mg/100g f.w.) and minimum β-carotene content (0.63 mg/100g f.w.) was recorded in the genotype Pol.4-9(Fig.2). Lila Babu (1988) also found similar variation of (0.93 to 7.56 mg/100 g f.w.) β-carotene content in their studies. Based on the flowering and compatibility studies kalinga and ST-14 were found to be cross compatible.

Crossing programme was conducted between the parents and seeds were collected from ST-14 and kept for germination. Hundred F_1 seeds were collected and sowed in portrays. Fifty five F_1 seeds were germinated and were transplanted for further evaluation. At the time of tuber harvest, fourteen orange flesh genotypes were identified. These 14 orange flesh genotypes were evaluated for both quantitative and qualitative characters along with parents by keeping released variety Kiran as check (Table.1).

Maximum vine length was recorded in VRSP-4 which was at par with VRSP-14, whereas maximum internodal length was recorded in the check variety Kiran. Maximum number of roots per plant were recorded in VRSP-13 which was on par with VRSP-1, VRSP-2, VRSP-3, VRSP-9 and VRSP-12. Maximum root length was recorded in VRSP-1, where as maximum root girth was recorded in VRSP-3 and VRSP 8. Maximum root yield was recorded in VRSP-3 and VRSP 8, were on par VRSP-1, VRSP-2, VRSP-5, VRSP-9, VRSP-12 and VRSP13.

Regarding qualitative characters, maximum amount of starch and reducing sugars were observed in VRSP-1, whereas highest amount of starch was identified in Kalinga. Highest amount of β-carotene was observed in ST-14 followed by VRSP-1 and VRSP-7.

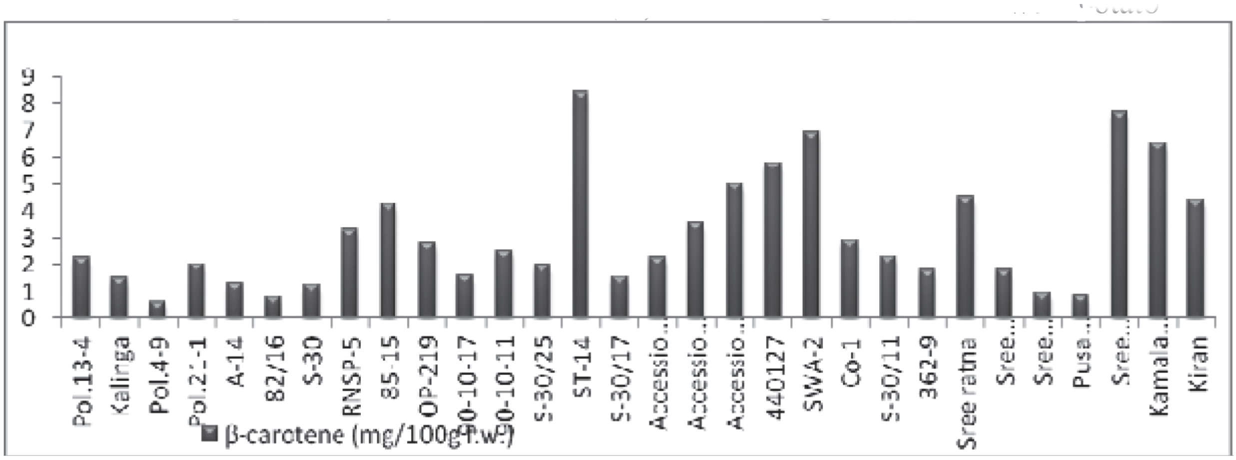

Fig.2. β-carotene (mg/100 g f. w.) content in different genotypes of sweet potato

Table 1. Performance of F_1 orange-fleshed genotypes

Geno-types	Length of vine (cm)	Inter-nodal length (cm)	No. of tubers per plant	Root tuber length (cm)	Root tuber girth (cm)	Starch (%)	Redu-cing sugar (%)	Non-re-ducing sugar (%)	Total sugar (%)	β-carotene(mg /100 gf.w.)	Root tuber yield (t ha^{-1})
VRSP-1	231.6	3.3	7.0	21.9	18.3	19.4	5.0	2.8	7.8	6.3	40.9
VRSP-2	242.1	2.8	7.0	18.6	16.5	14.1	3.3	1.7	5.0	4.0	40.0
VRSP-3	224.1	3.2	7.0	18.8	30.3	13.6	3.5	2.8	6.3	4.2	41.3
VRSP-4	372.4	4.1	2.6	14.0	21.6	18.1	3.9	2.4	6.4	3.9	17.8
VRSP-5	234.6	4.3	7.3	15.3	22.5	16.4	4.4	2.1	6.5	5.1	40.5
VRSP-6	172.4	4.2	4.0	12.0	11.0	14.7	4.2	3.2	7.2	5.1	17.5
VRSP-7	213.9	3.3	6.0	15.3	20.6	17.9	3.6	3.8	7.4	5.9	36.9
VRSP-8	172.7	3.3	7.0	17.0	23.1	16.3	3.3	2.5	5.8	4.3	41.3
VRSP-9	205.3	3.2	8.0	17.2	21.0	16.8	4.0	2.6	6.6	4.4	40.5
VRSP-10	252.2	2.9	3.0	16.0	21.5	18.3	4.8	1.0	5.8	3.7	18.2
VRSP-11	234.3	5.1	2.0	19.8	20.6	13.4	4.4	1.9	6.3	3.3	15.2
VRSP-12	125.0	2.8	8.6	20.0	21.5	15.3	3.1	2.0	5.1	3.5	40.9
VRSP-13	196.7	2.9	9.0	18.6	20.0	16.1	3.4	2.4	5.8	4.4	41.2
VRSP-14	323.5	2.9	3.0	16.0	21.0	14.7	2.8	1.4	4.2	5.3	20.0
ST-14 (Female)	252.2	5.5	4.0	15.5	20.8	16.8	3.2	0.7	3.9	8.3	20.3
Kalinga (Male)	140.9	4.6	3.0	14.6	18.1	25.2	4.7	1.8	6.4	1.5	14.4
Kiran (Check)	172.2	7.9	3.0	13.6	13.2	10.8	3.2	0.4	3.7	4.4	15.0
C.D. (P=0.05)	49.3	1.0	2.1	2.5	4.9	3.7	0.8	0.6	0.9	1.2	4.1
SEd	22.9	0.4	1.0	1.1	2.2	1.6	0.4	0.2	0.4	0.5	1.9

Conclusion

It is therefore concluded that VRSP-1 is found to be superior than the other F1 clones regarding quantitative and qualitative characters and which may be promoted for wide scale adoption in Andhra Pradesh.

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