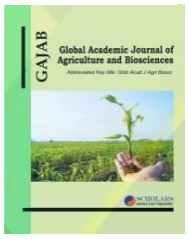
Global Academic Journal of Agriculture and Bio sciences

Available online at https://www.gajrc.com
DOI: 10.36348/gajab.2022.v04i01.002

OPEN ACCESS



ISSN:2706-8978 (P)
ISSN: 2707-2568 (O)

Original Research Article

Participatory Variety Selection of Orange Fleshed Sweet Potato (*Ipomoea batatas* L.) Varieties at Wondo Genet and Koka

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Article History
Received: 02.01.2022
Accepted: 07.02.2022
Published: 16.02.2022

Abstract: The experiment was conducted during the 2019 and 2020 growing seasons at wondo genet and Koka area. Five orange-fleshed sweet potato varieties were tested using a randomized complete block design with three replications using the mother-baby trial approach. All necessary data were collected from the mother trial and analyzed using SAS software and SPSS. The combined analysis of variance showed the presence of significant differences ($p \leq 0.05$) among tested varieties for plant height, root diameter, root yield per hectare, and root dry matter content. From the tested varieties, the highest root yield was obtained from Kulfo (33.90 t ha^{-1}), which was statistically similar with Kabode (31.64 t ha^{-1}), followed by Alamura variety (23.00 t ha^{-1}) and Vitae variety gave the lowest root yield of 10.8 t ha^{-1}as compared to the other varieties. The participated farmers have given a rank for the traits used for selection and evaluated the varieties using their selection criteria. Even though the Kulfo variety gave the highest yield, farmers have discarded it as a result of the taste after boiling. As a result, based on their preferences Kabode, Alamura, and Dilla varieties were selected as the first, second, and third choices. Therefore, scaling up of these selected varieties should be done in the study area and areas with similar agro-ecologies so that producers can able to access the variety to produce them resulted in overcoming the nutritional deficiency and food insecurity.

Keywords: Baby trial, Farmer preferences, Mother Trial, Root yield, Selection.

1. INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is a dicotyledonous plant belonging to the family Convolvulaceae (Tortoe *et al*., 2010). Globally, sweet potato is the seventh most important food crop after wheat, rice, maize, potato, barley, and cassava (FAO, 2014). More than 140 million tons had been produced globally per year. The world average storage root yield had been estimated to be 14.8t ha^{-1} (FAO, 2014). Asia is the world's largest producing continent (129 M tons per annum) and China is the leading country (121 M tons per annum) which is 86% of world production. In Asia, it is primarily used for human consumption and animal feed. In Africa, sweet potato is the second most important root crop after cassava and its production is concentrated in the East African and African great lake region countries (Ndole *et al.,* 2001; Dantata *et al.,* 2010). It is one of the most important sources of carbohydrates for smallholder farmers in Ethiopia (Amare *et al*., 2014) and the third root and tuber crop after Irish potato and cassava in the quantity of consumption in tropical Africa (Laban *et al*., 2015). Sweet potato yields are high per unit area

(Nwankwo *et al*., 2012) per unit of time (Nedunchezhiyan *et al*., 2012). Due to its higher productivity and drought tolerance, the crop can play a vital role in achieving food self-sufficiency in the region (Amare *et al*., 2014). This makes it an ideal sustainable crop for production in developing countries, where population growth has decreased the amount of arable land per person and increased the use of marginal land for food production (Woolfe, 1992). Sweet potato provides household food security because the crop can be harvested within 3-6 months (Anyaegbunam *et al*., 2008) and also can remain in the ground for "piece meal" harvesting, a common sweet potato "storage" practice in the tropics (Laban *et al*., 2015).

In Ethiopia, sweet potato ranks first in total production (36.78 t ha^{-1}) and third in area coverage next to Irish potato and taro from root and tuber crops cultivated in the country (CSA, 2019). Its root is used as food usually consumed in a boiled form which is one of the cheapest sources of vitamin A and its leaf and vine are used as feed for livestock. The sweet potato is tolerant to adverse conditions like drought. It is drought-resistant, hardy, and can grow in marginal areas, thus contributing to improved food security. Hence, it is considered an attractive food crop among farmer's growers because it requires less care and input (CIP, 1995). It is a widely produced and popular food in many parts of Eastern Africa countries. Even if different sweet potato varieties are grown in different potential areas of Ethiopia, the orange-fleshed type of sweet potato has not been widely grown and popular in the study areas. The orange fleshed sweet potato (OFSP) is one of the bio-fortified crops that contain high levels of beta-carotene to control vitamin A deficiency (Low *et al*., 2017). It is one of the starchy staple crops which contain ascorbic acid and the amino acid lysine that is deficient in cereal-based diets like rice in addition to appreciable amounts of β-carotene. It also contains soluble fibre which helps in reducing cholesterol concentration and anti-oxidant nutrients which can inhibit the development of coronary heart disease (Kays and Kays, 1998). As a result, it is better to evaluate the improved varieties by involving farmers in their field by their selection criteria. When the farmers select the variety by their selection criteria the newly generated technology is familiar to their farming activity and increases technology utilization. Hence, participatory variety selection is needed in this research to identify farmers' selection criteria and acceptable varieties to adapt and assimilate into the production system in the study areas.

Participatory Variety Selection (PVS) can effectively use to identify farmer-acceptable varieties and thereby overcome the constraints that cause farmers to grow old or obsolete varieties (Witcombe *et al.,* 1996). Moreover, participatory research complements the formal breeding system (Belay *et al*., 2006), increases the job efficiency of the researchers (Bellon, 2001) and farmers' knowledge that enables to be retained effectively from year to year (Grisley and Shamambo, 1993). PVS is a more rapid and cost-effective way of identifying farmer-preferred varieties if a suitable choice of varieties exists (Witcombe *et al*., 2008). In many parts of Ethiopia particularly at Wondo Genet, Sidama region, and Koka, Oromia region, orange-fleshed sweet potato varieties have not yet reached to farmers to grow, which resulted in farmers for highly demanding of better yielding, and disease resistant varieties of sweet potato. Therefore, participatory Varietal Selection has proposed as a solution to evaluate and select the best adaptable, high yielder and disease resistant varieties of orange fleshed sweet potato through farmer's selection preferences to diversify and popularize this economically important crop in the study areas.

2. MATERIALS AND METHODS

2.1. Description of Experimental Site

The experiment was conducted at Wondo Genet, sidama region and Koka, Oromia region. All experimental sites were described in the following Table

Table-1: Description of the study areas

Locations	Soil type	Temperature (^{0}c)		Soil pH	Annual RF	Altitude (m.a.s.l.)	Latitude	Longitude
		Min	Max					
Wondo Genet	Sandy clay loam	12.02	26.72	6.4	1000	1876	7°19' N 38°38' E	7°19' N 38°38' E
Koka	Loam	13.68	28.30	8.01	830.9	1604	8°26' N	39°1' E

2.2. Experimental Design and Field Management

The experiment consisted of five orange-fleshed sweet potato varieties (Kabode, Alamura, Dilla, Kulfo, and Vitae), which were released by Southern Agricultural Research Institute (SARI), Hawassa Agricultural research center. The experiment was carried out as Mother and Baby trials. The mother trial was arranged in a randomized complete block design (RCBD) with three replications. Thus, there were five treatments in triplicates. The treatments were randomly allotted to each plot. The experimental plot had an area of 9 m^2 (3 m length x 3 m width). The space between replications and plots was1.5 m and 1 m,

respectively. The space between rows and plants was60cm and 30cm respectively. Plants in the three middle rows out of the five rows per plot constituted the net plot used as the sampling unit. Five plants from the middle rows were taken for sampling and data analysis.

2.3. Farmers Preferences for Varieties Evaluation

Participatory variety selection was used in this research to identify farmers' selection criteria and acceptable varieties to adapt and assimilate into the production system. The selection of varieties was done in research stations at wondo genet and Koka areas. Researchers, experts from the woredas and kebeles agricultural development office, and farmers in both areas have participated in the selection of sweet potato varieties. A total of about 36 (females and males) participants have participated of which 26 of them were farmers (Females=7, males =19), 4 DA (Females=2 and Males= 2), and 6 experts (Females=1 and Males=5). Before the evaluation of varieties, discussions on plant characters were made with invited participants and the farmers provided their opinion on the preferred attributes and identified the traits such as root size, root color, root uniformity, diseases resistance/tolerance, earliness to maturity, root yield and taste. Two phases of selection ways were conducted on the field day. The first was to select varieties through observing at the vegetative stage and the second was through observing the yields/roots harvested from each variety based on farmer's preferences/criteria. In general, according to agronomic data and farmer preference criteria like disease resistant, high yielder, larger root size, good color and high number of root and good taste had considered as the variety had a good trait to be selected by farmers.

2.3. DATA ANALYSIS

Collected data were subjected to analysis of variance using SAS package (SAS 9.4). The least significance differences (LSD) were made to compare the treatments following the procedures of Gomez and Gomez (1984). Farmers' perception data were analyzed using SPSS software.

3. RESULT AND DISCUSSIONS

3.1. Performance of Oranges fleshed sweet potato Varieties for Growth and Yield Traits

The analysis of variance (ANOVA) revealed significant (P≤0.01) difference among the varieties for agronomic and yield traits, and indicated the presence of sufficient variability, which could be attributed to the genetic potential of the varieties and for the traits under consideration. This result is in agreement with similar findings in sweet potato varieties tested in different areas (Mekonnen, 2021) and potatoes (Zewdu *et al*., 2017). Alamura variety was the tallest (228.43cm) which was statistically similar to the Dilla variety and the shortest was Kabode (107.38cm), statistically similar to the Vita variety. Tested sweet potato varieties had no significant difference in root length and root number. As far as root diameter is concerned, the maximum root diameter (8.19 cm) is obtained from the Kulfo variety which was statistically similar to the value obtained from the Kabode variety while the lowest (5.75cm) was from the Dilla variety, statistically similar with the rest two varieties. The differences in plant height, root number, and root diameter among the sweet potato varieties might be due to the inherent characters of the varieties and the differences in the environment between the study areas. The present study results are in agreement with the result obtained by Mekonnen (2021).

Table-2: Combined mean values for different traits of tested orange-fleshed sweet potato varieties at Wondo Genet and Koka sites in 2019/20 main cropping season.

Varieties	Plant height (cm)	Root length (cm)	Root diameter (cm)	Root numbers/plant
Alamura	228.43^{a}	21.73	5.97^{b}	3.28
Dilla	213.48^{a}	23.19	5.75^{b}	3.75
Kabode	105.10^{c}	22.30	7.14a^{b}	5.43
Kulfo	1440.08^{b}	14.17	8.19^{a}	3.48
Vita	107.38^{c}	22.47	6.04^{b}	3.68
CV	11.13	12.97	13.55	18.33
LSD	18.23	NS	0.88	NS

Table-3: Combined mean values for different traits of tested sweet potato varieties at Wondo Genet and Koka sites in 2019/20 main cropping season.

Varieties	Root weight kg plant^{-1}	Root yield t ha^{-1}	Root dry matter Content (%)
Alamura	2.10^{b}	23.00^{b}	29.87^{b}
Dilla	2.25^{b}	16.81^{c}	30.16^{b}
Kabode	2.73^{a}	31.64^{a}	34.82^{a}
Kulfo	2.81^{a}	33.90a	23.31^{c}
Vita	1.99^{bc}	10.28^{c}	27.51b^{c}
CV	14.83	14.83	10.26
LSD	0.79	5.36	3.07

The maximum numbers of roots per plant was recorded from Kabode variety and the lowest was obtained from Alamura, which was statistically similar with all tested varieties. The highest root weight per plant was harvested from Kulfo (2.81kg) variety which was statistically similar with Kabode (2.73kg) variety but Vita variety was gave the lowest which was statistically similar with the rest two varieties. Kulfo variety gave the highest root yield per hectare (33.90 t ha^{-1}) which had no statistically difference with the yield obtained from Kabode variety while the lowest (10.28 t ha^{-1}) was recorded from Vita variety. The presence of highly significant differences among sweet potato varieties might be due to the presence of genetic differences used in the development of these varieties. Makonnen (2021) also reported that tested sweet potato varieties had a significance difference with respect to root and related traits. Moreover, Habtamu *et al*. (2016) also reported a similar result in which significance differences among potato varieties was found probably due to genetic variability presented.

3.2. Farmer's Preferences of Orange fleshed Sweet Potato Varieties

Fig-1: Evaluation of orange fleshed sweet potato varieties with integration of Researchers, Farmers and Agricultural experts at the Vegetative and Harvesting stages in both areas.

Yield and root quality play an important role in the successful production and marketing of sweet potato. Traditionally, high yielding ability alone was the most important factor to the producer but there should be other additional traits that should be considered in variety evaluation. For instance, in the two sites, wondo genet and Koka the highest yielder, disease-resistant, and best-tasting quality scored high percent response rate in participatory variety selection were ranked as first, second, and up to fifth. However, as shown in table 3 below even though the Kulfo variety gave the highest yield but discarded by farmers because of its tasting quality after boiling. Therefore, the participated farmers have given a rank for the traits used for selection and evaluated the varieties using their selection criteria. As a result, based on their preferences Kabode, Alamura, and Dilla varieties were selected as the first, second, and third choices (Table 4) while the other varieties were low yielder and had a low-quality taste, selected less by the farmers in both study areas.

Table-4: Farmers preferences for Orange fleshed sweet potato varieties at both testing locations in 2019/2020

Preference criteria's	Rank				
	Alamura	Dilla	Kabode	Kulfo	Vita
Earliness	3.6	3	3.5	3.2	2.4
Disease resistance	4	3.4	5	1	3.5
No. of roots/plant	3.5	3.2	4	4	2.5
Root size	2.4	3	3.5	3.5	2
Root color	2	2	4.2	2	2.8
Root uniformity	3.6	3	5	2.8	3
Taste	4	3	4	1	2
Rank sum	**23.1**	**20.6**	**29.2**	**17.5**	**18.2**
Overall rank	**2**	**3**	**1**	**5**	**4**

Note: Rank indicates, 1=poor, 2= satisfactory, 3=good, 4= very good, 5= excellent

Table-5: Pairwise ranking matrix for traits of sweet potato varieties at both sites in 2019/2020

Traits	RN	DR	RY	RS	RC	RU	TA	Total	Rank
RN		DR	RY	RN	RN	RN	TA	3	4
DR			DR	DR	DR	DR	TA	5	2
RY				RY	RY	RY	TA	4	3
RS					RS	RS	TA	2	5
RC						RU	TA	0	7
RU							TA	1	6
TA								6	1

RN= Root number, DR= Disease resistant, RY= Root yield, RS= Root size, RC= Root color, RU= Root uniformity, TA= Taste

4. SUMMARY AND CONCLUSIONS

Orange fleshed sweet potato (OFSP) is one of the bio-fortified crops that contain high levels of beta-carotene to control vitamin A deficiency. It is also one of the starchy staple crops which contain ascorbic acid and the amino acid lysine that is deficient in cereal-based diets like rice in addition to appreciable amounts of β-carotene. As a result, there is an increasing demand by farmers for production and consumption of improved OFSP varieties in the study areas. In order to respond to farmer requests, participatory variety selection trial was conducted with the objective of selecting superior OFSP varieties with farmer's preferred traits. The combined analysis of variance showed the presence of significant differences ($p \leq 0.05$) among tested varieties for plant height, root diameter, root yield/ha and dry matter content. The highest root yield was obtained from Kulfo (33.90 t ha^{-1}), which was statistically similar with Kabode (31.64 t ha^{-1}), followed by Alamura (23.00 t ha^{-1}) and Vitae variety gave the lowest root yield of 10.8 t ha^{-1}as compared to the others. The participated farmers have given a rank for the traits used for selection and evaluated the varieties using their own selection criterias. Even though Kulfo variety gave the highest yield, farmers have discarded it as a result of the taste after boiling. As a result, based on their preferences Kabode, Alamura and Dilla varieties were selected as the first, second and third choices. Therefore, scaling up of these selected varieties should be done in the study area and areas with similar agroecologies so that producers can able to access the variety to produce them resulted in overcoming the nutritional deficiency and food insecurity.

5. Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

6. ACKNOWLEDGMENT

We would like to thank the Ethiopian Institute of Agricultural Research (EIAR), Root crops research program through for financing this research and Wondo genet Agricultural Research Centre (WGARC) for facilities provided during the activities we did. It is also our pleasure to thank Hawassa Agricultural Research Center for provision of orange fleshed sweet potato varieties. Moreover, field assistants like Mr. Abebe Demisse and Mr. Teka Gebisso are highly acknowledged for their efforts in field management from beginning to end.

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