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Evaluation of improved orange fleshed sweet potato varieties at Gamo Zone, Southern Ethiopia

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Abstract

Six orange fleshed sweet potato varieties were tested in Gamo zone of southern region, Ethiopia in 2019 and 2020 to evaluate their total root yield potential and demonstrate best performing varieties. The experiment was laid out as a Randomized Complete Block Design with four replications. The combined analysis of variance showed highly significant differences among genotypes on growth, root yield and its components. The maximum number of marketable roots per plot was recorded on variety RW11-4743 (59.13) followed by Kyoyab werere and Kulufo (57.00 and 53.63 ton ha^{-1}), respectively. While, minimum number of roots per plot was recorded on variety Mayai. The highest root yield per hectare was obtained from varieties Kyoyab werere (53.23 ton ha^{-1}) and RW11-4743 (52.64 ton ha^{-1}) followed by Kulufo (48.42 ton ha^{-1}) whereas the minimum root yield per hectare was obtained from variety Carrot-C (37.84 ton ha^{-1}). Based on the result of this study from evaluated orange fleshed sweet potato varieties Kyoyab werere, RW11-4743 and Kulufo gave the highest yield but, except Kulufo, these varieties were not registered in the country (Ethiopia). Therefore, it needs further evaluation of Kyoyab werere and RW11-4743 including other genotypes at different locations for verification and registration and Kulufo was recommended for pre extension demonstration at the study area and similar agro ecological locations.

Keywords: Sweet potato; Orange fleshed; Root yield; Yield related traits

1. Introduction

Sweet potato (*Ipomoea batatas* L.) is one of the globally important crops ranking seventh and fifth in production in the world and in Africa, respectively [1]. It is mainly grown for human food and animal feed. It produces storage roots which are rich in carbohydrate, vitamins such as A, B complex, C, E and minerals such as potassium, calcium and iron.

In Ethiopia, sweet potato is widely grown in south, southwestern and eastern parts by small-scale farmers with limited land, labor and capital. Ethiopia is one of the largest sweet potato producing countries in the world. Sweet potato occupied about 53,499 hectares of land with a total annual production of 1.85 million tons during the main growing season only [2]. However, the productivity of the crop remained low (8 t ha-1) for a long time and the production of the crop is also declining due to many factors including recurrent drought, lack of planting materials, shortage of farmer preferred varieties, poor extension system that doesn't encourage production of root crops, market and postharvest related problems [3].

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Sweet potato viruses, sweet potato weevil and sweet potato butterfly are the major sweet potato production constraints in Ethiopia. Low root dry matter content (RDMC) in the orange fleshed sweet potato (OFSP) varieties and a lack of knowledge on postharvest storage and processing are also some of the prevailing constraints of the crop [4, 5].

The farmers in the study areas still use old released white fleshed sweet potato varieties that are susceptible to disease and have no beta carotene. Vitamin A deficiency is a serious public health problem happening mainly among children and women of childbearing age in Ethiopia [6]. Orange-fleshed sweet potato (OFSP) is an extremely rich plant-based source of pro-vitamin A (beta-carotene) [7].

Nowadays many improved sweet potato varieties have been introduced and released by research centers and universities for production. These improved sweet potato varieties together with improved management proved to give three to four fold yield advantage and nutrient composition as compared to old released white fleshed sweet potato varieties together with traditional production and management practices. Therefore, this study was proposed to evaluate and select the best high yielding, disease and insect pest resistant orange fleshed sweet potato varieties and to demonstrate the best adaptable sweet potato varieties in Gamo Zone, SNNPRS.

2. Material and methods

2.1. Description of the Study Areas

The experiment was conducted at Arba minch Zuria district of Gamo zone, SNNPRS, Ethiopia during 2019 and 2020 growing seasons. The site is located at 37o35'51''E longitude, 6o6'55''N latitude and altitude of 1220 m.a.s.l. The mean annual rainfall is 1050 mm and the soil textural class of the experimental site is clay loam.

2.2. Experimental Materials and Design

For this study, six orange fleshed sweet potato varieties were used. The name of the varieties, source and year of released presented in Table 1.

The experiment was laid out as a RCBD with four replications. Each plot was 3 m x 2.4 m = 7.2 m2 wide consisting of four rows, which accommodated 10 plants per row and thus 40 plants per plot. The spacing between plots and block were 1 m and 1.5 m, respectively. Health and young sweet potato vines were planted at a spacing of 60 cm between rows and 30 cm between plants. Cultural practices such as weeding, cultivation and ridging were practiced as per the recommendation. To reduce border effect, data were recorded from the two central rows of each plot.

Table 1 Orange fleshed sweet potato varieties used for the study

No	Varieties	Flesh colour	Source[1]	Year of release
1	RW11-4743	Orange	AwARC/ SARI	Introduced and Not registered
2	Kyoyab werere	Orange	AwARC/ SARI	Introduced and Not registered
3	Carrot-C	Orange	AwARC/ SARI	Introduced and Not registered
4	Ma'e (TIS 70357-5)	Orange	WARC/EIAR	2010
5	Kulufo(Lo-323)	Orange	AwARC/ SARI	2005
6	Vita	Orange		Introduced and Not registered

[1]AwARC/SARI = Awassa Agricultural Research Center / Southern Agricultural Research Institute and WARC/EIAR = Werer Agricultural Research Center / Ethiopian Institute of Agricultural Research

2.3. Data Collected

The following data were collected from the two central rows and used for analysis.

Stand count at harvest, Yield of top green parts per plot (fresh weight in kg), Vein & inter nod length at maturity (cm), Number of marketable roots per plot, Weight of marketable roots per plot (kg), Average marketable root length (cm), Average marketable root girth (cm), Number of unmarketable roots per plot, Weight of unmarketable roots per plot (kg), Number of marketable roots per hectare, Weight of marketable roots per hectare (t/ha), Number of unmarketable

roots per hectare, Weight of unmarketable roots per hectare (t/ha), Total number of roots per hectare, Total weight of roots per hectare (t/ha) were collected and analyzed.

2.4. Statistical Analysis

Analysis of variance for each year was done for tuber yield and other traits using the SAS software version 9.0 [8]. For factors showing significant effects, mean comparisons were made using the least significant difference (LSD) at 5% level of significance.

3. Results and discussion

The result of combined ANOVA showed that there is significant variation ($p < 0.05$) between varieties for stand count at harvest and yield of top green parts per plot (fresh weight in kg) and highly significant variation ($p < 0.01$) between varieties for yield and other yield related parameters (Table 2).

The highest number of roots per plot was recorded from variety RW11-4743 (59.13) followed by variety Kyoyab werere (57.00) whereas the lowest number of roots per plot was recorded from variety Mayai (45.25). The highest root yield per hectare was obtained from varieties Kyoyab werere (53.23 ton ha^{-1}) and RW11-4743 (52.64 ton ha^{-1}) followed by Kulufo (48.42 ton ha^{-1}) whereas the minimum root yield per hectare was obtained from variety Carrot-C (37.84 ton ha^{-1}) (Table 5). The current study was similar to [9] who reported the presence of high significant variation between sweet potato varieties for root dry matter content, β-carotene content and fresh root yield.

Table 2 Combined ANOVA for mean squares of growth, yield and yield related parameters for six orange fleshed sweet potato genotypes grown at A/Minch zuria district in Southern Ethiopia during 2019 and 2020

Source of variation	DF	SCAH	YTGPPP (kg)	VINLAM (cm)	NMRPP	WMRPP (kg)	AMRL (cm)	AMRG (cm)	NUMRPP
Yr	1	54.19**	712.48**	83842.44**	13233.52**	1076.74**	124.16**	3.19 ns	5985.33**
Yr(Rep)	6	2.77ns	3.67 ns	489.96 ns	21.35ns	7.63 ns	3.62 *	12.43ns	13.82 ns
Trt	5	8.37*	20.78*	7799.28**	209.27**	47.33**	43.4**	100.80**	1653.98**
Yr*Trt	5	10.04*	26.81**	1541.30 ns	596.67**	18.83**	4.05*	34.77**	419.83**
Error	30	2.77	6.19	688.40	19.20	3.52	1.19	8.90	17.55
Mean		15.15	15.80	179.24	52.73	13.97	21.88	23.19	44.54
CV (%)		10.99	15.75	14.64	8.31	13.43	4.99	12.87	9.41
Source of variation	**DF**	**WUMRPP (kg)**	**NMRPH**	**WMRPH (t ha^{-1})**	**NUM RPH**	**WUMRPH (t ha^{-1})**	**TNRPH**	**TWRPH (t ha^{-1})**	
Yr	1	59.07**	102623620829.00**	8321.07**	46183131984**	455.84**	28563673671**	12735.85**	
Yr(Rep)	6	0.46 ns	156839378.56ns	58.60ns	106631470 ns	3.62 ns	229498884.60 ns	67.28 ns	
Trt	5	3.85**	1620917136.30**	364.49**	12762217172**	29.69**	20031410852**	371.03**	
Yr*Trt	5	1.79**	4627860709.00**	144.95**	3239454881**	13.78**	11647923032**	189.21**	
Error	30	0.23	145393936.99	27.35	135438091.68	1.77	412112075.60	30.18	
Mean		2.68	146585.6	38.79	123726.9	7.45	270196.8	46.18	
CV (%)		17.86	8.23	13.48	9.41	17.86	7.51	11.90	

DF = Degree of freedom, SCAH = Stand count at harvest, YTGPPP= Yield of top green parts per plot (fresh weight in kg), VINLAM= Vein & inter nod length at maturity (cm), NMRPP =Number of marketable roots per plot, WMRPP= Weight of marketable roots per plot (kg), AMRL =Average marketable Root length (cm), AMRG =Average marketable Root girth (cm), NUMRPP= Number of unmarketable roots per plot, WUMRPP =Weight of unmarketable roots per plot (kg), NMRPH = Number of marketable roots per hectare, WMRPH = Weight of marketable roots per hectare (t/ha), NUMRPH = Number of unmarketable roots per hectare, WUMRPH = Weight of unmarketable roots per hectare (t/ha), TNRPH = Total number of roots per hectare, TWR = Total weight of roots per hectare (t/ha).

Table 3 Mean values of growth, yield and yield related traits of six orange fleshed sweet potato genotypes grown at A/Minch zuria district in Southern Ethiopia during 2019 and 2020

Genotypes	SCAH	YTGPPP(kg)	VINLAM (cm)	NMRPP	WMRPP(kg)	AM RL (cm)	AM RG (cm)	NUMRPP	WUMRP(kg)	NMR /ha	WMR (t/ha)	NUMR /ha	WUMR(t/ha)	TNR /ha	TWR (t/ha)
RW11-4743	17.13a	17.65a	170.83b	59.13a	15.28ab	21.35c	21.13b	68.88a	3.68a	164236a	42.43ab	191319a	10.21a	355556a	52.64a
Kyoyab werere	14.38b	13.69d	241.20a	57.00ab	16.66a	19.23d	28.80a	36.88c	2.50b	158333ab	46.29a	102431c	6.94b	260764c	53.23a
Carrot-C	14.63b	14.57cd	153.50b	52.50cd	10.72c	20.55c	20.08b	46.25b	2.91b	145833cd	29.77c	128472b	8.07b	274306bc	37.84c
Mayai	15.25b	17.19ab	173.10b	45.25e	11.21c	24.10b	20.38b	40.38c	2.53b	125694e	31.15c	112153c	7.02b	237847d	38.09c
Kulufo	14.50b	16.76abc	172.21b	53.63bc	14.50b	20.75c	26.23a	48.88b	2.93b	149653bc	40.29b	135764b	8.13b	284722b	48.42ab
Vita	15.00b	14.94bcd	164.58b	48.88de	15.44ab	25.33a	28.80a	26.00d	1.56c	135764de	42.82ab	72222d	4.34c	207986e	46.85b
mean	15.15	15.80	179.24	52.73	13.97	21.88	23.19	44.54	2.68	146585.6	38.79	123726.9	7.45	270196.8	46.18
LSD	1.70	2.54	26.79	4.48	1.92	1.12	3.05	4.28	0.49	12313	5.34	11884	1.36	20730	5.61

Means in the same column followed by the same letters are not significantly different at 5% level of significance. SCAH = Stand count at harvest, YTGPPP= Yield of top green parts per plot (fresh weight in kg), VINLAM= Vein & inter nod length at maturity (cm), NMRPP =Number of marketable roots per plot, WMRPP= Weight of marketable roots per plot (kg), AMRL =Average marketable Root length (cm), AMRG =Average marketable Root girth (cm), NUMRPP= Number of unmarketable roots per plot, WUMRPP =Weight of unmarketable roots per plot (kg), NMR = Number of marketable roots per hectare, WMR = Weight of marketable roots per hectare (t/ha), NUMR = Number of unmarketable roots per hectare, WUMR = Weight of unmarketable roots per hectare (t/ha), TNR = Total number of roots per hectare, TWR = Total weight of roots per hectare (t/ha).

4. Conclusion

From evaluated orange fleshed sweet potato genotypes, Kyoyab werere, RW11-4743, Kulufo and Vita gave the better yield. Except Kulufo, these varieties were not registered in Ethiopia. Therefore, it needs further evaluation of Kyoyab werere, RW11-4743 and Vita including other genotypes at different locations for verification and registration**,** Kulufo genotype is recommended for pre-extension demonstration at the study area and similar agro ecological locations. Genotypes Kyoyab werere, RW11- 4743 and Vita can also be cultivated side by side with verification and registration process.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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