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Evaluation of improved Cassava (*Manihot esculanta* Crantz) varieties in mid land area of South Omo Zone, Ethiopia

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Received 04 February 2022, Revised 10 June 2022, Accepted 25 June 2022, Published online 30 June 2022

ABSTRACT

Cassava is one of the most important foods security crops, especially in those regions disposed to difficult crop environments. The crop is also grown in the southern part of Ethiopia and plays an important role for home consumption, animal feed and source of income for small-scale farmers. However, its productivity is still low due to the lack of improved planting materials. Therefore, the experiment was conducted at Jinka Agricultural Research Center's research site during the 2018 and 2019 consecutive cropping seasons to investigate the adaptability of improved cassava varieties and to select high-yielding variety/varieties for the target area. Four improved cassava varieties (Hawassa-4, Kello, Qulle and Chichu) and one local check were used as treatments and arranged in randomized complete block design with three replications. ANOVA revealed that the interaction between year and variety showed non-significant, whereas varieties performed significantly different ($p < 0.05$) for root yield and other yield-related characters considered in this study. The higher mean value of total root yield was recorded on Hawassa-4 (56.91 ton ha⁻¹) followed by Kello (42.8 ton ha⁻¹) and showed good mean performance for root yield-related parameters than local and Qulle varieties. In general, the varieties Hawassa-4 and Kello yielded better than local checks by 50.95% and 13.5%, respectively. Therefore, the variety Hawassa-4 followed by Kello was identified as the highest yielding and adaptable Cassava varieties at the midland area of South Omo Zone and similar agro-ecologies.

Keywords: Adaptability, Improved, Cassava varieties, Root Yield

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Cite this article as: Eshbel, A., Muluneh, M. and Awol, M. 2022. Evaluation of improved Cassava (*Manihot esculanta* Crantz) varieties in mid land area of South Omo Zone, Ethiopia. *Int. J. Agril. Res. Innov. Tech.* 12(1): 101-104. <https://doi.org/10.3329/ijarit.v12i1.61038>

Introduction

Cassava (*Manihot esculenta* Crantz) is a dicotyledonous perennial shrub plant that belongs to the family Euphorbiaceae. It is native to Brazil and it was familiarized to Africa by the Portuguese in the sixteen century (FAO and IFAD, 2001; Andoh, 2010). Now it is extensively cultivated for consumption in the tropics and subtropics area (Burns *et al.*, 2010). It is known as an important food security root crop for many African countries smallholders farmers because of its wide adaptation to a variety of soil, climate, drought tolerance and generally, able to grow in difficult crop environments (FAO and IFAD, 2001; Misganaw and Bayou, 2020). In addition, its storage root is rich in carbohydrates, calcium, vitamin B, C, and essential minerals (Alo *et al.*, 2017).

The crop was believed to be exotically introduced to Ethiopia in the middle of the nineteenth century (Tassew, 2007) and it is currently grown in the southern part of Ethiopia and plays an important role for consumption, animal feed and source of income to many rural and urban households (Tadesse *et al.*, 2013). In Ethiopia, its annual average land coverage and productivity are 195,055 hectares and 501,278.5 tons, respectively. This indicates the average productivity of cassava in the country is not more than 25 tons per hectare (SNNPR, 2014), which is too lower than the yield obtained by other tropical countries such as Nigeria, 35 tons per hectare per year (FAOSTAT, 2013).

Among potential production areas in southern Ethiopia, the production of cassava in South Omo zone is obvious. but, production and productivity

have faced different constraints because farmers cultivate by using local varieties which are not only low-yielding and less nutritive but also susceptible to diseases including insects (Anshebo *et al.*, 2004; Gezahegn *et al.*, 2018). To alleviate, these problems, different research activities have to be conducted nationally and improved cassava varieties were released by Hawassa agriculture research center, but there are limited studies related to the evaluation of those developed varieties to find out the suitability for different agro-ecologies. Therefore, this study was designed to test the adaptability of improved cassava varieties and to select the high-yielding variety/varieties for the target area of South Omo zone.

Materials and Methods

Description of the experimental site

The experiment was conducted at Jinka Agricultural Research Center's research site, during the 2018 and 2019 consecutive cropping seasons. Jinka is located in the southern part of Ethiopia in SNNP Regional State. The administrative center of South Omo Zone Jinka is located 729 km southwest of Addis Ababa at a geographical coordinate of 36° 33' - 37° 67' E and 5° 46' - 6° 57' N with an altitude of 1450 m.a.s.l. The rainfall distribution of the area is bimodal with the main rainy season extends from January to May and the second cropping season, from July to October. The average annual rainfall of the area in the last ten years was 1307.3 mm with two seasons, while average temperatures ranging from 21.0°C to 28.0°C. The soil of the experimental site is sandy loam in texture with a soil pH of 6.41 (Tekele and Walegn, 2014).

Treatment and Experimental Design

Four improved cassava varieties (Hawassa-04, Kello, Qulle and Chichu) and one local check were evaluated in this study. The experiment was laid in Randomized Complete Block Design (RCBD) with three replications. The total size of each plot was 16 m², which contains 4 meters in width and 4 meters long. The spacing was 1 m between plant and ridge, which contained four rows per plot giving 10,000 plants per hectare. Healthy stem cuttings from 12 months old cassava measuring 30 cm were planted at inclined of 45° orientations on well-prepared land. The crop is grown under rain-fed conditions. Weeding was performed five times during the whole crop growth period. The crop was harvested 15 months after planting.

Data Collected

Agronomic parameters such as root length, root girth, number of roots per plant, number of

marketable roots per plant, number of unmarketable root per plant, marketable yield, unmarketable yield, total yield and dry matter were recorded at the fifteenth month after planting. Four representative plants were taken from the harvestable row of each plot from the respective treatments by avoiding the border. Total root yield per hectare was calculated as:

$$\text{yield ton ha}^{-1} = \left(\frac{\text{yield per plot (kg)} \times 10000 \text{ m}^2}{16 \text{ m}^2 \text{ (net plot size)}} \right) / 1000$$

For root dry matter content, a peeled fresh root is chopped into small pieces and weighted. Then, it was put into oven-dried at 105°C for 24 hours (Asare, 2004). After that, it was weighed again to determine the dry weight and calculated as:

$$DM = \left(\frac{\text{dry root weight (g)}}{\text{fresh root weight (g)}} \right) * 100$$

Data analysis

The collected data were subjected to analysis of variance (ANOVA) using the SAS computer software version 9.00. Mean separation was carried out to determine the significant difference among varieties using Least Significance Difference (LSD) test at a 5% probability level. Over years data were combined after testing the normality and homogeneity of collected data.

Results and Discussion

The combined analysis of variance results for the two years' data is summarized in Table 1. Significant differences for all parameters except dry matter content were observed among the varieties. The mean square for years effect was highly significant for the number of roots plant⁻¹, the number of unmarketable roots plant⁻¹, unmarketable root yield and dry matter content. For variety-year interaction, the mean square was not significant for all parameters.

Varieties had a significant ($p < 0.05$) effect on root length and a very highly significant ($P < 0.001$) effect on root diameter. The longest root was recorded from varieties Hawassa-4 (54.5 cm) followed by Kello (50.8 cm) and the shortest was recorded from Chichu (41.4 cm) (Table 2). The highest root diameter (8.85 cm) was recorded from the variety Hawassa-4 while the lowest root diameter (5.7 cm) was recorded from the local variety (Table 2). The main yield components that contributed to cassava yield enhancement were storage root size and storage root diameter (Tadesse *et al.*, 2018). This study was in agreement with the findings of Gebisa and Gezu (2017), Misganaw and Bayou (2020) who stated that root length and diameter had significantly ($P < 0.01$) affected due to varietal differences.

Significant differences ($P < 0.05$) among the varieties were observed for the number of roots plant⁻¹ and the number of marketable roots plant⁻¹. The maximum number of roots plant⁻¹ (9.83) and marketable root plant⁻¹ (8.12) was recorded from Hawassa-4 followed by Kello; Whereas the minimum number of roots plant⁻¹ (7.45) and the number of marketable roots plant⁻¹ (5.16) were recorded from Chichu and Qulle respectively

(Table 2). The variation in the number of roots plant⁻¹ and marketable root plant⁻¹ area mainly depends on the varietal difference. The number of roots plant⁻¹ is one of the primary root yield components and was expected that Hawassa-04 and Kello have a higher production potential than the other tested varieties (Muli, 2019).

Table 1. Combined analysis of variance result of mean squares for root yield and yield components of cassava varieties tested in 2018 and 2019.

SV	DF	RL	RD	NRPP	NMRPP	NUMRP	MRY	UMRY	TRY	DM
Replication	2	6.25	0.04	1.41	0.40	0.30	57.86	0.28	66.32	0.54
Year	1	29.60 ^{ns}	0.05 ^{ns}	19.60*	0.46 ^{ns}	14***	165.2 ^{ns}	7.803*	101.2 ^{ns}	210.67***
Treatment	4	141.03*	9.94***	7.78*	7.33**	2.18*	501.5*	6.22**	444.6*	8.66 ^{ns}
Yer*trt	4	20.77 ^{ns}	0.13 ^{ns}	3.07 ^{ns}	3.51 ^{ns}	1.28 ^{ns}	37.82 ^{ns}	2.043 ^{ns}	32.31 ^{ns}	20.67**
Error	18	46.57	0.67	2.16	1.52	0.55	119.71	0.99	130.37	3.71

RL= Root length, RD=Root diameter, NRPP= Number of root plant⁻¹, NMRPP= Number of marketable root plant⁻¹, NUMRPP= Number of unmarketable root plant⁻¹, MRYP= Marketable root yield, UMY= Unmarketable root yield, TY= Total root yield, DMC=Dry matter content, SV= Source of variation, DF= Degree of freedom.

The number of unmarketable roots plant⁻¹ and unmarketable root yield was also significantly affected at $p < 0.05$ and $p < 0.01$ accordingly. The minimum number of unmarketable root plant⁻¹ (1.33) and unmarketable root yield (2.25 ton ha⁻¹) were recorded from the variety Chichu and the maximum number of unmarketable root plant⁻¹ (2.66) and unmarketable root yield (4.53 ton ha⁻¹)

were observed on Kello and Qulle, respectively (Table 2). Based on the mean result, the number of unmarketable roots plant⁻¹ has directly proportional to unmarketable root yield. The current unmarketable root yield result is in line with Tadesse *et al.* (2018).

Table 2. Combined means values of root yield and yield component of cassava varieties tested at Jinka agricultural research center research site in 2018 and 2019 cropping season.

	Cm					Ton ha ⁻¹			%
Varieties	RL	RD	NRPP	NMRP	NURP	MRY	UMRY	TRY	DMC
Hawass-4	54.5 ^a	8.85 ^a	9.83 ^a	8.12 ^a	1.7 ^{bc}	54.35 ^a	2.56 ^{bc}	56.91 ^a	43.25
Chichu	41.4 ^b	6.86 ^b	7.45 ^b	6.12 ^{bc}	1.33 ^c	37.26 ^b	2.25 ^c	39.51 ^b	44.04
Local	47.23 ^{ab}	5.7 ^c	8.12 ^{ab}	6.5 ^{bc}	1.62 ^c	34.18 ^b	3.51 ^{ab}	37.70 ^b	43.56
Qulle	49.43 ^{ab}	5.86 ^{bc}	7.75 ^b	5.16 ^c	2.58 ^{ab}	30.48 ^b	4.53 ^a	35.01 ^b	42.83
Kello	50.8 ^a	6.17 ^{bc}	9.79 ^a	7.12 ^{ab}	2.66 ^a	38.98 ^b	4.31 ^a	43.29 ^{ab}	45.91
Mean	48.67	6.69	8.59	6.60	1.98	39.95	3.43	42.39	43.91
LSD (0.05)	8.27	0.99	1.78	1.49	0.9	13.27	1.2	13.85	Ns
CV%	14.02	12.29	17.14	18.67	37.6	28.02	28.97	26.82	4.39

*RL= Root length, ***RD=Root diameter, *NRPP= Number of root plant⁻¹, **NMRPP= Number of marketable root plant⁻¹, NUMRPP= Number of unmarketable root plant⁻¹, *MRYP= Marketable root yield, UMY= Unmarketable root yield, *TY= Total root yield, DMC=Dry matter content, CV=Coefficient of variance, LSD= List significance difference.

The varieties had a significant ($p < 0.05$) difference in marketable and total root yield. The difference in root yield might be associated with the potential of varieties to adapt to the testing agro-ecology. The higher marketable root yield (54.35 ton ha⁻¹) and total root yield (56.91 ton ha⁻¹) were recorded from Hawassa-4; whereas the lower marketable root yield (30.48 ton ha⁻¹) and total root yield (35.01 ton ha⁻¹) were recorded from Qulle with no significant difference over the variety local and Chichu (Table 2). In general, the total root yield of the variety Hawassa-4 was yielded better than the local check by 50.95%. This result is in agreement with the findings of

Tadesse *et al.* (2018) who reported that Hawassa-4 was high yielder than Qulle. However, these yields were higher than the yield obtained from the study of Misganaw and Bayou (2020) who evaluated the performance of the same varieties in Fafen District, Ethiopia.

Conclusion

The current result of analysis of variance (ANOVA) showed that the interaction between year and variety was non-significant, whereas varieties performed significantly differently ($p < 0.05$) for all root yield and other characters

except dry matter content. The higher mean value of root length (54.5 cm), root diameter (8.85 cm), number of roots plant⁻¹ (9.85), number of marketable roots plant⁻¹ (8.12), marketable root yield (54.35 ton ha⁻¹) and total root yield (56.91 ton ha⁻¹) was recorded on the variety Hawassa-4) followed by Kello. The varieties Hawassa-4 and Kello were yielded better than local checks by 50.95% and 13.5%, respectively. Therefore, the variety Hawassa-04 followed by Kello was identified as the highest yielding and adaptable Cassava variety at the midland area of South Omo Zone and similar agro-ecologies. In addition, it is advisable to undertake a demonstration of these Hawassa-4 and/or Kello varieties to improve cassava production in the study area.

Acknowledgment

Our special thanks go to the south agricultural research institute for financial support. Grateful acknowledgment is also going to Jinka agricultural research center, crop science case team staff members for their moral and technical support.

Conflict of Interest

The authors declare that they have no conflict of interest with the publication of this article.

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