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Correlation and Mean Performance Evaluation of Sweet Potato (*Ipomoea batatas* (L.) Lam.) Genotypes Middle Awash Areas, Ethiopia

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Abstract

Sweet potato (*Ipomoea batatas* (L.) Lam.) is drought resistant, hardy and can grow in marginal areas. It is highly contributing to improving food security. The optimal production altitude range is 1500-1800 means above sea level (m.a.s.l). The study was conducted for one season over two locations, at Werer Agricultural Research Center (WARC) experimental field and Fentalle Woreda on a farmer's field, where the altitudes represent lowlands (less than 1500 m.a.s.l). The objective was to evaluate morphological traits and select highly performing sweet potato genotypes for the lowland areas. The field experiments were arranged in a randomized complete block design with three replications. Each variety was planted on a 2 m long and 2.4 m wide plot consisting of four rows, which accommodate six plants per row and a total of 24 plants per plot. The middle two rows were used for data collection. The statistical analysis of variance for mean leaf length, plant height, vine length, marketable storage root yield and stand count at harvest showed significant differences among genotypes (P=0.0056) and locations (P<0.0001). The Pearson's correlation analysis also showed that marketable storage root yield was weakly and positively associated with root diameter ($r=0.29^{**}$), while a negative correlation was observed in plant height ($r=-0.22^{*}$). The highest marketable storage root yield was recorded for Dilla (18.14 t/ha) followed by Kulfo and Wagobolige, whereas the lowest yielder genotypes were Cacilia which is statistically at par with Sumaia, Ininda, Jane and Gloria. Measured total above ground biomass by far greater at WARC than Fentalle, where the yields were statistically similar. From this, it is concluded that the above ground biomass of sweet potatoes is inversely correlated with storage root yield parameters. This might be due to the existence of photo assimilate competition between the above ground biomass and tubers. However, it needs further study to identify photo assimilate translocation and sink source relationships of sweet potatoes.

Keywords: Ethiopia; Fentalle; Genotypes; Sweet potato; Storage root

Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam.) is a member of the morning glory family *Convolvulaceae,* producing edible roots and leaves. The crop has great potential to alleviate hunger, malnutrition and poverty in developing countries [1]. It has a significant amount of proteins, provitamin A, B and C and minerals such as Ca, Fe and Na [2,3]. It is drought resistant, hardy and can grow in marginal areas, thus contributing to improving food security.

Food insecurity is increasing in Ethiopia with 55% of farmers reporting that their total annual harvest is insufficient to maintain the family for more than six months. At least seven million people require food aid every year and twice that total in 1 in 3 years. Efforts to address the problem through a grain led approach have failed even to keep up with population increase. A new approach is needed. An alternative to the cereal staples is the root and tuber crops. The root and tuber crops are one of the traditional food crops in Ethiopia. Their contribution to food self-sufficiency, income generation and soil based resource conservation are indispensable.

In Ethiopia, sweet potato is largely produced in the mid and lower altitudes of the country. The optimum altitude range is 1500-1800 means above sea level. It performs poorly and the maturity period is also extended when planted in areas with more than 2000 meters in elevation [4,5]. Though, available irrigable land and enough irrigation water in the lowlands, fewer varieties are adapted and released to the area. Thus, to have a choice of varieties experimental study is needed to evaluate traits and select highly performing sweet potato genotypes for the lowland areas.

Materials and Methods

The study was conducted for one season at two locations, *viz.* Werer Agricultural Research Center (WARC) experimental field, Amibara Woreda, Afar regional state and on a farmer's field at Fentalle Woreda, Oromia regional state. WARC is located at 285 km North-East of Addis Ababa, which is found at 9°16'8" N latitude and 40°9'41" E longitudes. It has an altitude of 740 m above sea level and the annual mean temperature maximum and the minimum are 34°C and 19°C, respectively. The precipitation in the study area is characterized by unpredictable and uneven distribution with an annual average rainfall

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of about 571 mm which is not sufficient for crop production. Supplementary irrigation is used where the Awash River is the main irrigation water source. The soil in the testing field of WARC is predominantly Fluvisols while vertisol is the second dominant soil that occupies about 30% of the total area [6].

Fifteen sweet potato genotypes (Bela, Cacilia, Delvia, Dilla, Erica, Gloria, Ininda, Jane, Kulfo, Lourdes, Naspot-8, Sumaia, Tio-joe, Tumura-buka and Wagobolige) were obtained from Hawasa agricultural research center. The experiment was arranged in a randomized complete block design with three replications. Each variety was planted on a 2 m long and 2.4 m wide plot consisting of four rows, which accommodate six plants per row and thus 24 plants per plot. A distance of 1 m was maintained between the plots and the row to row spacing was 60 cm while plant to plant distance was 30 cm. The middle two rows were used for data collection. The data were recorded for various characters *viz.* leaf length, leaf diameter, plant height, vine length, number of branches per plant, number of tubers per plant, marketable storage root yield (t/ha), unmarketable storage root yield (t/ha), stand count at harvest, storage root diameter (cm), storage, root length (cm), the weight of above ground biomass. The mean performance of individual genotypes was pooled and employed for statistical analysis. Analysis of variance to test the significance for each character and Pearson's correlation was carried out by R-software.

Results and Discussion

Mean performances of growth variables

The statistical analysis of variance for mean leaf length, plant height, vine length and stand count at harvest showed highly significant differences among genotypes (P=0.0056) and locations (P<0.0001) as indicated in Table 1.

Bela genotype had the highest leaf length whereas, statistically at par with Cacilia, Delvia, Erica, Kulfo, Naspot-8, Tumura-buka and Wagebolige genotypes. Gloria, Ininda and Sumaia genotypes showed the lowest leaf length which was also statistically the same as Jane and Toe-joe genotypes. Gloria genotype followed by Sumaia had the highest plant height, whereas the Lourdes genotype which was statistically at par with the rest genotypes was the shortest in plant height. Gloria genotype was followed by Naspot-8, Sumaia and Delvia, whereas the shortest vine was recorded for Lourdes. The difference might be due to the genotypic variation that exists among genotypes plus environment. Berhanu and Beniam also reported that, vine length was significantly affected by the interaction effects of site and variety [7].

Sweet potato genotypes grown at WARC were taller in plant height, longer in vine length and higher in above ground biomass in kg/plots than the Fentalle site. In another way, the sweet potato genotypes grown at Fentalle farmer's field showed longer leaf length and significantly higher in stand count at harvesting time. This might be due to the denser emergence and higher competition among plants per plot at Fentalle. Due to the high heat and soil salinity problems that exist at the WARC field fewer plants per plot grown with less competition.

Mean squares	Sources of variation						
	REP	TRT	LOC	TRT*LOC	Error	CV%	R^2
	2	14	1	14	58		
Leaf length (cm)	5.21	5.60*	41.13***	2.86	239.85	15.78	0.57
Leaf diameter (cm)	38.29	1.9	2.34	5.68	4.13	25.16	0.43
Plant height (cm)	763.46	6732.67***	74000.71***	2435.28	83815.13	27.17	0.71
Vine length (cm)	1825	1940.37***	50453.55***	534.89	572.77	24.81	0.73
Number of branch/ Plants	1.12	1.76	0.64	0.63	1.12	28.78	0.35
Number of tubers/ Plants	2.26	5.44*	77.44***	8.26***	2.41	38.1	0.66
Marketable storage root yield (t/ha)	24.86	72.75***	15.44ns	0.68ns	8.74	26.23	0.68
Unmarketable storage root yield (t/ha)	0.6	0.14	2.64***	0.25	0.18	80.73	0.47
Stand count at harvest	92.01	36.47*	1152.04***	4.66	16.38	22.51	0.66
Storage root diameter (cm)	1.06	3.89***	38.45***	4.19***	0.89	18.92	0.75

Storage root length (cm)	1.438	22.35^{**}	164.27^{***}	25.22^{**}	8	18.36	0.64
Weight of above ground biomass	0.64	37.36	3056.02^{***}	36.59	23.43	53.92	0.75
Note: *,** Significant at 5% level and 1% level, REP-Replications, TRT-Treatment, LOC-Location, CV%-Coefficient of Variation in percentage							

Table 1: Mean squares of sweet potato genotypes evaluated at Fentalle and WARC in 2020.

Mean performance of yield and yield related variables

The statistical analysis of variance for the mean number of tubers per plant, marketable storage root yield, storage root diameter and storage root length showed significance among genotypes and locations (Table 2).

Loc	LL (cm)	LD (cm)	PH (cm)	VL (cm)	NBPP	NTPP	MY (t/ha)	uMY (t/ha)	RL (cm)	RD (cm)	SC	TGW kg/ha
WARC	8.63^{b}	7.91	168.58^{a}	120.14^{a}	3.76	5.01^{a}	11.68	0.69^{a}	14.05^{b}	4.33^{b}	14.40^{b}	14.80^{a}
Fentalle	9.98^{a}	8.24	111.23^{b}	72.78^{b}	3.59	3.15^{b}	10.85	0.35^{b}	16.75a	5.63^{a}	21.55^{a}	3.15^{b}
CR 5%	0.62	Ns	43.93	27.66	Ns	0.65	Ns	0.32	1.194	0.39	1.71	2.042
Note: LL: Leaf Length (cm); LD: Leaf Diameter; PH: Plant Height (cm); VL: Vine Length (cm); NBPP: Number of Branches /Plant; NTPP: Number of Tubers/Plant; MY (t/ha): Marketable tuber Yield in tone per hectare; uMY: unmarketable tuber Yield in tone per hectare; RL (cm): Root Length; RD (cm): Root Diameter; SC: Stand Count at harvesting TWF (kg)-above ground fresh biomass weight per plot (kg)												

Table 2: Mean performance of genotypes variables as influenced by location.

Delvia genotype, which is statistically at par with Dilla, Erica, Gloria, Lourdes sumaia and Tio-joe gave the highest number of tubers per plant. The highest marketable storage root yield was recorded for Dilla (18.14 t/ha) followed by Kulfo and Wagobolige, whereas the lowest yielder genotypes were Cacilia which is statistically at par with Sumaia, Ininda, Jane and Gloria. The result indicated that Gloria has the thinnest roots diameter, whereas the Sumaia genotype has a shortest roots length (Table 3). Naspot-8 which was statistically at par with Bela, Delvia, Dilla, Gloria, Ininda, Jane, Lourdes, Tio joe and Tumura-buka had the highest root length, whereas Cacilia was the shortest in which it was also followed by Erica and Wagobolige [8].

The number of tubers per plant performance was higher in WARC than in Fentalle. However, the roots were either not fully developed in diameter (root girth) or shorter roots were harvested as indicated in above, where the highest unmarketable roots yield was recorded compared to the Fentalle site. In another way having insignificant marketable root tuber yield of the two locations indicated that Fentalle site suits more for the production of sweet potato. This is due to the less unmarketable roots tuber yield recorded there (Table 3).

TRT	LL (cm)	LD (cm)	PH (cm)	VL (cm)	NBPP	NTPP	MY (t/ha)	uMY (t/ha)	RL (cm)	RD (cm)	TGW
Bela	11.17^{a}	7.43	137.03^{bcd}	98.47^{bcd}	4.37	3.10^{c}	12.22^{bcd}	0.35	15.88^{abcd}	6.07^{a}	12.37
Cacilia	9.52^{abc}	7.88	144.57^{bcd}	96.23^{cd}	3.27	3.27^{c}	5.95^{f}	0.32	12.29^{d}	5.21^{ab}	7.11
Delvia	9.58^{abc}	7.71	143.57^{bcd}	107.83^{abc}	3.57	5.90^{a}	12.28^{bcd}	0.65	16.43^{abc}	6.09^{a}	7.74
Dilla	8.86^{bc}	8.46	139.87^{bcd}	84.70^{cd}	4.13	4.23^{abc}	18.14^{a}	0.56	16.60^{ab}	5.90^{a}	12.59
Erica	9.23^{abc}	8.65	126.40^{cd}	93.10^{cd}	3.43	4.67^{abc}	9.83^{de}	0.5	12.73^{cd}	4.46^{bc}	9.59
Gloria	7.95^{c}	8.35	237.33^{a}	137.20^{a}	2.9	4.00^{abc}	7.17^{ef}	0.38	16.00^{abcd}	3.66c	8.65
Ininda	8.23^{c}	7.29	107.00^{cd}	77.57^{cd}	3.1	3.01^{c}	9.26^{def}	0.33	14.72^{abcd}	4.05^{bc}	8.02
Jane	8.88^{bc}	7.83	115.40^{cd}	85.53^{cd}	3.97	4.03^{abc}	6.46^{ef}	0.37	17.93^{ab}	4.21^{bc}	8.46
Kulfo	10.49^{ab}	8.24	133.00^{bcd}	93.60^{cd}	4.67	3.00^{c}	14.71^{b}	0.85	14.13^{bcd}	5.13^{ab}	14.41
Lourdes	8.89^{bc}	8.74	96.97^{d}	73.30^{d}	3.83	5.87^{ab}	$10.22c^{de}$	0.65	16.30^{abc}	4.15^{bc}	4.74
naspot-8	10.39^{ab}	9.17	137.43^{bcd}	110.38^{abc}	3.33	3.00^{c}	13.97^{bc}	0.49	18.37a	4.92^{abc}	8.8
Sumaia	8.07^{c}	7.56	181.55^{b}	128.43^{ab}	3.8	4.66^{abc}	8.35^{ef}	0.66	14.30^{bcd}	5.73^{a}	7.79
Tio-joe	8.51^{bc}	8.25	120.67^{cd}	81.30^{cd}	3.2	4.60^{abc}	13.80^{bc}	0.6	17.70^{ab}	5.84^{a}	7.29
Tumura-buka	10.39^{ab}	7.3	126.57^{cd}	86.10^{cd}	4.43	3.77^{bc}	12.25^{bcd}	0.65	15.05^{abcd}	4.87^{abc}	9.91

Wagobolige	9.44^{abc}	8.35	151.23^{bc}	93.2^{cd}	3.2	4.10^{abc}	14.47^{b}	0.49	12.65^{cd}	4.45^{bc}	7.15
CR 5%	1.69		43.93	27.66		1.22	3.42		3.26	1.09	

Note: LL: Leaf Length (cm); LD: Leaf Diameter; PH: Plant Height (cm); VL: Vine Length (cm); NBPP: Number of Branch/Plant; NTPP: Number of Tuber/Plant; MY (t/ha): Marketable tuber yield in tone per hectare; uMY: unmarketable tuber Yield in tone per hectare; RL (cm):Root Length; RD: Root Diameter; WF (kg)-above ground fresh biomass weight per plot (kg).

Table 3: Mean performance of sweet potato genotypes evaluated at Fentalle and WARC, 2020.

Correlation

The Pearson's correlation coefficients among some crop growth and yield parameters of sweet potato genotypes are presented in Table 4. The analysis showed that marketable storage root yield was weakly and positively associated with root diameter ($r=0.29^{**}$), while a negative correlation was observed in plant height ($r=-0.22^{*}$). It was also stated in sweet potatoes, plant height is negatively associated withstorage root yield [8]. Above ground fresh biomass weight was associated positively with plant height (r=0.46), vine length (r=0.53), number of branches per plant (r=0.28) and unmarketable tuber yield (r=0.34), whereas a negative association was observed for leaf diameter (r=-0.32), root length (r=-0.31) and root diameter (r=-0.32). This may signify that a genotype that possesses vigorous vegetative growth tends to produce fewer storage roots, which in turn implies the presence of competition between the shoots and roots for photosynthesis.

	LL (cm)	LD (cm)	PH (cm)	VL (cm)	NBPP	NTPP	MY (t/ha)	uMY (t/ha)	RL (cm)	RD (cm)	TGW
LL (cm)	1										
LD (cm)	0.37***	1									
PH (cm)	-0.24*	0.03^{ns}	1								
VL (cm)	0.30**	-0.11^{ns}	0.88***	1							
NBPP	0.36***	0.23*	0.02^{ns}	0.04^{ns}	1						
NTPP	-0.29**	-0.07^{ns}	0.18^{ns}	0.26*	0.04^{ns}	1					
MY (t/ha)	0.20^{ns}	0.07^{ns}	-0.22*	-0.18^{ns}	0.17^{ns}	0.1^{ns}	1				
uMY (t/ha)	0.02^{ns}	-0.14^{ns}	0.12^{ns}	-0.05	0.09^{ns}	0.51***	0.13^{ns}	1			
RL (cm)	0.20^{ns}	0.17^{ns}	-0.13^{ns}	-0.18^{ns}	0.11^{ns}	0.1^{ns}	0.18^{ns}	0.07^{ns}	1		
RD (cm)	0.29**	0.03^{ns}	-0.21*	-0.26*	0.09^{ns}	-0.0^{ns}	0.22*	-0.01^{ns}	0.45***	1	
TGW	-0.06^{ns}	-0.32**	0.46***	0.53***	0.28***	0.1^{ns}	0.06^{ns}	0.34***	-0.31**	-0.32**	1

Note: LL=Leaf Length (cm) LD=Leaf Diameter, PH=Plant Height (cm), VL=Vine Length (cm), NBPP =Number of Branch /Plant, NTPP=Number of Tuber/Plant, MY (t/ha)=Marketable tuber yield in tone per hectare, uMY=unmarketable tuber yield in tone per hectare, RL (cm)=Root Length, RD: Root Diameter and TWF (kg)-above ground fresh biomass weight per plot (kg)

Table 4: Pearson's correlation coefficient of crop growth and yield characters of sweet potato genotypes evaluated at Fentalle and WARC 2020.

Conclusion

The highest marketable storage root yield was recorded for Dilla (18.14 t/ha), whereas the lowest yielder genotypes were Cacilia which is statistically at par with Sumaia, Ininda, Jane and Gloria. Measured total above ground biomass kg/plot by far greater at WARC than Fentalle, where the yields were statistically similar. From this, it is concluded that the above ground biomass of sweet potatoes inversely correlated with storage root yield parameters. This might be due to the existence of photo assimilate competition between the above ground biomass and storage roots. Further study is suggested to identify photo assimilate translocation and sink source relationships of sweet potatoes.

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References

1. Shonga E, Gemu M, Tadesse T, Urage E (2013) Review of entomological research on sweet potato in Ethiopia. J Agric Food Sci 1: 83-92.
2. Alvarez MN (1986) Sweet potato and the African food crisis. Int Dev Res 66-69.
3. Chekol W, Mnalku A (2012) Selected physical and chemical characteristics of soils of the middle awash irrigated farm lands, Ethiopia. Ethiop J Agric Sci 22: 127-142.
4. Tigabu B, Tilahu B (2015) Performance evaluation of improved sweet potato (*Ipomoea batatas* L.) varieties at Gedeo Zone, Southern Ethiopia. Int J Sci Res 6: 2319-7064.
5. Magaji YT, Sodangi IA (2020) Correlation and path coefficient analysis of yield characters of sweet potato (*Ipomoea batatas* L.) varieties as influenced by minero organic fertilizer. Sci World J 15: 135-138.
6. Perez-Pazos JV, Amparo R, Remberto M, Jos'e P, Julio M, et al. (2021) Influence of morpho physiological traits on root yield in sweet potato (*Ipomoea batatas* Lam.) genotypes and its adaptation in a sub humid environment. Sci Hortic 275: 109703.
7. Tsegaye E, Sastry ED, Dechassa N (2006) Correlation and path analysis in sweet potato and their implications for clonal selection. J Agron 5: 391-395.
8. Gizaw S, Abegaz S, Rischkowsky B, Haile A, Okeyo AM, et al. (2013) Review of sheep research and development projects in Ethiopia.