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Performance Evaluation of Potato Genotypes for Yield, Yield Related Traits in Bale High Lands South Eastern Ethiopia

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Abstract: Potato is an important food security crop in the world spacially for Africa, specifically Ethiopia which ranked 9th in potato production in Africa. Bale Zone South Eastern Ethiopia is known for potato production both in irrigation and rainfed. Howevere, the productivity of the crop is low due to many factors among which lack of improved potato varieties which were high yeilder and tolerance to potato disease is major. This study was conducted to evaluate potato genotypes for high-yielding, stability and resistance to late blight. The experiment was laid out in a randomized complete block design with three replications at three locations (Sinana, Goba and Dinsho districts) for three years. The highest total tuber yield was recorded from genotypes CIP-392640-524 (45.75t/ha^{-1}) followed by CIP-395114.5 (40.01t/ha^{-1}) while the lowest total tuber yield was obtained from local checks (25.27t/ha^{-1}). Result from stability papameters indicated the stability of tested genotypes over the tested environment. The yield performance of genotypes (CIP-392640-524) across environments and yield advantage of genotype over standard checks (Moti) 11.45% with less disease (late blight reaction) and the result from AMMI analysis of variance and stability parameter also indicated the stability of genotype over tested environments. This suggested that the genotypes are promoted to a variety of verification trials for Bale highlands and similar agro-ecologies.

Keywords: Potato, Genotype, Stability, Marketable, Unmarketable, Tuber Yield

1. Introduction

Potato is an important food security crop in the world. Potato helps to meet the rising food demands in the tropical highlands of Sub-Saharan Africa. It is a key food crop in the region mainly Rwanda, Kenya, Uganda, Ethiopia and Tanzania in decreasing order [1, 2]. Like many other countries in the world, potato is a very important food and cash crop, especially in the highland and mid-altitude areas of Ethiopia. In the highlands of Ethiopia, the potato holds great promise for improving the livelihoods of millions of smallholder farmers [3]. The potential for high yield, early maturity and excellent food value gives potato great potential for improving food security, increasing household income and reducing poverty. Potato ranked fourth in the world in terms of the volume of production after rice, wheat and maize [4]. In Ethiopia, potato ranks first in the category of root and tuber crops in terms of area coverage and total production. Its contribution to the food security and food self-sufficiency strategy of the country, income generation and export is also great. The exports of potatoes grew substantially in recent years, both in terms of quantity and value. Ethiopia exported approximately 71 thousand tonnes of potatoes to regional markets. Djibouti is by far the largest market outlet, absorbing approximately 80 to 90% of Ethiopian's potato export while Somalia is the second largest market, receiving 8 to 15% of the total. Other regional markets such as Sudan, Yemen and Saudi Arabia import small quantities of potatoes from Ethiopia [5]. According to Kolech Semagn Asredie, potato is one of the most productive

food crops in terms of nutrition (edible energy and good quality protein) and terms of yield per hectare approximately double that of grains [1]. It is grown in Ethiopia in almost all the states. It is possible to see the crop in the field round the year in one part of the country or other both in irrigation and rain-fed (Personal observasion).

In Bale high lands potato production mainly depends on rain-fed and also irrigation in some areas. However, its average yield is not as much as the potential of the Zone. The low yields are attributed to many factors, a shortage of good quality seeds of improved potato varieties and diseases (mainly late bight) have prevented growers from achieving full yield. Although improved potato varieties resistant to late blight are being developed, some varieties with major gene resistance are quickly overcome by Phytophthora infestans. Hence, it is necessary to introduce potato genotypes from the source. The introduced genotypes need to be evaluated for the target area. Therefore, varieties with better resistance to late blight are needed every time. Accordingly, this activity was initiated to evaluate potato genotypes for high yielding, stable and tolerant to late blight for Bale highlands and similar agroecologies.

2. Material and Methods

A total of eight potato genotypes which consisted of 6 advanced clones, one standard check (Moti) variety which was released from Sinana Agricultural Research Center and as local checks one farmer's cultivar 'kellecho' were evaluated at Sinana Agricultural Research Centre on the station, Goba and Dinsho on the farmer's field from 2017-2019 for three years during 'Gena' cropping season.

The experiment was arranged in a randomized complete block design (RCBD) with three replications. The spacing between rows and plants was 0.75 and 0.30 m, respectively. The spacing between plots and adjacent replications was 1 and 1.5 m, respectively. Fertilizer application was made as per the recommendation made for the crop which is NPS 195 kg ha^{-1} and the whole rate was applied at planting. Nitrogen fertilizer was applied at the rate of 75 kg ha^{-1} in the form of Urea in two splits, half rate after full emergence (two weeks after planting) and the half rate at the initiation of tubers (at the start of flowering). Moreover, other agronomic managements rather than varietal differences, like weeding and earthing up were uniformly applied to all experimental plots.

3. Data Collection and Statistical Analysis

The four middle rows were used for data collection. Data were collected on phenology, growth parameters, tuber yields and yield components. Collected data were subjected to analysis of variance (ANOVA) for RCBD using R - software. Means that are significantly different were computing using the Least Significant Difference (LSD) of probability at a 5% level of significance.

4. Results and Discussions

The mean total tuber yield of genotypes across environments ranged from 45.75 to 25.27 t/ha^{-1} (Table 1). The highest total tuber yield was recorded from genotypes CIP-392640-524 (45.75 t/ha^{-1}) followed by CIP-395114.5 (40.01 t/ha^{-1}) while the lowest total tuber yield was obtained from local checks (25.27 t/ha^{-1}). The genotypes (CIP-392640-524) have a total tuber yield advantage of 11.45% over standard check Moti. [6-9] also reported some of the newly introduced potato genotypes had higher tuber yields than the existing commercial potato varieties and the mean total tuber yield of released varieties (Belete, Gudanie and Ararsa) was within the range of 15.9 to 41 t ha^{-1}. Likely Awoke *et al.,* reported the maximum total tuber number was recorded from genotype CIP-395123.6 (4.8) followed by Gudanie (4.5) while the lower tuber number per hill was recorded from CIP-3956023.109 [10]. This indicated the presence of variation in genotypes under study for total tuber yield that can be exploited in improving the crop. The highest means of marketable tuber yield and marketable tuber number per hill and the lowest unmarketable tuber yield and unmarketable tuber number per hill were recorded from the same genotypes. It has a 22% of marketable tuber yield advantage over standard check Moti. According to Asefa, G. and W. Mohammed, positive and significant genotypic correlations in the range were observed between total tuber yield per hectare and marketable tuber yield [11], Similarly Kolech Semagn Asredie, reported the potato genotypes had a wide range of variation in total tuber yield that ranged from 21.48 to 42.68 t ha^{-1} with the mean performance of 31.63 t ha^{-1} [1], while Getie, A *et al*., [12] reported 30.6 to 20.35 total tuber yield. Hence, improvement of total tuber yield in potatoes is possible through the selection of genotypes that perform best than others for those strongly correlated traits. This showed that total tuber yield per hectare is the end product of components of several yield contributing characters. Days to maturity and days to flowering ranged from 114.89 to 104.93 and 65.7 to 59.26 respectively. CIP-392640-524 recorded similar days to emergence, flowering, and maturity with standard check moti while it recorded higher days to maturity than local check. Acording to Adane H *et al.,* [13] and Kolech Semagn Asredie, reports variability for days to flowering and maturity among 12 tested genotypes namely CIP-395169.17 and CIP-396023.109 took long days (73 and 70 days respectively) to attain 50% flowering while other tested potato genotypes took short days (less than 70 days) to attain 50% flowering while Days to maturity was ranged from 117.33 to 139 [1]. The highest means of total tuber yield was recorded from Dinsho (56.27 t/ha^{-1}) followed by Goba (51.77 t/ha) (Table 2). This may be due to the potential of both districts than Sinana for potato production.

Table 1. *Combined Summary of Mean tuber Yield, Other agronomic traits and Disease measured on promising potato genotypes Selected as a candidate for release and checks in regional variety trial across nine environments.*

No	Genotypes	DE	DF	DM	PH	NSH	UTNH	MTY	TTY	UMTY	MTNH	DI
1	CIP 396039-1	18.11	65.7	114.89	54.22	3.81	9.06	23.10	27.4	4.53	11.76	2.67
2	CIP 396029-2	18.33	61.70	107.33	43.15	2.02	10.07	32.31	37.35	5.03	12.12	4.04
3	CIP-395112-1	17.22	64.56	110.44	45.50	2.12	7.13	28.14	30.2	2.07	8.03	4.37
4	CIP-395114.5	16.89	59.26	108.07	56.22	3.15	8.30	38.41	41.01	3.65	12.34	4.33
5	CIP-392640-524	16.89	64.96	113.37	54.79	3.89	5.53	44.96	45.75	1.79	14.69	2.30
6	Moti	18.89	63.26	110.89	46.46	3.08	7.79	37.62	40.51	3.89	6.73	3.59
7	CIP-36240.23	16.59	63.78	112.48	53.96	3.36	7.52	37.69	39.95	3.26	13.29	2.22
8	Local	16.30	62.22	104.93	48.53	4.42	20.49	15.02	25.27	10.24	7.13	4.83
Mean		17.53	63.14	110.3	50.35	3.12	9.48	33.4	35.93	4.3	10.71	
CV		25.00	17.90	15.20	34.10	47.70	19.50	22.60	16.50	19.50	53.00	
LSD		2.38	6.04	9.02	9.07	0.79	2.93	11.63	11.90	1.46	3.09	

Footnote: DE = days of emergence, DF = days to flower, DM = days to Maturity, PH = plant height, NSH = number of stem per hill, UTNHunmarketable tuber number per hill, MTY = marketable tuber yield t/ha, TTY = total tuber yield t/ha, UMTY = unmarketable tuber yield t/ha, MTNH = marketable tuber number per hill, DI = late bligtht.

Table 2. *Means of tuber yield (t/ha^{-1}) of eight potato genotypes across locations and years.*

Genotypes	Sinana			Goba			Disho			Grand
	2017	2018	2019	2017	2018	2019	2017	2018	2019	Means
CIP 396039-1	37.6	35.49	37.5	35.49	35.49	36.07	33.66	36.83	36.07	27.4
CIP 396029-2	51.0	39.06	34.0	39.06	39.06	34.00	35.39	12.28	24.13	37.35
CIP-395112-1	57.5	28.63	45.9	28.63	28.63	28.63	14.03	17.35	16.20	30.2
CIP-395114.5	39.5	43.50	39.5	49.25	43.50	42.25	54.87	49.48	56.87	41.01
CIP-392640-524	46.0	49.70	49.9	51.77	49.70	50.74	36.44	49.74	56.27	45.75
Moti	40.4	40.01	40.4	40.10	40.01	42.01	43.72	44.25	42.43	40.51
CIP-36240.23	24.6	47.97	42.0	36.00	47.97	32.00	38.93	22.57	37.09	39.95
Local	23.9	29.28	15.7	29.28	29.28	29.28	12.27	29.08	12.70	25.27
Mean	42.1	37.37	40.2	38.05	37.37	38.17	1.022	32.17	31.73	
CV	13.1	40.90	20.1	29.70	40.90	26.00	35.00	21.80	25.10	
LSD	16.3	13.73	16.0	21.06	13.73	14.00	20.53	10.21	9.70	

Analysis of variance for AMMI revealed a significant difference at ($p<0.01$) for Genotype, environment and interaction (Table 3) as well as both IPCA [1] and IPCA [2]. The lowest IPCA nearest to zero, the more genotypes were stable over tested environments. Accordingly, (CIP-392640-524) recorded IPCA1 and IPCA2 (0.04 and 0.09) respectively. In other cases, ASV was calculated for rank genotypes in terms of yield stability (Table 4). Accordingly, genotypes (CIP-392640-524) recorded ASV 0.42. The result from IPCA1, IPCA2 and ASV indicated the stability of tested genotypes over the sampled environment (Table 4). The result is inline with Tekalign and Worku A *et al*., [15] who reported Stability in performance of genotypes across locations and seasons using ASV for marketable tuber yield was performed, genotype CIP-395112.36 as stable while Gudenie was as the most unstable variety and from combined over seasons and locations analysis CIP-396004.337 and clone Local variety as stable and unstable clones [14].

Table 3. *Analysis of variance of AMMI for tuber yields of 8 potato genotypes across the environment.*

Source	df	SS	MS	TSS explained in %	F	F_prob
Genotypes	7	5.45	0.49*	17.8		
Environments	2	16.53	3.98*	54.01		
Interactions	14	4.56	0.01*	14.91		
IPCA [1]	14	2.53	0.255**		1.09	0.007
IPCA [2]	12	1.09	0.054**		2.02	0.004
Total	23	30.6				

Footnote:- * significance, **- highly significance

Table 4. *Stability parameter for each Variety.*

Genotype	Means (TTY)	IPCA (1)	IPCA (2)	ASV
CIP 396039-1	27.4	0.09	0.19	0.21
CIP 396029-2	37.35	0.15	0.03	0.18
CIP-395112-1	30.2	0.35	0.16	0.41
CIP-395114.5	41.01	0.37	0.45	0.19
CIP-392640-524	45.75	0.04	0.12	0.42
Moti	37.51	-0.55	0.36	-0.29

Genotype	Means (TTY)	IPCA (1)	IPCA (2)	ASV
CIP-36240.2	39.95	0.32	0.22	0.14
Local	25.27	0.36	0.05	0.31

5. Conclusions and Recommendation

The yield performance of genotypes (CIP-392640-524) across environments and yield advantages over standard checks (Moti) 11.45% with less disease reaction mainly lateblight and stability of the genotypes over environment suggested that the genotypes is promoted to variety verification trial for release as new potato variety for Bale high lands and similar agro-ecologies.

Declerations

Tthe authors do not have confilicts of interest with the publication of the article in Journal of plant science.

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References

[1] Kolech Semagn Asredie, Walter De Jong, Donald Halseth and Steffen Schulz. 2019. Understanding farmer needs and unlocking local genetic resources for potato improvement: a case study in Ethiopia. Afr. J. Food Agric. Nutr. Dev.; 19 (1): 13883-13905 DOI: 10.18697/ajfand.84.BLFB1012.

[2] Yohannes Gelaye, Melkamu Alemayehu and Dereje Ademe 2022. Potato Growth and Quality as Influenced by Inorganic Fertilizer Rates in Northwestern Ethiopia, International Journal of Agronomy, Volume 2022 | Article ID 9476021 | https://doi.org/10.1155/2022/9476021

[3] Abebe 2019, Review of Potato Research and Development in Ethiopia: Achievements and Future Prospects Journal of Biology, Agriculture and Healthcare Vol. 9, No. 19, 2019 https://www.iiste.org/Journals/index.php/JBAH/article/view/49946

[4] Devaux, A., Goffart, J. P., Petsakos, A., Kromann, P., Gatto, M., Okello, J., Suarez, V., & Hareau, G. (2020). Global food security, contribution from sustainable potato agri-food systems. The Potato Crop, 1–35. doi: https://doi.org/10/1007/978-3-030-28683-5_1.

[5] Brasesco, F., Asgedom, D., Casari, G. 2019. Strategic analysis and intervention plan for potatoes and potato products in the Agro-Commodities Procurement Zone of the pilot Integrated Agro-Industrial Park in Central-Eastern Oromia, Ethiopia. Addis Ababa, FAO. 80 pp. Licence: CC BY-NC-SA 3.0 IGO.

[6] Abebe Chindi, Gebremehin Wgiorgis, Egata Shunka, Kasaye Negash, Tesfaye Abebe, Alemu Worku and Fikadu Gebretensay 2021, Evaluation of Advanced Potato (Solanum tuberosum L.) Clones for High Tuber yield and Processing Quality inCentral Highlands of Ethiopia. International journal of Horticulture, Agriculture and Food Science (IJHAF) Vol-5, 2021]. Article DOI: https://dx.doi.org/10.22161/ijhaf.5.3.5.

[7] Addisu F. Yohannes P. and Habtamu Z. 2013. Genetic variability and association between agronomic characters in some potato (Solanum tuberosum L.) genotypes in SNNPRS Ethiopia. Int. Biodiversity Con. 5: pp: 523-28.

[8] Baye, B., Ravishankar, R. and Singh, H. 2005. Variability and association of tuber yield and related traits in potato (Solanum tubersum L.). Ethiopian Agric. Sci. 18: 103-21.

[9] Shamil Alo and Dereje Geremew, Adaptability of Released Potato (Solanum tuberosum L.) Varieties at Masha and Chena, South western Ethiopia, World Journal of Agriculture and Soil Science. DOI: 10.33552/WJASS.2021.06.000646.

[10] Awoke Ali Zeleke, Dasta Tsagaye Galalcha and Demis Limeneh 2021, Performance Evaluation of Potato Genotypes for Tuber Yield at Bekoji, Southeastern Ethiopia. International Journal of Research in Agricultural Sciences Volume 8, Issue 1, ISSN (Online): 2348 – 3997.

[11] Asefa, G. and W. Mohammed. 2016. Correlation coefficients, path analysis and disease reaction between yield and yield components in Potato (Solanum tuberosum L.) genotypes in Bale, South Eastern Ethiopia. Plant Science Today 3 (3): 293-297. http://dx.doi.org/10.14719/pst.2016.3.3.201.

[12] Getie, A. T., Madebo, M. P. and Seid, S. A. (2018). Evaluation of Growth, Yield and Quality of Potato (Solanum tuberosum L.) Varieties at Bule, Southern Ethiopia. African Journal of Plant Science, 12 (11), pp. 277-283.

[13] Adane H, Meuwissen MPM, Agajie T, Lommen WJM, Lansink AO, Admasu T, Struik PC. Analysis of seed potato systems in Ethiopia. Am Potato J. 2010; 87: 537–52.

[14] Tekalign, 2011. Genotype x environmental interaction for tuber yield, dry matter content and specific gravity in elite tetraploid potato (Solanum tuberosum L.) genotypes. East Africa Journal of Sciences.

[15] Worku A, Mulugeta G, Berhun B, Abebe T, Giorgis G, 2018) Performance and Yield Stability Analysis of Potato Genotypes in Ethiopia. Adv Crop Sci Tech 6: 336. doi: 10.4172/2329-8863.1000336.