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Performance Evaluation of Potato Genotypes for Tuber Yield at Bekoji, Southeastern Ethiopia

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Abstract **– Potato (*Solanum tuberosum* L.) is one of the most important food crops worldwide including Ethiopia. The study was conducted at field condition to evaluate the performance of potato genotypes for their tuber yield and yield related traits at Bekoji from 2014 to 2015 under rain growing season in RCBD with three replication. The analysis of variance (ANOVA) revealed that potato genotypes had highly significant (P<0.001) difference for all agronomic traits and; the interaction between genotypes and year was non-significant difference for all traits except days to maturity, total tuber number per hill and total tuber yield t ha^{-1}. Variety Gudanie, CIP-396027.111 and CIP-396009.239 gave higher marketable tuber yield (46.25, 45.69 and 44.12 t ha $^{-1}$ respectively) and total tuber yield (48.55, 47.44 and 46.59 t ha $^{-1}$ respectively) than the other tested genotypes.**

Keywords **– CIP Genotype, Potato Traits, Tuber Variance Yield.**

I. INTRODUCTION

Potato (*Solanum tuberosum L.*) is one of the most important food crops worldwide. It is cultivated under various environmental conditions. It can be found in both temperate and tropical regions from sea level to 4000 m above sea level [1]. The total world potato production in 2017 was 388,191,000 metric tonnes [2]. There has been a dramatic increase in potato production and demand in Africa [2]. Potato is an important food and cash crop in eastern and central Africa, playing a major role in national food security and nutrition, poverty alleviation and income generation, and provides employment in the production, processing and marketing sub-sectors [3]. Potato was introduced to Ethiopia in 1858 by the German botanist Schimper, since then it becomes an important crop in many parts of the country [4]. Now a day Potato is a high potential food security crop in Ethiopia due to its high yield potential, nutritional quality, short growing period and wider adaptability [5].

In Ethiopia, during 2018/19 growing season more than 1.2 million small holders are engaged in potato production. The total area allocated to potato has reached 73,677.64 ha, total production of 1,044,436.359 tons produced [6].The highest production is in the Oromia, Amhara and SNNP region sufficient moisture, favorable day to night temperature regimes, and irrigated production [6]. On the other hand, the productivity of this crop in the country is very low (14.2 t ha^{-1}) as compared to the world's average yield of 20.1 tons ha^{-1} [2] [6]. The low yield is attributed to many factors, such as poor agronomic practices, lack of high-quality and improved planting material, high cost of improved seed tubers, disease and pest problems [7] [8]. Therefore, the objective of this study was to evaluate the performance of potato genotypes for their tuber yield and yield related traits at Bekoji southeastern part of Ethiopia.

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II. MATERIALS AND METHODS

2.1. *Description of the Study Area*

The experiment was conducted at Bekoji, Southeastern Ethiopia during the rain growing season in 2014 and 2015. Bekoji is far away 52 km from Asela town (capital Zone of Arsi) and 227 km from Addis Ababa. The study area was located at latitude 07^0 32' 37'' N and longitude 39^0 15' 21'' E with an altitude of 2780 meter above sea level. The maximum and minimum temperature was 3.8 and 20.4 ^{0}C respectively with annual rain fall 939 mm. The soil type of the area was Clay soil (Nitosols) with P^H of 5.0 [9].

2.2. *Experimental Materials, Design and Procedure*

A total of 12 potato genotypes consisting of 10 advanced genotypes were introduced from International Potato Center (CIP) and two recently nationally released potato varieties as standard checks were used (Table 1). The genotypes arranged in Randomized Complete Block Design with three replications and each gross plot were 3 m x 3 m = 9 m^2 consisting of four rows, which accommodated 10 plants per row and thus 40 plants per plot. The net plot size is 1.5 m x 2.4 m = 3.6 m^2. The spacing between rows and plants were 0.75 m and 0.30 m, respectively. The spacing between plots and adjacent replications were 1 m and 1.5 m, respectively. The two middle rows were used for data collection. The experimental field was cultivated to a depth of 25-30 cm by a tractor and ridges were made manually after leveling. The planting depth was maintained at 10-15 cm [10]. Fertilizer application was made as per the specific recommendation for the location, in which DAP as a source of phosphorus was applied at a rate of 195kg /ha and Urea as a source of nitrogen was applied at rate of 165 kg/ha. DAP was applied once during planting in the rows, while urea was applied in split application half at emergence and half at 50% flowering as a side dress application. All other agronomic practices such as weeding, cultivation and spraying Redomil chemical were kept uniform for all treatments in each plot.

Table 1. List of Studied Potato Genotypes and their Sources.

Potato Genotypes	Sources
CIP-395077.12	CIP
CIP-395037.107	,,
CIP-396009.239	,,
CIP-396027.111	,,
CIP-395169.17	,,
CIP-399071.17	,,
CIP-395109.29	,,
CIP-396023.109	,,
CP-395123.6	,,
CIP-399053.7	,,
Gudenie (CIP-386423.13)	National released variety
Dagim (CIP-396004.337)	National released variety

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2.3. *Data Collection*

Days to 50% flowering: - was recorded as actual number of days taken from emergence to the days at which 50% of the plants in each plot produced flowers.

Days to maturity: - was recorded by counting days from emergence to days on which more than 90% of the plant in each plot get yellow.

Plant height in cm: The height of five plants in each plot was measured in centimeter from the ground surface to the tip of the main stem and averaged to get the mean plant height.

Stem number per plant: was recorded as the average stem count of five hills or plant per plot at 50% flowering. Only stems that were emerged independently above the soil as single stems were considered as main stems.

Total tuber number per hill: - The total number of tubers produced per hill (count) was recorded or it was recorded by the sum of both marketable and unmarketable tubers number per hill.

Average tuber weight (g/tuber):- It was determined by dividing the total fresh tuber weight to the respective total tubers number which was harvested from five plants (hills).

Marketable tuber yield (t/ha):- The total tuber weight which were free from diseases, insect pests, and greater than or equal to 20 g in weight determined from the net plot area and were converted to tons per hectare.

Unmarketable tuber yield (t/ha):- It was determined by weighting tubers that were sorted out as diseased, insect attack and small-sized (< 20 g) from the net plot area and converted to tons per hectare.

Total tuber yield (t/ha): This was determined as the sum of the weights of marketable and unmarketable tubers from the net plot area and converted to tons per hectare.

2.4. *Data Analysis*

The data was subjected to analysis of variance (ANOVA) using GLM model in SAS software version 9.0 statistical packages. LSD was used to compare means at 5% level of significance.

III. Results and Discussion

The analysis of variance (ANOVA) showed that potato genotypes had highly significant ($p<0.001$) difference for all traits and; the interaction between genotypes and year was non-significant difference for all agronomic traits except days to maturity, total tuber number per hill and total tuber yield t ha^{-1}. The presence of significant difference among the genotype for these traits was due to genetic variation (Table 2). Many authors also reported the existence of significant variation among potato genotypes for different traits. Reported that, highly significant difference among potato genotypes with respect to days to flowering, days to maturity, plant height, number of stem per plant, tuber number per plant and tuber yield (Kg) per plant [11]. Similarly, highly significant difference for plant height, average tuber number per plant, average tuber weight (g/tuber) and total tuber yield (t ha^{-1}) reported by [12] [13] [14] [15].

From the total of 12 tested materials two potato 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

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days (less than70 days) to attain 50% flowering. Days to maturity was ranged from 117.33 to 139 with a population mean of 130.83. The variety Gudenie and genotype CIP-399053.7 matured early (117.33 and 118.83 days respectively) while CIP-399071.17 matured lately (139 days) and CIP-395123.6 (137.17 days) than the other tested genotypes (Table3). Evaluated 24 potato genotypes at different location and [13] [14]; reported that significant difference between potato genotypes with respect to days to flowering and to maturity due to genetic variation. Similarly [15] stated that significant variation between potato varieties was observed in terms of 50% flowering (46.4 to 66.3 days) and maturity date (91.63 to 115.65 days). Significance difference between varieties for emergence and flowering date was due to genetic difference [16].

Plant height in cm was ranged from 34.50 cm to 67.78 cm with an over mean of 53.62 cm. The highest plant height was measured from CIP-396009.239 (67.78 cm) followed by CIP-395037.107 (62.67 cm), while the lower plant height was measured from CIP-396023.109 (34.50 cm) followed by CIP-395077.12 (43.61 cm). The highest stem number was recorded by variety Gudanie (5.14) followed by genotype CIP-399053.7 (4.50) and genotype Cip-395123.6 (4.45) while the lower stem number per hill was obtained from genotype CIP-395077.12 and Cip-395169.17 (1.92 and 2.44 respectively). 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 (1.91) (Table 3). Accordingly [13] [14] reported a great variation among potato genotypes with respect to plant height, average stems number per plant. Variety Gudanie, CIP-396027.111 and CIP-396009.239 gave higher marketable tuber yield (46.25, 45.69 and 44.12 t ha $^{-1}$ respectively) and total tuber yield (48.55, 47.44 and 46.59 t ha $^{-1}$ respectively) than the other tested genotypes. The reason higher total tuber yield was due to maximum stem number, tuber number and average tuber weight. Lower marketable and total tuber yield was obtained in genotype CIP- 3955277.12 (4.32 and 5.29 respectively) due to minimum stem and tuber number per hill and average weight of tuber in gram. Maximum average tuber weight in gram was weighted in genotype CIP-395037.107 (141 g/tuber) followed by CIP-396009.239 (114 g/tuber) while the minimum average tuber was measured from genotype CIP-395123.6 (72.63 g/tuber) followed by genotype CIP-399071.17 (73.52 g/tuber) (Table 3). Reported that, the potato genotypes had a wide range of variation for total tuber yield ranged from 0.8 to 46.1 t ha^{-1} with the mean performance of 19.4 t ha^{-1} [13]. Similarly, [14] 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}. Accordingly [15] reported a significant variation was observed between potato varieties for their average tuber weight, total tuber number per hill, marketable, un marketable and total tuber yield in t ha^{-1}.

Table 2. Mean Square for yield and yield components of potato genotypes at Bekoji in 2014 & 2015.

Mean Square									
Traits	**Rep (2)**	**Variety (11)**	**Year (1)**	**Variety X year (11)**	**Error (22)**	**Mean**	**CV**	**R^2**	**LSD**
DDF	14.59	68.87**	29.38ns	37.78ns	19.08	66.30	6.59	0.58	5.08
DM	7.17	288.97**	3.56ns	85.07**	20.78	130.83	3.48	0.81	5.30
PH	266.15	511.51**	207.2ns	49.17ns	62.63	53.62	14.76	0.71	9.20
SN	0.43	5.87**	0.49ns	1.17ns	0.81	3.65	24.62	0.68	1.05
TTN	0.016	5.68**	7.35**	2.57*	0.70	3.28	25.59	0.75	0.97
MTY	111.78	1247.27**	50.52ns	137.43ns	57.35	30.52	24.81	0.85	8.80

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Mean Square									
Traits	**Rep (2)**	**Variety (11)**	**Year (1)**	**Variety X year (11)**	**Error (22)**	**Mean**	**CV**	**R^2**	**LSD**
UMTY	3.24	10.14**	2.93ns	3.73ns	2.14	2.21	66.25	0.62	1.70
TTY	108.44	13.87**	29.09ns	147.77*	68.66	32.73	25.32	0.84	9.63
ATWg	5.62	2521.07**	1098.09ns	50.34ns	249.19	89.89	17.56	0.72	18.35

DF = Degree of freedom, DDF = Days to 50% flowering, DM = Days to maturity, PH = Plant height in cm, SN = Average stem number per hill, TTN = Total tuber number per hill, MTY = Marketable Tuber Yield (t/ha); UMTY = Unmarketable Tuber Yield (t/ha), TTY = Total Tuber Yield (t/ha), ATWg = Average tuber weight in gram, CV = Coefficient of variance, LSD = Least Significant Difference.

Table 3.Combined mean performance of potato genotypes for tuber yield and yield related traits at Bekoji, 2014 & 2015.

Varieties	**DDF**	**DM**	**PH**	**SN**	**TTN**	**MTY**	**UMTY**	**TTY**	**ATWg**
Cip-395077.12	69.33^{a-c}	133.83^{ac}	43.61^{ef}	1.92^{e}	2.17^{fg}	4.32^{d}	0.97^{de}	5.29^{c}	75.17^{de}
Cip-395037.107	64.67^{c-e}	134.83^{ab}	62.67^{ab}	2.72^{c-e}	3.0^{d-f}	29.74^{b}	1.46^{c-d}	31.20^{b}	141.43^{a}
Cip-396009.239	63.83^{de}	128.17^{de}	67.78^{a}	4.33^{a}	3.31^{de}	44.12^{a}	2.46^{b-d}	46.58^{a}	114.35^{b}
Cip-396027.111	62.83^{e}	128.83^{c-e}	57.30^{bc}	4.28^{ab}	4.35^{a-c}	45.69^{a}	1.75^{c-e}	47.44^{a}	99.23^{bc}
Cip-395169.17	73.12^{a}	133.17^{b-d}	50.61^{c-e}	2.44^{de}	2.19^{fg}	10.49^{cd}	0.63^{e}	11.12^{c}	90.77^{c-e}
Cip-399071.17	67.67^{b-e}	139.00^{a}	53.95^{b-d}	3.58^{bc}	3.81^{b-d}	27.59^{b}	1.62^{c-e}	29.21^{b}	73.52^{e}
Cip-395109.29	66.00^{b-e}	135.67^{ab}	47.03^{de}	3.22^{cd}	3.46^{cd}	27.82^{b}	1.56^{c-e}	29.38^{b}	81.65^{c-e}
Cip-396023.109	70.00^{ab}	135.5^{ab}	34.50^{f}	3.00^{cd}	1.91^{g}	13.13^{c}	1.77^{c-e}	14.90^{c}	75.17^{de}
Cip-395123.6	68.50^{a-d}	137.17^{ab}	48.95^{c-e}	4.45^{ab}	4.81^{a}	39.35^{a}	3.62^{b}	42.97^{a}	72.63^{e}
Cip-399053.7	63.33^{e}	118.83^{f}	60.61^{ab}	4.50^{ab}	3.40^{c-e}	38.84^{a}	2.85^{bc}	41.69^{a}	84.71^{e}
Gudene	63.50^{e}	117.33^{f}	60.55^{ab}	5.14^{a}	4.5^{ab}	46.25^{a}	2.30^{b-d}	48.55^{a}	76.08^{de}
Dagim	62.83^{e}	127.67^{e}	55.94^{b-d}	4.28^{ab}	2.44^{e-g}	38.89^{a}	5.43^{a}	44.32^{a}	93.32^{cd}

DF = Degree of freedom, DDF = Days to 50% flowering, DM = Days to maturity, PH = Plant height in cm, SN = Average stem number per hill, TTN = Total tuber number per hill, MTY = Marketable Tuber Yield (t/ha); UMTY = Unmarketable Tuber Yield (t/ha), TTY = Total Tuber Yield (t/ha), ATWg = Average tuber weight in gram, CV = Coefficient of variance, LSD = Least Significant Difference.

IV. Conclusion and Recommendation

From the total of 12 tested potato genotypes and varieties significant difference was observed in the analysis. Thus indicated that genetic variation was presented between potato genotypes. Based on the analysis most of the tested potato genotypes gave more than 40 t/ha tuber yields in the study area. Genotype number CIP-396027.111, CIP-39609.239, CIP-395123.6 and CIP-399053.7 gave comparatively higher tuber yield with the standard check varieties Gudane and Dagim. From thus results it concludes that those potato genotypes were selected for production purpose in the study area.

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