

RESEARCH ARTICLE

Adaptability and Performance Evaluation of Potato (*Solanum Tubersum L*) Varieties under Irrigation in West and Kellem Wollega Zones

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Abstract

The trial was done at Aleku Badesso and Nedjo sites of Haro Sabu Agricultural Research Center (HSARC) during the 2016/2017-2018 minor (belg) planting season using irrigation the objective of identifying the adaptable, high yielding, insect pest and disease tolerant varieties of Potato in mid-altitude Potato producing areas of Western and Kelem Wollega Zones of Oromia Regional State. Seven improved potato varieties introduced from Sinana, Holeta and Kulumsa Agricultural Research Center and one Local Check were evaluated using Randomized Complete Block Design (RCBD) with three replication. Inorganic fertilizer DAP-195 Kg/ha at planting while UREA-165 Kg/ha were applied in split form (50% at planting and the remaining 50% early before planting). Data were collected on seven observed traits and analysis of variance was done accordingly. The mean square indicated significant ($p < 0.01$ or 0.05) varietal differences for all observed traits over year and locations. The highest number of main stem was recorded from variety Belete at Aleku Badesso location in the first year and lowest was from Ararsa variety at Nedjo in the second year. The highest and the lowest number of tuber per was recorded from Belete in the first year and Hunde in the second year respectively. Highest tuber size was recorded from Belete variety and the lowest was from local variety. The highest and the lowest total tuber yield (TYt/ha) was recorded from Belete and Ararsa varieties. The highest and the lowest total tuber yield were recorded from Belete and Ararsa. The highest and the lowest marketable yield was recorded Gudane variety at Nedjo and Ararsa variety at the same site. Except variety Dagim all varieties had no significant difference. This might be due high deterioration of Dagim variety. From the tested potato varieties Belete and Gudane showed better performances on desirable traits such as, number tuber per hill, tuber size, marketable yields and unmarketable yields which determine total tuber yield in t/ha. Therefore, Gudane and Belete were identified and selected as the best for different merits to be demonstrated and popularized in the studied areas.

Keywords: Belete; Gudane; Marketable Yield; Tuber Size

Introduction

Potato (*Solanum tuberosum L.*) is one of the most important food crops in developed as well as developing countries. It is an important crop for smallholders in Kenya, Uganda and Ethiopia, serving as both cash and food security crop. Potato is regarded as high-potential food security crop because of its ability to provide a high yield of high-quality product per unit input with a shorter crop cycle. It is considered to be one of the cheapest sources of energy and the production of protein per unit land and it is the highest among the four major food crops (rice, maize, wheat and potato) [1]. In Ethiopia it is the fastest growing staple food crop and source of cash income for small holder having high potential for food security due to its high yield potential and nutritional quality tuber, short growing period (mostly < 120 days), and wider adaptability [2].

Irish potato is the first root crops produced in Ethiopia next to Taro/Godere and sweet potato that accounts 66,923.33 ha in 2016/17 Meher cropping season (the main cropping season in Ethiopia from April to December). The estimated potato production was 9,214,031.85 quintals with average yield obtained is 137.68 quintals per hectare [3]. The estimated producers of potatoes in both Belg and Meher season were accounted 3,705,879 holders in the country [4]. Potato is produced at minor (belg) season than main season due to its susceptibility to bacterial blight diseases. The production of potato in oau of the main season is dependent of irrigation. According to report 70,131.32 ha and 226,428.84ha were cultivated; and 9,432,334.43 and 26,911,691.98 quintals of potatoes was produce respectively [3,5].

Most highlands with altitudes ranging from 1,500 - 3,000 meters above sea level (m.a.s.l) and annual precipitation of 600 - 1,200 millimeters (mm) are suitable for potato cultivation [6]. In West and Kellem Wollega farmers produced potato under rain fed,

irrigation and residual moisture (bone) to ensure food security and food self-sufficiency and income generation. However, due to lack of potato technology innovation, farmers in these areas still use local potato variety that is susceptible to disease and has low yield potential. Moreover farmers are following poor agronomic and postharvest practices such as unimproved variety, erathing up frequency and storage problem. By recognizing these problems, adaptability and performance evaluation of potato varieties was carried out at Seyo and Nedjo sub-sites with identifying, selecting and recommending adaptable and high yielding potato varieties for Western and Kelem Wollega Zones of Western Oromia.

Materials and Methods

The study was conducted at Aleku Badeso of sayo district in Kellem Wollega and Nedjo district of Western Wollega zones during the belg (minor) season of 2016/17-2017/2018 from December to March. Seven improved potato varieties namely; Dagim, Belete, Gudane, Hunde, Ararsa, Jalane and Gera were introduced from Sinana, Holeta and Kulumsa Agricultural Research Center and one Local Check were evaluated using Randomized Complete Block Design (RCBD) with three replicated blocks with 60 independent plants per each plot. The gross plot size for the experiment was 13.5m² (4.5 m × 3 m) with six rows of plants spaced at 75 cm and 30 cm between rows and plants, respectively, and the net plot size was 3 m × 3 m (9 m²). A space of 1.5 m and 1m between blocks and plots was maintained, respectively. Inorganic fertilizer DAP-195 Kg/ha at planting while UREA-165 Kg/ha were applied in split form (50% at planting and the remaining 50% was applied early before flowering at 45 days after planting. The type irrigation used is furrow irrigation and the experimental area was irrigated with the interval of three days from land preparation till plant maturity.

Results and Discussions

Analysis of Variance

Data collected for days to 90% maturity, number of main stem, number of tuber per hill, tuber size in centimeter, total tuber yield in tone per hectare, weight of marketable yield, and weight of marketable yield observed traits were organized and analyzed using Gen Stat computer software procedure [7]. Fisher's Protected Least significant difference (LSD) test was used to compare treatment mean differences at the probability level of 0.05. Analysis of variance revealed the main effect of variety, location and year had highly significant ($p < 0.01$) effect on days to maturity and the main effect of variety had significant ($p < 0.05$) effect on total tuber yield (t/ha) and weight of marketable and unmarketable yield. Likewise the interaction effect variety and location revealed significantly different ($p < 0.05$) on insect pest resistance, number of main stem, number of tuber per hill and weight of marketable yield. On the other all the interactions were only revealed significant effect ($p < 0.05$) number of main stems (Table 1).

Source of Variation	DF	Mean squares						
		DM	NMS	NTPH	TS(cm)	TYQha ⁻¹	WMY(Kg)	WUMYKgpp
Replication	2	20.57	5.48	9.56	42.69	16501	0.5422	0.051
Variety	7	95.14**	3.39	60.914**	72.08*	25764*	5.0399**	0.119
Location	1	137.76**	0.27	14.714	4.78	71049*	1.4166	0.018
Year	1	1464.84**	96.25**	206.85**	1141.84**	1547	0.4323	0.05
Variety*Location	7	1.784	6.48*	17.098*	29.39	12582	1.895*	0.0366
Variety*Year	7	68.82**	5.098*	18.923*	56.21	5923	1.0708	0.068*
Location*Year	1	137.76**	34.79**	119.44**	30.28	390	7.4195*	0.201*
Variety*Location *Year	7	1.784	6.514*	9.448	18.52	11473	0.889	0.0362
Error	62	3.637	2.023	7.756	26.77	7206	0.7648	0.039

Where DF = Degree freedom of error; DM = Days to 90% maturity; DR=disease reaction; NMS = Number of main stem; NTPH = Number of tuber per hill; TS= tuber size in centimeter; TYtha⁻¹ =total tuber yield in tone per hectare; WMY=weight of marketable yield; WUMYH= Weight of marketable yield; *and ** represent significant and highly significant effect respectively

Table 1: Analysis of Variance (ANOVA) for Performance evaluation of potato varieties

Growth parameters of potato

The interaction effect variety and year revealed highly significant effect ($p < 0.01$) on days to maturity, where Belete variety was earlier than others in the first year and late matured in the second year (Table 2). This might be due the varietal effect and environmental conditions such as light and soils which influence crop maturity [8].

Variety	Year	
	1	2
Dagim	103.3g	110.3a
Belete	97.7h	109.8ab
Hunde	104.3fg	109.2abc
Gudane	107.7bcde	108.2abcd

Variety	Year	
	1	2
Jalane	93.7j	107.7bcde
Gera	95.3ij	107cde
Local	97hi	106.3def
Ararsa	102.7g	105.7ef
LSD(0.05)	2.201	
CV (%)	1.8	

Table 2: The markers for analysis of fragrance in rice

The interaction effect of variety, location and year showed significant different ($p < 0.05$) on number of main stem per plant (Table 3). The highest number of main stem was recorded from variety Belete at Aleku Badeso location in the first year and lowest was from Ararsa variety at Nedjo in the second year. The differences might be due varietal effect and plant canopy which determine main stem to different locations [9].

Variety	Location	Year	
		1	2
Belete	Aleku Badeso	9.667a	3.583f-m
	Nedjo	5.111c-j	2.861j-m
Ararsa	Aleku Badeso	3.222h-m	3.417g-m
	Nedjo	8.222ab	1.417m
Local	Aleku Badeso	5c-j	4.833c-k
	Nedjo	7.111bc	3.917e-l
Jalane	Aleku Badeso	3.889e-l	3.667f-m
	Nedjo	6.778bcd	3.625f-m
Hunde	Aleku Badeso	4e-l	3.083i-m
	Nedjo	6.111b-e	2.528klm
Dagim	Aleku Badeso	5.444c-h	4.583d-l
	Nedjo	5.778c-f	2.5lm
Gudane	Aleku Badeso	5.222c-i	5.667c-g
	Nedjo	5c-ij	2.917i-m
Gera	Aleku Badeso	3.444g-m	4.667d-l
	Nedjo	4.556d-l	3.25h-m
LSD(0.05)	2.3		
CV (%)	31.4		

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV= Coefficient of variation

Table 3: Interaction effect of variety, location and year on number of main stem

Yield Parameters of potato

The interaction effect of variety and location as well as variety and year revealed significant ($p < 0.05$) effect on number of tuber per hill; whereas the interaction effect of location and year showed highly significant ($p < 0.01$). The highest (16.44) and the lowest (6.75) number of tuber per was recorded from Belete in the first year and Hunde varieties in the second year respectively (Table 4). On the other hand the highest and the lowest number of tuber per hill were recorded Gudane (16.1) at Nedjo site and Gera (8.44) varieties at Aeku Badeso site respectively (Table 5). These differences might be due to soil fertility problem since it varies from time to time and number and size of tubers basically depends on varietal character and edaphic factors. Similarly reported that the highest number of tuber per hill was recorded from Gudane variety [10].

Variety	Year	
	1	2
Belete	16.44a	11.62 def
Gudane	15 abc	16.17 ab
Local	15.28 abc	12.23 cdef
Gera	13.22 bcd	10.08 defg
Hunde	13.11 bcd	6.75 h
Jalane	12.56 cde	7.69 gh
Dagim	11.44 def	9.17 fgh
Ararsa	9.89 efgh	9.75 efgh
LSD(0.05)	2.3	
CV(%)	31.4	

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV= Coefficient of variation

Table 4: The interaction effect of variety and year on number of tuber per hill

Variety	Location	
	Aleku Badeso	Nedjo
Gudane	11.97 b	16.1 a
Belete	15.79 a	15.38 a
Jalane	11.86 b	15.65 a
Hunde	11.92 b	11.39 bc
Local	10.01 bc	9.85 bc
Dagim	10.89 bc	9.35 bc
Ararsa	11.18 bc	9.43 bc
Gera	8.44 c	11.19 bc
LSD(0.05)	3.2	
CV(%)	23.4	

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV= Coefficient of variation

Table 5: The interaction effect of variety and location on number of tuber per hill

The main effect of variety and year revealed significant ($p < 0.05$) and highly significant ($p < 0.01$) effect on tuber size (cm) where the highest tuber size (27.95cm) was recorded from Belete variety and the lowest (19.83cm) was from local variety. This might be due varietal character; numbers of tuber per hill and tuber size are mostly influenced by genetic and environmental factors (sunlight).

The main effect of variety and location showed significant ($p < 0.05$) different on total tuber yield t/ha (TYt/ha). The highest and the lowest total tuber yield (TYt/ha) was recorded from Belete (38.59t/ha) and Ararsa (23.16t/ha). On the other hand the highest (35.15t/ha) and the lowest (30.47t/ha) total tuber yield (t/ha) was recorded at Aleku Badeso site and Nedjo sites respectively (Table 7). This might be due to performance adaptability of different varieties of the same crop to different environments. On the other hand Gudane, Gera, Local, Jalane, Hunde and Dagim varieties non-significant from each other. Depending on the number of tuber per hill, tuber size and weight of marketable yields Belete and Gudane varieties are superior to the left varieties (Table 4,5,6 and 8). Singh and Singh (1973) also indicated that yield per unit area is the end product of components of several yield contributing characters which are highly influenced by the environment [11-13].

Variety	Tuber size(cm)
Belete	27.95 a
Dagim	25.64 ab
Gera	24.93 ab
Ararsa	24.71 ab
Hunde	24.21 ab
Jalane	22.52 bc
Gudane	22.35 bc
Local	19.83 c
LSD(0.05)	4.223

Variety	Tuber size(cm)
Year	
1	27.47a
2	20.57b
LSD(0.05)	4.223
CV (%)	21.5

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV= Coefficient of variation

Table 6: Main effect of variety and year on tuber size of potato varieties

Variety	Total tuber yield(t/ha)
Belete	38.59a
Gudane	35.54ab
Gera	34.82ab
Local	34.11ab
Jalane	34.02ab
Hunde	31.18b
Dagim	31.08b
Ararsa	23.16c
LSD(0.05)	64.832
Location	
Aleku Badeso	35.15a
Nedjo	30.47b
LSD(0.05)	32.416
CV (%)	24.2

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV= Coefficient of variation

Table 7: Main effect of variety and year on total tuber yield t/ha (TYt/ha) of potato varieties

Similarly Habtamu, *et al.* reported that Gudane and Belete variants were produced the highest marketable and total average tuber weight which directly determine total tuber yield per hectare [14]. In addition to this Addis Shiferaw, *et al.* reported the highest yield (55.12t/ha) was recorded from Gudanievariety at Bule Hora District of Borena Zone [15]. Similarly, Dembi and Basha reported that Gudanie yielded 26.69t/ha on farm evaluation at Guji highlands of Oromia region [16]. The result of different authors who reported at different locations indicates the yield of different potato varieties affected by environment. The current investigation also agreed with these different scholars findings. The variation in total yield of potato genotypes at different location may be due to a response of the genotypes to growing environmental factors. This suggestion is in agreement with other authors who reported that yield differences among genotypes were attributed both by the inherent yield potential of genotypes and growing environment as well as the interaction of genotype x environment.

Variety	Location	
	Aleku Badeso	Nedjo
Gudane	3.365abc	4.321a
Belete	3.702ab	3.344abc
Dagim	3.2bcd	1.695fg
Hunde	2.914bcde	2.924bcde
Gera	2.652cdef	2.705bcde
Ararsa	2.603cdef	1.394g
Jalane	2.161efg	2.457cdef
Local	2.33defg	2.145efg
LSD(0.05)	1.009	
CV (%)	31.7	

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV= Coefficient of variation

Table 8: Interaction effect of variety and location on weigh of marketable yield

The interaction effect of variety and location as well as the interaction effect of location and year had a significant ($p < 0.05$) effect on weight of marketable yield. The highest (4.32) and the lowest (1.39) marketable yield was recorded Gudane variety at Nedjo and Ararsa variety at the same site (Table 8). The differences among varieties might be due to potential adaptability of varieties to different locations. Likewise Habtamu, *et al.* was reported that Belete variety produced the highest total tuber yield per hectare in the eastern parts of Ethiopia [14]. On the other hand tuber size is among desirable traits (desirable tuber size, color, shapes) which determine market quality and key for variety adoption [17]. Similarly, other researchers also investigated that marketable yield was significantly varied by variety, location and genotypes x environment interaction [18,19].

The interaction effect of variety and year revealed significant ($p < 0.05$) effect on the unmarketable yield. Except variety Dagim all varieties had no significant difference. This might be due high deterioration of Dagim variety. The variation in unmarketable yield of the genotypes may be due to adaptability, crop maturity, and inherent ability of potato genotypes in producing unmarketable tubers per plant. The result was in line with the findings of Habtamu, *et al.* who reported that the interaction effects of growing environment and genotype; significantly influence unmarketable tuber yield [14].

Variety	Year	
	1	2
Dagim	0.37667a	0.07167b
Hunde	0b	0.17833b
Ararsa	0.17638b	0.11833b
Local	0.12962b	0b
Belete	0.10792b	0.075b
Gudane	0.07367b	0.08b
Gera	0.06932b	0.06167b
Jalane	0b	0.05633b
LSD(0.05)	0.19	
CV (%)	31.5	

Means in columns and rows followed by the same letter(s) are not significantly different at 5% level of significance; LSD (0.05) = Least Significant Difference at 5% level; CV= Coefficient of variation

Table 9: Interaction effect of variety and year on unmarketable yield of potato varieties

Conclusion and Recommendation

The experiment was done to identify the performance evaluation potato varieties under irrigation in Kelem and West Wollega zone on Aleku Badeso and Nedjo locations for two consecutive years. Seven improved varieties were evaluated with local variety. The result of the study revealed that Belete and Gudane showed better performances on desirable traits such as number tuber per hill, tuber size, marketable yields and unmarketable yields which determine total tuber yield in t/ha. The highest (38.59 t/ha) and the lowest (35.54t/ha) total tuber yield was recorded from Belete and Gudane varieties. From the tested potato varieties Belete and Gudane showed better performances on desirable traits such as, number tuber per hill, tuber size, marketable yields and unmarketable yields which determine total tuber yield in t/ha. Belete and Gudane were selected for their adaptability and higher tuber yield/ha in the study area. Therefore, Gudane and Belete were identified and selected as the best for different merits to be demonstrated and popularized in the studied areas.

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