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Evaluation of Potato Varieties for Yield and Growth Parameters at Libokemkem and Fogera Districts, Northwest Ethiopia

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Abstract

Limitation of well adapted varieties and unavailability of quality seed are the main constraint of farmer's potato production in Libokemkem and Fogera Districts in Northwest Ethiopia. Consequently, the study was carried out to evaluate the yield and growth performance of six improved potato varieties with a local cultivar as a check on two farmers' fields at Taragedam and Awuramba kebeles from Libokemkem and Fogera districts, respectively. The varieties were planted in randomized complete block design with three replications in rain fed growing season of 2018/19. Data for tuber yield and yield attributing traits like tuber numbers, tuber weight, plant height, stem numbers per hill, days to emergence, days to 50% flowering and days to maturity were recorded. Results of analysis of variance indicated that there were highly significance differences (P <0.01) among varieties for almost all measured traits in the study. The mean yield of tested potato varieties over two locations was 22.2 t ha^{-1}. The varieties Belete and Jalene were found to be the higher tuber yield with mean values of 32.5 and 28.8 t ha^{-1}, respectively. In conclusion, these varieties are safely recommended for potato growers in the study and having similar agro ecology areas in the surrounding. Furthermore, successive quality tuber seed multiplications of these varieties are essential to satisfy farmer's seed demand.

Keywords: Irish potato; Local cultivar selection; Tuber yield; Varieties

Introduction

Potato (Solanum tuberosum L.) is an important tuber crop grown widely in humid tropics and sub-tropical areas of the world [1]. It ranked as the third most important food crop following rice and wheat and it is consumed by over a billion people throughout the world [2,3]. It is regarded as a high-potential food security crop due to its ability to provide high yield and quality product per unit input with a short crop cycle (mostly <120 days) [4]. Potato is one of the crops becoming more and more relevant to address food and nutrition security, and climate change challenges globally [5].

According to FAO (2011), potato is a staple food crop for more than 600 million people who live in Sub-Saharan Africa. Ethiopia is one of the principal potato producing countries in Africa [6]. The total world potato production was 374,777,763.43 tons [7]. In Ethiopia, more than 1.1 million small holder farmers engaged in potato production that are grown primarily for human consumption. The total area allocated for potato was 78,478.72ha, with a total production of 1,309,566.804 tons and its average yield of 16.69 tons. North-Western Ethiopia is a major potato growing areas which accounting about 40% of the potato farmers in the country [8].

Potato produced on a year round basis in Fogera, Dera and Libokemkem districts of South Gondar Zone in North West Ethiopia. The suitability of agro-climatic conditions and availability of cultivated land for both irrigated and rain fed growing conditions in these districts has made a good potential to grow potatoes. In the districts, however, limitation of well adapted and diseases tolerance varieties as well as unavailability of quality seeds are the major potato production constraints. Due to this problems, the potato yield under farmers' conditions ranges between 7 and 8 t.ha^{-1} which is far below the potential yield of improved varieties. So that varietal information is very important to increase potato production in the existing agro-ecology. Therefore, this experiment was designed to test the performance of improved potato varieties for their adaptability and to select superior ones in the study areas.

Materials and Method

Description of the study area

The field experiment was conducted in Libokemekem and Dera districts in rain fed growing seasons. The locations are under humid climatic zone of the country where the weather conditions are suitable for potato productions. The experimental site at Libokemekem is located between 11o58'15"to 12o22'67" N latitude and 37o33'25.4" to 37o58'16.5"E longitude with altitude ranges from 1560 m to 2200 m meter above sea level. It received an average annual rain fall from 900-1200 mm. The average minimum and maximum temperature of Libokemkem are 11.6oc and 29.4oc, respectively. While Fogera district lies between 37°25′45′E - 37°54′10′ E longitude and 11°23′15′ -11°53′30′N latitude. It has altitude ranges of between 1,560 to 2,600m.a.s.l and receives the average rainfall ranging from 1000-1500mm. This area has also the mean minimum and maximum annual temperature of 13 and 30°c, respectively.

Experimental materials and field management

Six improved potato varieties viz. Dagim, Belete, Gudene, Jalenie and Shenkola; and a local check was planted at the recommended rate of 18 t ha^{-1} tuber seeds. The tuber seed was obtained from Adet Agricultural Research Centers, the national potato research-coordinating center.

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The land ploughed and ridged with spacing of 0.75m apart each other. Tuber seeds were sown with a regular spacing of 0.3m apart each. The varieties were arranged in a randomized complete block design with three replications; and spaced between replication was 1m. Each replication was divided into six plots and each of them measured 3m x 3m sides and consisted 40 plants. Recommended potato field management such as two times hoeing and parallel weeding was also done uniformly to establish a well field experiment in each location.

Tuber yield, days to emergence, days to 50% flowering and days to maturity were collected from the middle two rows of twenty plants from each plot. On the other hand, data on tuber numbers, tuber weight, plant height and stem numbers per hill were scored on five plants randomly sampled plants taken from the middle two rows for each plots and averaged values were made.

Results and Discussion

Results of analysis of variances based on the combined means over locations are presented in Table 1. Highly significance differences (P <0.01) among varieties for all measured traits except days to 50% flowering were observed. Regarding to location, highly significant effect were exhibited for marketable tuber number/hill, marketable tuber yield, total tuber yield and plant height. Significant effects of location were also observed for unmarketable tuber number and its weight and maturity date. Nevertheless, insignificant effects of location were observed for traits of a single tuber weight, total marketable tuber number, average stem number per hill, days to 50% emergence and flowering. Interaction effect of varieties by location resulted insignificant influence for all considered traits except total unmarketable tuber numbers and yield which may be due to less influences of environmental effects on growth of these tested potato varieties. Many authors reported that significant variation was occurred between improved potato varieties for tuber yield and related traits [9].

Mean performance of potato varieties for tuber yield

At Taragedam, varieties Belete (35.86 t ha^{-1}) and Jalene (30.89 t ha^{-1}) showed higher total tuber yield, In addition, varieties Belete and Jalene revealed the highest single marketable tuber weight (0.12kg) and marketable tuber numbers per hill (13 tuber numbers/hill), respectively. Meanwhile, variety Dagim gave the lowest yielder among the tested varieties.

The study also indicated that the varieties differed significantly in marketable tuber number per hill and they showed highly significant differences in marketable tuber weight, total marketable tuber number, marketable tuber yield, non-marketable tuber number, total tuber yield, plant height and stem number per hill, days to 50% emergence and maturity at Awuramba.

Likewise, at Awuramba from Fogera district, the highest total tuber yield were produced from varieties Belete (27.5 t ha^{-1}) and Jalene (25.2 t ha^{-1}); whereas, the lowest total tuber yield was from local check (11 t ha^{-1}) variety. Moreover, variety Belete revealed that the highest average marketable tuber weight (0.12kg) and variety Jalene was recorded the highest average values on marketable and non-marketable tuber numbers per hill and total marketable and non-marketable tubers

Table 1: Mean squares from the analyses of variance for seven potato varieties over two locations.

SV	DF	Mean Squares										
		MTN	UMTN	ATW	MTY	UMTY	TTY	PH	SN	DFE	DFF	DM
Loc	1	64.38 **	7.71 *	0.0005	336.6 **	0.02 *	407.4 **	1418.7 **	0.86	12.595	57.18	85714*
				NS					NS	NS	NS	
Rep	4	22.950 *	2.62 NS	0.0006	265.4 **	0.003 NS	198.4 **	32.1 NS	0.761 NS	0.8571	48.29	2.9524
				NS								
Var	6	31.05 **	3.33 *	0.0035 **	375.9 **	0.14 **	360.4 **	619.3 **	2.43 **	21.024*	21.02	90.103**
											NS	
Var*Loc	6	5.050NS	2.10 NS	0.0005	20.3 NS	0.04**	35.1 NS	19NS	0.63	7.484	15.056	1.992NS
				NS					NS	NS		
Residual	24	7.12	1.04	0.0003	22.7	0.003	17.71	25.6	0.32	8.4725	15.824	18.824

Where, **SV:** Source of variation, **Var:** variety, loc- location, Rep-replication, **DF:** degree of freedom,* indicate Significant at 0.05 and ** significant at 0.01 probability levels, **NS** = non- significant at 0.05 and 0.01 probability level, **MTN**= marketable tuber number/plant, **UNMTN**= unmarketable tuber number/plant, **ATW**= marketable tuber weight in kg , **MTY**= marketable tuber yield t ha^{-1}, **TTY**= Total tuber yield t ha^{-1}, **UMTY**= unmarketable tuber yield t ha^{-1}, **PH**= plant height in cm, **SN**= stem number/plant, **DFE**= days to 50% emergence, **DFF**= Days to 50% flowering and **DM**= Days to Maturity

Table 2: Mean values of tuber yield and related traits of seven potato varieties at Taragedam.

Varieties	MTN	UMTN	ATW	MTY	UMTY	TTY	PH	SN	DFE	DFF	DM
Dagim	4.67	2.00	0.05	9.23	1.2	9.93	54.6	3.00	18.33	48.00	83.67
Gudene	9.00	4.33	0.08	17.32	7.4	20.66	67.7	4.33	16.67	49.00	83.00
Belete	9.33	2.33	0.11	35.12	2.4	35.86	71.2	1.67	14.00	50.67	88.00
Zengene	9.00	1.33	0.09	26.30	1.9	26.76	84.9	2.67	14.00	47.00	84.33
Shenkola	9.67	2.33	0.07	24.23	2.4	24.85	69.9	3.67	12.00	48.00	85.67
Jalene	13.33	2.67	0.07	30.39	2.2	30.89	64.8	3.00	11.66	48.67	84.67
Local check	11.33	3.67	0.04	15.00	2.0	15.43	54.3	3.33	12.66	46.00	75.33
mean	9.47	2.66	0.07	22.50	2.8	23.48	66.7	3.10	14.19	48.19	83.5
CV	32.7	32.04	29.8	26.9	34.7	23.7	7.3	20.2	22.83	5.45	5.55
$LSD_{0.05}$	7.74NS	2.13*	0.05*	10.78**	2.4**	9.92**	12**	1.6**	5.76NS	4.66NS	8.24NS

Where,* indicate Significant at 0.05 and ** significant at 0.01 probability levels, **NS** = non- significant at 0.05 and 0.01 probability level, **MTN**= marketable tuber number/plant, **UNMTN**= unmarketable tuber number/plant, **ATW**= marketable tuber weight in kg , **MTY**= marketable tuber yield t ha^{-1}, **TTY**= Total tuber yield t ha^{-1}, **UMTY**= unmarketable tuber yield t ha^{-1}, **PH**= plant height in cm, **SN**= stem number/plant, **DFE**= days to 50% emergence, **DFF**= Days to 50% flowering and **DM**= Days to Maturity

Table 3: Mean values of tuber yield and related traits of seven potato varieties at Awuramba.

Varieties	MTN	UMTN	ATW	MTY	UMTY	TTY	PH	SN	DFE	DFF	DM
Dagim	5	3	0.08	10.7	0.8	12.8	46.3	3	16	47	78
Gudene	4	3	0.05	8.7	1	11.8	52.3	4.33	13	52	81
Belete	5	2	0.12	25.1	0.5	27.5	53.7	1.67	15	50	85
Zengene	8	3	0.06	19.8	1	22.5	75.7	2.67	11	53	82
Shenkola	7	3	0.06	19.9	0.8	22.7	58.3	3.67	13	55	83
Jalene	10	4	0.06	24.1	1	25.2	54	3	12	51	82
Local check	9	5	0.04	9.6	0.5	11	45.7	3.33	12	46	73
mean	7	4	0.07	16.8	0.8	19	55.1	3.1	13.14	50.57	80.57
CV	30.7	32.8	20.5	17.5	46.9	15.7	9.5	20.2	19.76	4.13	3.86
LSD $_{0.05}$	3.2*	3.2NS	0.0001NS	5.2**	0.7NS	5.3**	9.3**	1.60**	4.6NS	3.71**	5.54*

Where,* indicate Significant at 0.05 and ** significant at 0.01 probability levels, **NS** = non- significant at 0.05 and 0.01 probability level, **MTN**= marketable tuber number/ plant, **UNMTN**= unmarketable tuber number/plant, **ATW**= marketable tuber weight in kg , **MTY**= marketable tuber yield t ha^{-1}, **TTY**= Total tuber yield t ha^{-1}, **UMTY**= unmarketable tuber yield t ha^{-1}, **PH**= plant height in cm**, SN**= stem number/plant, **DFE**= days to 50% emergence, **DFF**= Days to 50% flowering and **DM**= Days to Maturity

Table 4: Combined mean values of tuber yield and related traits of seven potato varieties over two locations.

Varieties	MTN	UMTN	MTW	MTY	UMTY	TTY	PH	SN	DFE	DFF	DM
Dagim	5	2.5	0.06	10	0.21	11.6	50.5	2.5	18.33	48	83.67
Gudene	6.5	3.67	0.06	13	0.61	18.2	60	3.83	16.67	49	83
Belete	7.33	2.33	0.12	30.1	0.24	32.5	62.4	1.83	14	50.67	88
Zengene	8.33	2.33	0.08	23.1	0.22	25.4	80.3	3	14	47	84.33
Shenkola	8.5	3	0.07	22.1	0.22	24.7	64.1	3.33	12	48	85.67
Jalene	11.83	3.67	0.06	27.3	0.23	28.8	59.4	3	11.66	48.67	84.67
Local check	10.17	4.17	0.04	12.3	0.16	14	50	3.17	12.66	46	75.33
mean	8.24	3.1	0.07	19.7	0.27	22.2	61	2.95	14.19	48.19	83.5
CV	32.4	32.9	25.9	24.2	22.5	19	8.3	19.1	22.83	5.45	5.55
LSD $_{0.05}$	4.49*	1.72*	0.03**	8.0**	0.102**	7.1*	8.5NS	0.95NS	7.74NS	2.13*	0.05*

Where,* indicate Significant at 0.05 and ** significant at 0.01 probability levels, **NS** = non- significant at 0.05 and 0.01 probability level, **MTN**= marketable tuber number/ plant, **UNMTN**= unmarketable tuber number/plant, **ATW**= marketable tuber weight in kg , **MTY**= marketable tuber yield t ha^{-1}, **TTY**= Total tuber yield t ha^{-1}, **UMTY**= unmarketable tuber yield t ha^{-1}, **PH**= plant height in cm, **SN**= stem number/plant, **DFE**= days to 50% emergence, **DFF**= Days to 50% flowering and **DM**= Days to Maturity

number. Variety Zengene (75.7cm) was the tallest variety followed by Shenkola (58.3cm) and Jalene (54.0cm) varieties at Awuramba.

Based on the combined mean yield data, Belete (30.1 t ha^{-1}) was recorded the highest total marketable tuber yield followed by Jalene (27.3 t ha^{-1}) and Zenegene (23.1 t ha^{-1}). The significance difference between varieties in terms of tuber yield may be due to genetic variation. This result is in line with Arega et al. (2021) and Alemayehu et al. (2018) who found that maximum total and marketable tuber yield was recorded from variety

Belete. Similarly, Lemma Tessema et al. (2019) have reported the marketable tuber yield ranging from 29.1 t ha^{-1} (recorded from variety Belete) to 12.4 t ha^{-1} (obtained from variety Zengena) while studied the performances of 21 potato varieties at Central Highlands of Ethiopia. The mean performance of Belete, Jalene and Zenegene over two locations indicated that it gave 39.8%, 34.8% and 24.5% more tuber yield than the local check, respectively. This investigation indicated the overall performances of tested varieties at Taragedam kebele in Libokemkem district was better than at Awuramba kebele in Fogera district. In general, Belete, Zengene, Jalene and shenkola varieties yielded the above grand mean while Dagim and Gudene varieties were poor performed in this experiment relatively.

Regards to number and size of tubers, Belete and Jalene varieties produced larger average weight of a tuber (0.12kg) and higher number of marketable tubers per hill (11.8), respectively. Similarly Alemayehu et al (2018) reported that larger tuber size was obtatined from variety Belete (63.38g). Variety Zengene was the tallest (80.3cm) variety with relatively less average number of unmarketable tubers per hill (2.33). High stem numbers per hill (4) with large amount of unmarketable tuber yield (0.61 t ha^{-1}) were recorded by Gudene variety. Jalene variety was required shortest days to attained 50% emergence (11.66 days). The minimum days to attained 50% flowering and maturity was observed by local variety. On the other hand, Belete variety was found late matured with the mean value of 88 days and the difference from a local check variety was almost two weeks (75 days). In general, most of the tested varieties were late maturing as compared to a local check variety. The difference between varieties for yield and related traits may be due to the genetic variation and environmental effects.

Conclusions and Recommendation

It was interesting to note that varieties Belete and Jalene produced the higher total tuber yield in both tested locations, Taragedam from Libokemkem district and Awuramba from Fogera district. The varieties Belete and Jalene have made yield advantages of 39.8% and 34.8% over the local cultivated cultivar, respectively. Furthermore, variety Belete exhibited the highest single tuber weight and variety Jalene was produced highest number of tubers per plant in both locations. The present study suggest that Belete and Jalene were the most important potato varieties which showed best performed on total tuber yield and other related traits among the tested varieties in the rainy season of Libokemkem and Fogera districts. It is therefore, the two varieties revealed greater potential for tuber yield and related traits in the target areas and it needs seed multiplication and successive demonstration for potato growers in Libokemkem and Fogera districts as well as have alike agro-ecological areas.

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Conflict of Interest

The Authors declared that they have no conflict of interest

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