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## Research Article

# Evaluation of Released and Local Potato (*Solanum tuberosum* L.) Varieties for Growth Performance

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### Abstract

**Objectives:** Five potato varieties during the autumn and seven potato varieties during the winter season were evaluated for their vegetative growth performance under rain fed condition of the 2015/16 crop calendar with the objective of evaluating the performance and adaptability of improved and local varieties of Irish potato in Chencha district Gamo-Gofa zone Ethiopia. **Methodology:** The experimental field was laid out in Randomized Complete Block Design (RCBD) with four blocks and three replications. Treatments include five improved and two local varieties (Jalene, Gudenie, Belete, Degemegn, Tolcha, Father and Susallu). **Results:** The statistical findings demonstrated that plant height and number of shoots were significantly influenced during autumn season of growth while during the winter cropping season, plant height and number of leaves per plant was significantly influenced by cultivars. Belete variety had the highest plant height and shoot numbers whereas; Local variety-1 (Father) had the lowest plant height and shoot number among the other varieties. Statistically significant differences were recorded among the varieties in leaf number during the winter season. The maximum number of leaves was recorded in Degemegn variety followed by Belete variety whereas; the least number of leaves was recorded in Gudene in the winter season. Tolcha variety had the least number of leaves per plant in the autumn cropping season. **Conclusion:** Finally, it is conclude that the study evidently demonstrated the effect of varietal difference on the growth potential of potato varieties. The growth performance of the Irish potato varieties brought from Holeta Research Center was promising.

**Key words:** Irish potato varieties, growth performance, Chencha, Gamo Gofa, Jalenie, Gudenie, Susallu, Degemegn

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**Competing Interest:** The authors have declared that no competing interest exists.

**Data Availability:** All relevant data are within the paper and its supporting information files.

## INTRODUCTION

The cultivated potato (*Solanum tuberosum* L.) originated in the highlands of the Andes in South America. The potato had been cultivated by the Incas for over 2000 years probably consisting of a mixture of varieties<sup>1</sup>. Potatoes are a source of both food and cash income in the densely populated highlands of Sub-Saharan Africa. Through this double purpose, the potato crop plays an important role in the rural livelihood system. Because of high prospects for growth of the market for fresh potatoes<sup>2</sup>, the commodity could be a good starting point for rural development in Sub-Saharan Africa, particularly under current conditions of increased cereal prices in the international markets. Like many other countries in the world, potato is a very important food and cash crop especially on the highland and mid altitude areas of Ethiopia<sup>3</sup>. Potato provides food and income as a cash crop for over 2.3 million households in different part of Ethiopia.

Potato is among the major tuber crops that are being produced in Ethiopia. According to CSA<sup>4</sup>, more than 1 million farmers are involved in the production of potato in the country. Potato is regarded as a high-potential food crop. Today potato is regarded as the major food security crop in the world because of its potential to provide a high yield and highly nutritious product per unit input with a shorter crop cycle (mostly within less than 120 days). Since the last two decades, the price of cereals, pulses and oil crops have strongly increased worldwide whereas; the price of roots and tubers such as potato remained relatively low during the entire food crisis in Ethiopia. The Ethiopian population has been growing very fast in the last 3 decades reaching more than 92.7 million today which makes it the second largest in Africa next to Nigeria. Despite the country is the center of origin for a pronounced number of food crops, less has been attempted to breed these indigenous crops for high yield and nutrition per unit of land.

Potato is a food security crop as it has high yield potential, a staple food, a major source of household income in Gamo Gofa Zone). There is huge market demand for potato and it is known for its high nutritional value. Despite its importance, farm yields are frequently below 10 t ha<sup>-1</sup> in comparison to 30-50 t ha<sup>-1</sup> achievable in good growth conditions. Several constraints like traditional potato production practices and approaches; high incidence of disease and pest; lack of knowledge and skills on the implication of the growth parameters on the yield attributes, limited knowledge on the ontogeny of the crop are among the few factors that contributed to the less production and productivity potential of potato in the area. Specific objectives of this study are:

- To identify the superior potato variety for morphological adaptability
- To evaluate the growth performance and morphological adaptability of improved and local varieties of Irish potato

## MATERIALS AND METHODS

**Study site description:** The project was established at Chencha Woreda; AMU-Gircha research Center which is located approximately 6 km Northwest of Chencha Woreda. Chencha is located in the Gamo Gofa administrative zone of the SNNPR. The woreda encompasses 50 administrative 'Kebeles' and with an altitude ranging between 1600-3200 m a.s.l. It has two agro-ecological zones: 'Dega' (2300-3200 m a.s.l., 82%) and 'Woinadega' (1500-2300 m a.s.l., 18%); with total area coverage of 37,650 ha. The mean annual temperature and rainfall of the study areas are 22.5°C and 1400 mm respectively. The altitude of Gircha is 3007 m a.s.l. The soil textural class is clay loam<sup>5</sup>.

**Experimental materials and designs:** Five improved varieties of potato cultivars (Gudenie, Degemegn, Belete, Jalene, Tolcha) were collected from Holeta Agricultural Research Center and two local varieties (Qay Dinich/Father (Local-1 in our research work) and Susalluh (Local-2 in this study) that are indigenous to the area were established and evaluated at Gircha Highland Fruits and Vegetables Research Center agro-ecological condition during the 2015-16 autumn 'Meher' and winter 'Belg' cropping calendar. The field was laid out in a randomized complete block design (RCBD) with four blocks and three biological repeats. The unit plot size was 3.0×1.8 m that is 36 plants per plot and 5 rows per plot. Tubers were planted with a spacing of 60×25 cm.

Fertilization, weeding, irrigation, earthing up and disease and insect pest scouting were committed following the conventional recommendations.

**Data collection and analysis:** All data on growth attributes were recorded. Data on growth performance comprised of number of leaves, plant height (cm), number of stem per hill. The raw data was subjected to ANOVA and analyzed statistically by using SAS statistical software (SAS, 2002/3) version 9.1. Means were separated by least significant difference test at 0.05 probability level.

## RESULTS AND DISCUSSION

Potato cultivation in Ethiopia would need intensification of the improved variety and year round supply of good quality

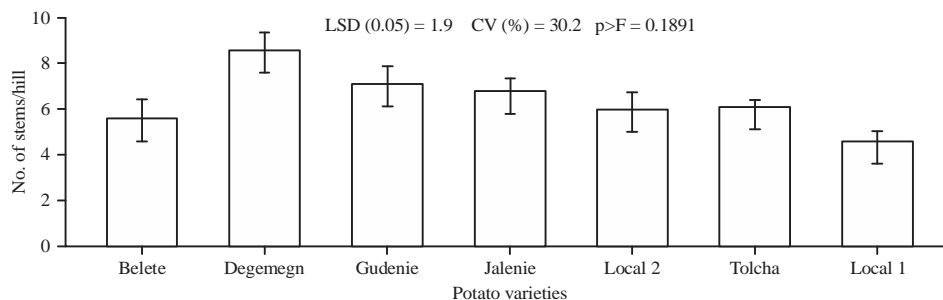


Fig. 1: Differences in stem numbers per hill among Irish potato varieties at Chencha-Gircha Highland Fruits and Vegetables Research Center during the winter season (February-June, 2016)

Table 1: Mean plant height, leaf No. and stem No. of potato cultivars at Chencha district (AMU-Gircha Research Center) during autumn season (August-December, 2015)

Varieties	Autumn cropping season		
	SN plant <sup>-1</sup>	PH (cm)	LN plant <sup>-1</sup>
Belete	10.25 <sup>a</sup>	46.18 <sup>a</sup>	180.0
Degemegn	9.25 <sup>a</sup>	42.65 <sup>ab</sup>	146.8
Local 2/Susaloh	3.45 <sup>b</sup>	41.90 <sup>ab</sup>	124.7
Local 1/Red potato/Father	2.70 <sup>b</sup>	41.44 <sup>ab</sup>	119.6
Gudenie	4.05 <sup>b</sup>	37.52 <sup>b</sup>	100.8
LSD (0.05)	2.7	5.7	NS
CV (%)	29.5	17	30

\*SN: Stem No. plant<sup>-1</sup>, \*PH: Plant height (cm) and \*LN: Leaf No. plant<sup>-1</sup>, NS: Non-significant

produce. Adaptation trial to specific agro-ecology has been a key strategy for improving potato productivity. With this view point, this study was conducted to screen the superior potato variety in terms of morphological adaptability under Chencha condition. Based on supervision made after planting, seed tubers planted in the autumn season sprouted variably in which variety Gudenie and the two local varieties sprouted completely within fifteen days from sowing while the other varieties sprouted after 25 days. Tolcha variety did not sprout totally and this could be attributed to the fact that either the seed was not stored in an appropriate diffused light condition or the particular soil temperature condition or moisture content might not allow the tubers of this variety to sprout potentially during the autumn season. During the winter cropping season, seed tubers of all the potato varieties sprouted completely within 15 days of sowing. According to Struik and Wiersema<sup>6</sup>, the length of time from planting to sprouting in potato depends on storage age of seed tubers.

Stem number and plant height are desirable characteristics which contribute much in plant canopy and biomass. More biomass has the capacity for higher photosynthetic rates and their translocation to sink (tuber) resulting in to larger tuber size and hence higher yield. In the autumn cropping season, Irish potato varieties showed highly

significant difference ( $p < 0.01$ ) in stem number per plant and significant difference ( $p < 0.05$ ) in plant height. However, the effect of varieties showed no significant difference in number of leaf per plant (Table 1). During the winter season the varieties showed highly significant difference ( $p < 0.01$ ) in plant height and significant difference ( $p < 0.05$ ) in number of leaves per plant. Varieties did not show statistically significant difference in number of stems per plant (Fig. 1).

The statistically significant differences among the varieties entail variability in genetic variability which is accounted to the variations in ecological adaptation and evolutionary niche of the varieties.

The result revealed that the highest stem number per plant (10.25) was recorded in Belete variety. Nonetheless, the mean for stem number per plant in Belete variety was not significantly different from Degemegn variety. The least mean value (2.70) for stem number per plant was recorded in Local-1 variety, which is not significantly different from the other two varieties Gudenie and Susallu respectively. The difference in stem number among the varieties could also be explained by the genetic variability and adaptation history of the varieties. Our finding is in agreement with the finding of De la Morena *et al.*<sup>7</sup> where they found that number of stems per plant is influenced by variety.

The plant height ranged from 46.18-37.52 cm and 76.4-51.2 cm in the autumn and winter season respectively. Belete variety was found to be the tallest in both cropping seasons whereas; Gudenie variety is found to be the shortest variety in the autumn cropping season and Local-1 variety demonstrated the shortest height in the winter cropping season (Fig. 2). The rest varieties (Degemegn, Local-2 and Local-1) demonstrated similar mean plant height; 42.65, 41.90 and 41.44 cm respectively in the autumn season. Degemegn and Gudenie have attained significantly high mean plant height succeeding Belete variety in the winter season. This result is in agreement with that of Elfinesh<sup>8</sup> finding, where they reported varietal difference attributing to plant height

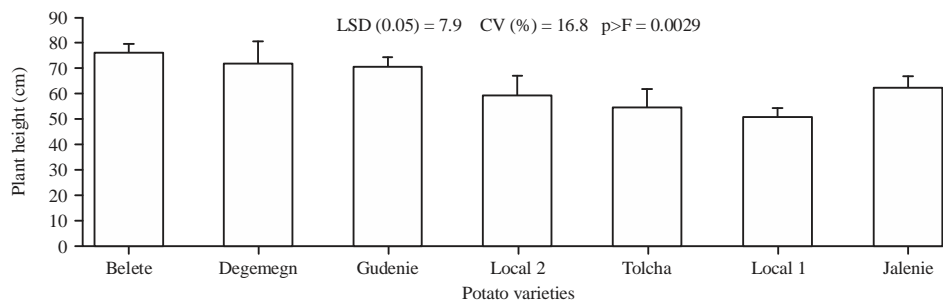


Fig. 2: Differences in plant height among Irish potato varieties at Gircha Highland Fruits and Vegetables Research Center during the winter cropping season (February-June, 2016)

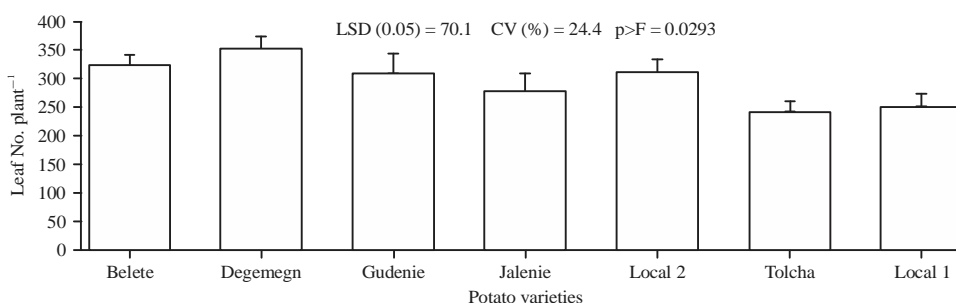


Fig. 3: Differences in leaf number among Irish potato varieties at Gircha Highland Fruits and Vegetables Research Center during the winter cropping season (February-June, 2016)

across locations and seasons. These current finding is also in line with the findings by Ranjbar and Mirzakan<sup>9</sup> on plant height and number of stems and Belhaji *et al.*<sup>10</sup> on average number of main stems of different potato cultivars.

The statistics demonstrated that difference in number of leaves per plant was non-significant among the varieties in the autumn season whereas; the varieties showed statistically significant difference ( $p < 0.05$ ) in number of leaves per plant in the winter season (Fig. 3). The maximum number of leaves per plant was recorded in Belete variety (180) followed by Degemegn (146) in the autumn season and in variety Degemegn (353) followed by Belete variety (324) in the winter season while the lowest number of leaves were recorded in Gudene (100) and Tolcha (242) variety in the autumn and winter seasons respectively. All other varieties were at par with each other and significantly higher than Local-1 variety during the winter season. This difference in the number of leaves per plant among the cultivars could be accounted to the genotypic variation associated to leaf morphology. This result agrees with the findings of Fleisher *et al.*<sup>11</sup>, where they reported that leaf number in potato is influenced by temperature, when the temperature is higher than the optimal level, leaf number will be smaller with decreased leaf area.

## CONCLUSION AND RECOMMENDATIONS

Seven potato varieties during the winter season and five potato varieties during the autumn cropping season were evaluated for their growth potential and yield attributes at Chencha agro-ecology condition during the 2015/2016 crop calendar. The vegetative growth was higher during winter/‘Belg’ season as compared to autumn/‘Meher’ season. The winter season of production was found to be more suitable for potato production in Chencha-Gircha condition.

This result further revealed the existence of variations among nationally released potato varieties in growth potential in both season of production in Chencha-Gircha condition.

Finally, we conclude that the study evidently demonstrated the effect of varietal difference on the growth performance of potato varieties at Chencha-Gircha condition. The growth performance of the entire Irish potato varieties brought from Holeta Research Center was promising. Moreover, all varieties performed much better in the winter cropping season compared to the autumn cropping season. Gudenie during autumn and more importantly Degemegn followed by all other improved varieties except Tolcha performed better during the winter cropping season. Local-1 variety is not suitable to be cultivated in the study area

during both of the seasons. Apparently, we recommend the farmers in the study area to avoid use of this variety for production but, it can be used for further breeding works in research center.

Annex 1: Anova results for autumn 'Meher' season growth and yield data

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Mean Plant Height					
Source	DF	Type III SS	Mean Square	F Value	Pr>F
Variety	4	153.0661200	38.2665300	2.77	0.0444
Block	3	41.5954200	13.8651400	1.00	0.4245
Error	15	207.28	13.82		
Mean Stem Number per plant					
Source	DF	Type III SS	Mean Square	F Value	Pr>F
Variety	4	199.2080000	49.8020000	16.21	<.0001
Block	3	16.3280000	5.4426667	1.77	0.2061
Error	15	53.2	3.55		
Mean Leaf Number per plant					
Source	DF	Type III SS	Mean Square	F Value	Pr>F
Variety	4	3675.2080000	918.8020000	2.23	0.1273
Block	3	1312.7740000	437.5913333	1.06	0.4023
Error	15	6267.5	417.8		

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Annex 2: Anova results for winter 'Belg' growing season growth and yield data

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Mean Plant Height					
Source	DF	Type III SS	Mean Square	F Value	Pr>F
Variety	6	537.3250500	89.5541750	5.20	0.0029
Block	3	295.8758107	98.6252702	5.73	0.0062
Error	18	605.75	28.85		
Mean Leaf Number per Plant					
Source	DF	Type III SS	Mean Square	F Value	Pr>F
Variety	6	38408.03714	6401.33952	3.09	0.0293
Block	3	10505.60429	3501.86810	1.69	0.2046
Error	18	47781	2275		
Mean Number of Stem per hill					
Source	DF	Type III SS	Mean Square	F Value	Pr>F
Variety	6	15.31428571	2.55238095	1.66	0.1891
Block	3	7.55428571	2.51809524	1.63	0.2166
Error	18	35.28	1.68		

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