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# Adaptability study of improved Potato (*Solanum tuberosum* L.) varieties in highlands of Guji zone, Southern Oromia

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**The experiment was conducted in Guji zone at Bore Agricultural Research Center Bore on-station, Raya and Yirba Buliyo during 2014/15 Gena cropping season with the objective of to select adaptable, high yielder, late blight resistant of potato varieties with good agronomic traits in Highlands of Guji zone. The experiment was arranged in RCBD with three replications. The Phenological, yield and yield components data were collected and analyzed by using Gen stat 15th edition software computer. As the overall results of varieties over location analyzed data revealed that between varieties over location significantly different at ($p \leq 0.05$) among Days to 50% emergence, flowering and maturity, marketable yield except average tuber weight, main stem, plant height, unmarketable yield and total yield(Table 3 & 7 ). As combined analysis of varieties over locations means revealed that the highest total yield obtained from Belete 66.88t/ha and followed Gudanie 51.28 t/ha (Table 6). However, the lowest total yield obtained from Bule 31.48t/ha (Table 6). In this study, Variety Belete showed highest mean yield performance (66.88t/ha) over the standard check Gudanie (table 6).It is also, showed maximum yield advantage (23.3%) than standard check thus, Belete can be substitute and recommended in Guji highland areas next to Gudanie and Jalane of potato varieties that were under production of the area. The variety highest yielder, wider adaptable and late blight resistance Belete that having highest production were selected and recommend in highlands of Guji zone and similar agro-ecologies.**

**Key Words** Adaptable, Improved Varieties. Irish Potato and Yield advantage

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## INTRODUCTION

Potato (*Solanum tuberosum* L.*)* is the fourth most important food crop in the world after rice, maize and wheat in terms of human consumption (Kandil *et al*., 2011) and in the world's third most important food crop in overall production after rice and wheat and is a food security crop (Devaux *et al*., 2014) in some countries, including Ethiopia and first cultivated 6000 years ago by Incas in Peru (Quinn, 2011). It is belongs to the family solanaceae and genus Solanum (Thompson and Kell,1972). Potato is one of the widely grown root and tuber crops of the world being a rich source of nutrients for human nutrition. It contains about 79% water,18% starch as a good source of energy, 2% protein and 1% vitamins including vitamin C, minerals including calcium and magnesium and many trace elements (Ahmad *et al*., 2011).

Potato is grown for food and feed industry and seed tuber production. The past few decades have seen a

dramatic increase in potato production and demand in many developing countries (FAO,2014). It gives an exceptionally high yield per acre and are used in a wide variety of table, processed, livestock feed, and industrial uses (Feustel, 1987).

Introduced to Ethiopia in 1859 by a German Botanist called Schimper (Berga *et al.,* 1994b). Potato production area has increased more than fivefold from 30,000ha during the 1970s (Kidane Mariam, 1979) to more than 169,000ha today (CSA, 2014). In Ethiopia total production from potato was 943,233 tons with an average productivity of 13.5 t/ha. The area under potato was 70,132 ha cultivated by 1.4 million households in the main cropping season of 2015/16. During the same period, it ranks first in area coverage and third in both total production and productivity among the root crops grown in Ethiopia (CSA, 2016).

In Ethiopia, among root and tuber crops potato ranks first in volume produced and consumed followed by Cassava, Sweet potato and Yam (CSA, 2015). The food potential of horticultural crops, particularly that of root and tuber crops, has not yet been fully exploited and utilized despite their significant contributions towards food security, income generation, provision of food energy and resource base conservation (Gebremedhin *et al*., 2008). About 70% of the available agricultural lands is located at an altitude of 1800-2500masl and receives an annual rainfall of more than 600mm, which is suitable for potato production (Ermias *et al*., 2007 and Solomon Yilma, 1987). An altitude of 1500-3000 m.a.s.l. and receives an annual rainfall between 600-1200mm, which is suitable for potato production (Gebremedhin *et al*., 2008).

The Productivity of Potato is constrained by multidimensional factors such as lack of disease resistant and high yielding varieties with desirable market qualities, limited knowledge of agronomic and crop protection management technologies, and poor post-harvest handling (Nigussie *et al*., 2012). Many diverse and complex biotic, abiotic and human factors have contributed to existing low productivity of potato. Some of the production constraints which have contributed to the limited production of potato in Ethiopia include shortage of good quality seed tubers of improved cultivars ,disease and pests, and lack of appropriate agronomic practices including optimum plant density ,planting date, soil moisture ,row planting depth of planting ,ridging and soil fertility status (Berga *et al*.,1994).

However, in Guji zone especially at areas found at distant due to many production constraints like their in accessibility, shortage of improved technologies, lack of improved genotypes, lack of late blight resistance varieties & absence of awareness were the major constraints in the studied area. Therefore, to overcome the above stated problems and to acquaint smallholder farmers with new technologies of widely grown horticultural crops production with the objectives of to select high yielder, late blight resistance and desirable agronomic traits wider adapted potato genotypes in highlands of Guji zone, southern Oromia.

## MATERIALS AND METHODS

### Description of the Study Area

The experiment was carried out during the 2014 Belg cropping season in highlands Guji zone of Bore on station, Yirba Buliyo and Raya boda. Bore Agricultural Research Center site is located at the distance of about 8 km north of the town of Bore in Songo Bericha '*Kebele'* just on the side of the main road to Addis Ababa via Awassa town. Geographically, the experimental site is situated at the latitude of 06$^{o}$23'55'' N– 06$^{o}$24'15''N and longitude of38$^{o}$34'45'' E– 38$^{o}$35'5''E at an altitude of 2728 m above sea level. The climatic condition of the area is moist humid and sub humid, with relatively longer growing season. The area is found at the annual rainfall ranges from 1400 -1800 mm with a bimodal pattern that extended from April to December. The mean annual minimum and maximum temperature is 10.10C and 20 OC, respectively (National Meteorological Agency, Hawassa Branch directorate 2004-2013). The research site represents highlands of Guji Zone, receiving high rainfall and characterized by a bimodal rainfall distribution. The first rainy season is from April up to October and the second season starts in late November and ends at the beginning of March. The major soil types are *Nitosols* (red basaltic soils) and *Orthic Aerosols* (Yazachew and Kasahun, 2011; Wakene *et al*., 2014).

### Experimental Materials and Methodologies

The experiment was conducted an area occupied by plot size of 3mx1.8m and a distance1m and 1.5m between plots and blocks respectively. The planting materials used were brought from Holeta, Hawassa and Sinana Agricultural Research Center the varieties are Gudanie as Standard check, Belete, Wochecha, Bule and Milki were planted at April 2014/15 belg cropping season. A recommended spacing of 75cm x 30cm between row and plant respectively ,and fertilizer rates 200kg DAP and100kg Urea applied in two split at planting and 20 days after emergence. Other agronomic and crop protection practices weeding, Earthingup, top killing and etc. were done uniformly as per recommended for potato production.

### Statistical Analysis

The collected data were analyzed using simple mathematical test for significant parameters of Day's to 50% emergence, flowering and Maturity, Average plant height, number of tubers/ plant, number of main stems, number of tuber per hill, tuber weight and tuber yield.

**Table 1.** Combined analysis of Varieties over locations on Days to 50% emergence, flowering and Days to 90% Maturity means

| Varieties | Days to 50% Emergence | Days to 50% Flowering | Days to 50% Maturity |
|---|---|---|---|
| BELETE | 18[b] | 50[a] | 95[a] |
| GUDANE | 15[e] | 46[b] | 83[d] |
| WOCHECHA | 17[c] | 42[c] | 86[c] |
| MILKI | 16[d] | 38[d] | 78[e] |
| BULE | 19[a] | 42[c] | 88[b] |
| Mean | 17.244 | 43.578 | 85.911 |
| LSD(5%) | 0.9973 | 0.9973 | 0.8840 |
| CV(%) | 3.458 | 1.4 | 0.6 |

Means followed by different letters in the same column are significantly different at 5% level of probability, LSD= Fisher's least significant difference at (p≤0.05) and CV= Coefficient of variation.

**Table 2.**Combined analysis of varieties over locations plant height (cm) and number of main stem means

| Varieties | Average of plant height (cm) | Average of number of main stems |
|---|---|---|
| BELETE | 98[a] | 6[b] |
| GUDANIE | 83[d] | 10[a] |
| WOCHECHA | 86[c] | 7[b] |
| MILKI | 78[e] | 7[b] |
| BULE | 88[b] | 6[b] |
| Mean | 87.837 | 7.29 |
| LSD (5%) | 14.50 | 2.836 |
| CV (%) | **9.9** | **23.3** |

Means followed by different letters in the same column are significantly different at 5% level of probability, LSD= Fisher's least significant difference at (p≤0.05),CV= coefficient of variation.

## RESULT AND DISCUSSION

**Days to 50% Emergence:** The Analysis of variance showed that**,** varieties over locations highly significant differences as well as among varieties and location ($p \leq 0.05$) with respect to days to 50% emergence (Table 3).Variety Bule took longer days (19days) followed by Belete (18 days) for emergence and variety Gudanie on the other hand emerged earlier than other varieties within 15 days after planting (Table 1).

**Days to 50% Flowering:** The Analysis of variance showed that**,** varieties over location highly significant differences as well as among varieties and location ($p \leq 0.05$) with respect to days to 50% flowering (Table 3).Variety Belete took longer days (50 days) followed by Gudanie (46days)for flowering and variety Milki on the other hand flowered earlier than other varieties within 38days after emergence. However, Belete flower late (Table 1).

**Days to 50% Maturity:** From the analysis of variance revealed that varieties over location showed that highly significant difference as well as among varieties and location ($p \leq 0.05$) with respect to days to 90% Maturity (Table 3). Variety Belete took longer days (95days) followed by Bule (88days)for Maturity and Milki on the other hand mature earlier than other varieties within 78 days after emergence. However, Belete matured late (Table 1).

**Average plant height (cm):** The analysis of variance showed that varieties over location non significant different, but significant among varieties and location ($p \leq 0.05$) with respect to plant height(Table 3). Variety Belete highest plant height (98 cm) followed by Bule (88 cm).However, Milki on the other hand relatively shorter plant height within (78 cm) was recorded(Table 2).

**Number of main stem:-** The analysis of variance showed that varieties over locations non significant different ,but highly significant among varieties and location ($p \leq 0.05$) with respect to number of main stem (Table 3). Variety Gudanie has highest main stem number (10) followed by Wochecha and Milki (7) respectively. However, variety Belete on the other hand lowest main stem number (6) was recorded (Table 2).

**Table 3.** Mean squares values on Phenological and Yield components parameters of Potato (*Solanum tuberosum L*)

| S.Varation | DF | DE | DF | DM | PH | AMS |
|---|---|---|---|---|---|---|
| Rep | 2 | 0.36** | 0.36** | 0.42** | 96.9** | 1.09** |
| Location | 2 | 8.3** | 63.02** | 372.7** | 5118.9** | 25.3** |
| Variety | 4 | 21.7** | 165.02** | 37.4** | 1121.5** | 25.76** |
| V X L | 8 | 3.29** | 4.52** | 27.2** | 114.4ns | 3.48ns |
| Error | 30 | 0.36 | 0.36 | 0.28 | 75.14 | 2.88 |
| Total | 44 | | | | | |
| CV (%) | | 3.5 | 1.4 | 0.6 | 9.9 | 23.3 |

In the column Mean squares values showed that **=highly significant,*=significant, ns=non significant are at 5% level of probability, LSD= Fisher's least significant difference at (p≤0.05),CV= coefficient of variation, L=Location and V=variety

**Table 4.** Combined analysis of varieties over locations on average tuber number per hill and average tuber weight (g)

| Varieties | Average Tuber number per plant(hill) | Average Tuber weight (g) |
|---|---|---|
| BELETE | 13[a] | 172[a] |
| GUDANIE | 12[a] | 106[b] |
| WOCHECHA | 7[c] | 109[b] |
| MILKY | 9[c] | 108[b] |
| BULE | 11[b] | 97[b] |
| Mean | 10.311 | 118.31 |
| LSD ( 0.05) | 3.448 | 49.03 |
| CV(%) | **19.45** | **23.974** |

Means followed by different letters in the same column are significantly different at 5% level of probability, LSD= Fisher's least significant difference at (p≤0.05),CV= coefficient of variation.

**Table 5.** Total yield of Potato (*Solanum tuberosum L.*) mean as affected by varieties over locations in Guji zone.

| Varieties | Mean each locations | | | Overall location mean t/ha |
|---|---|---|---|---|
| | Bore on-station t/ha | Irba Buliyo t/ha | Raya Boda t/ha | |
| BELETE | 76.36a | 63.34a | 60.95a | 66.88a |
| GUDANIE | 51.31b | 47.11ab | 55.43a | 51.28b |
| WOCHECHA | 39.23bc | 36.14bc | 32.25cd | 36.77c |
| MILKI | 27.02c | 31.38bc | 23.3bc | 33.22c |
| BULE | 43.22bc | 27.87c | 23.3d | 31.48c |
| Mean | 474 | 412 | 26 | 43.93 |
| LSD 0.05 | 213.9 | 179.4 | 159.3 | 152.9 |
| CV (%) | 24 | 23.1 | 19.9 | 20.138 |

**Average tuber number per hill:** The analysis of variance showed that varieties over locations non significant different, but significant different among varieties and location ($p \leq 0.05$) with respect to average tuber number per hill (Table 7). Belete has highest average tuber number per hill (13) followed by Gudanie (12). However, Wochecha has gave lowest average tuber number per hill than the other varieties (Table 4).

**Table 6.** Combined analysis of varieties over locations on unmarketable yield (t/ha), marketable yield (t/ha) and total yield (t/ha)

| Varieties over location means | | | | |
|---|---|---|---|---|
| Varieties | Unmarketable yield (t/ha) | Marketable yield (t/ha) | Total yield (t/ha) | YA (%) |
| BELETE | 26.86[a] | 39.61[a] | 66.88[a] | 23.3 |
| GUDANIE | 12.94[b] | 37.69[a] | 51.28[b] | |
| WOCHECHA | 13.57[b] | 23.2[b] | 36.77[c] | |
| MILKI | 11.54b[c] | 21.68[b] | 33.22[c] | |
| BULE | 0.54[c] | 26.12[b] | 31.48[c] | |
| Mean | 14.053 | 29.66 | 43.93 | |
| LSD ( 0.05) | 129.8 | 90.24 | 152.9 | |
| CV ( %) | - | 18.283 | 20.138 | |

Means followed by different letters in the same column are significantly different at 5% level of probability, LSD= Fisher's least significant difference at ($p \leq 0.05$),CV= coefficient of variation and YA=Yield Advantage

**Table 7.** Mean squares values on Yield and Yield components parameters of Potato (*Solanum tuberosum L.*)

| S.Varation | DF | ATN | ATWT | MYLD | UMYLD | TYLD |
|---|---|---|---|---|---|---|
| Rep | 2 | 0.82** | 36.3** | 3360** | 3183** | 320** |
| Location | 2 | 50.52** | 8323.8** | 63286** | 55665** | 202934** |
| Variety | 4 | 49.42** | 1898.9ns | 18678** | 1011ns | 14158ns |
| V X L | 8 | 6.26ns | 780.1ns | 8483** | 3407ns | 16272ns |
| Error | 30 | 4.25 | 859.4 | 2911 | 6027 | 8363 |
| Total | 44 | | | | | |
| CV (%) | | 20 | 24.8 | 18.2 | 55.2 | 20.8 |

In the column Mean squares values showed that **=highly significant,*=significant, ns=non significant are at 5% level of probability, LSD= Fisher's least significant difference at ($p \leq 0.05$),CV= coefficient of variation, L=Location and V=variety

**Average Tuber weight:** The analysis of variance showed that varieties over location non significantly different, but significant different among varieties and location ($p \leq 0.05$) with respect to average Tuber weight (Table 7). Belete has gave highest average tuber weight **(**172 qt/ha) followed by Wochecha (109 qt/ha). However, Bule has gave lowest average tuber weight (97 qt/ha) recorded (Table 4).

**Unmarketable yield (t/ha)**:-The analysis of variance showed that ,varieties over locations non significantly difference, but significant different among varieties and location ($p \leq 0.05$) with respect to unmarketable yield (Table 7 ).Belete has gave highest unmarketable yield (t/ha26.86 t/ha) followed by Wochecha (13.57 t/ha). However, Bule has gave lowest unmarketable yield (t/ha (0.54 qt/ha) was recorded (Table 6).

**Marketable yield (t/ha):-** The analysis of variance revealed that varieties over location highly significantly difference ($p \leq 0.05$) with respect to marketable yield (Table 7). Belete gave highest marketable Yield **(**39.61 t/ha) followed by Gudanie (37.69 t/ha). However, Bule has gave lowest marketable Yield (21.68 t/ha) was recorded (Table 6)

**Total yield (t/ha):-** The analysis of variance showed that varieties over locations and varieties non significantly difference, but significant different among location ($p \leq 0.05$) with respect to total yield (Table 5). The variety Belete has gave highest total Yield **(**66.88 t/ha) and Belete has gave highest total yield at over all location and especially at Bore onsite followed by Gudanie (51.28 t/ha). However, Bule on the other has gave lowest total yield (31.48 t/ha) was recorded (Table 6).

## CONCLUSION AND RECOMMENDATION

As the over results revealed that the total fresh yields are increased markedly. Thus, Belete and Gudanie have gave highest total fresh yield and significant different ($p \leq 0.05$) among Days to emergence, Days to flowering, Days to maturity, Average plant height, Average tuber number/hill , Average tuber weight per hacter, Unmarketable tuber yield per hacter and Marketable tuber yield per hacter and total yield t/ha$^{-1}$. Belete performs very well in areas having an altitude 2540 and above 2752 m.a.s.l ; annual rainfall of 500mm and above1000 mm. It can also possibly extend the production of this variety to other areas having similar agro-ecologies. Therefore, based on their agronomic performance, highest yielder and disease resistance varieties Belete and standard check Gudanie that having highest production were selected and recommend in highlands of Guji zone and similar agro-ecologies.

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