Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.8, No.16, 2018

Adaptability Study of Irish Potato (Solanum Tuberosum L.) Varieties for Yield and Yield Components Under Kaffa Zone, South Western Ethiopia

Henok Fikre
Department of Plant Breeding, Southern Agricultural Research Institute, Bonga Agricultural Research Center
P.O.Box

Abstracts
Potato is one of the most important food crops grown in mid and high altitude areas of Ethiopia. To meet the production need several potato genotypes have been introduced and evaluated at different areas of the country. However, the performances of different released potato varieties were not yet assessed in the study area. To this end, the present study was undertaken with the focus on determining the adaptability of Irish potato varieties for yield and yield components. It was conducted at Kaffa zone Adiyo District in Alarigeta experimental sub-station in 2013 and 2014 Belge cropping season. Seven improved potato varieties; namely Bule, Marachare, Wochecha, Dancha, Jallanie, Gudanie and Belete were used as treatment. Treatments were arranged in randomized complete block design with three replications. Average tuber diameter, average tuber number, average tuber weight, marketable tuber number, unmarketable tuber number, total tuber number, marketable tuber yield, unmarketable yield and total tuber yield data were recorded and submitted to analyze using SAS software version 9.0. Analysis of variance for each year showed significant ($p< 0.05$) difference among the varieties for all studied traits except Average tuber diameter and marketable tuber number in 2013, and Average tuber diameter and unmarketable tuber yield in 2014. The highest and consistent tuber yield was found in variety Belete (40.54 t/ha and 39.98 t/ha) in 2013 and 2014 respectively. Therefore, variety Belete, which was given high yield in both years, could be used instated of currently cultivating varieties to increase production and productivity of the crop for better enhancement of food security and livelihood income of the locality.
Keywords: potato, varieties, tubers, adaptability

1. INTRODUCTION

Potato (*Solanum tuberosum* L.)is one of the most important food crops in many countries of the world [1]. In volume of production it ranks fourth in the world after maize, rice, and wheat with annual production of 314.1 million tons cultivated on about 18.1 million hectares of land [1] and among the root crops, potato ranks first in volume produced and consumed, followed by cassava, sweet potato, and yam [11].

It is an important food and cash crop in eastern and central Africa, playing a major role in national food security and nutrition specially in disaster situations, poverty alleviation and income generation, and provides employment in the production, processing and marketing sub-sectors [9, 10].

Potato is efficient in converting resources such as labor and capital in to a high energy food. Its efficiency of protein production is also higher than commonly realized. If carefully managed, it gives the highest yield of nourishment per hectare of all basic food stuffs in tropical countries. Furthermore, the growing period is only 90-125 days, enable multiple cropping for optimum use of the available land moisture. Hence, it is noted that in potato producing areas double cropping is possible [8].

Potato is grown for food, animal feed, industrial uses and for seed tuber production. The main use is still as direct food but, an increasing proportion is processed into snack food. Potato is important for subsistence farmers but may also be a cash crop [12].

Potato was introduced to Ethiopia in 1858 by the German Botanist Schemper. Since then, potato became an important garden crop in many parts of the country. About 70% of the available agricultural land is suitable for potato production which is located at an altitude of 1500 to 3000 m.a.s.l with an annual rainfall between 600 and 1200 mm [10]. More than 3.3 million smallholders are engaged in potato production and over 1.61 million tones of potato was produced in 2013/14, a 71% increase compared to production in 2008/09 [5]. According to the [4], the average potato tuber yield in Ethiopia is estimated to be 9.0 t/ha in 2013/14. Even though this increased average national yield is very low as compared with the world average potato tuber yield (17.16 t/ha) [4]. A number of production constraints that accounts for low yield have been identified in the country and which are also commonly prevailed in the study area. The major ones are lack of stable, well-adapted, high yielding, acceptable and disease resistant cultivars and using of local cultivars, which are highly susceptible to late blight that sometimes leads to 100% yield loss [6]. Improved potato varieties together with improved management proved to give three to four fold yield advantage as compared to local varieties together with traditional production and management practices [2]. Thus, testing improved potato technologies to specific areas would help to identify best fit technologies to the existing production system that can ensure sustainable food security

[2]. Therefore, the experiment was amid to test the adaptability and select high yielding potato variety to increase production and productivity of the crop for better improvement of food security and self sufficiency of livelihood of the area.

2. MATERIALS AND METHODS

2.1 Description of the study area: The experiment was conducted at Adiyo District, Alarigeta experimental sub-station in South Western Ethiopia during 2013/2005and 2014/2006 belg cropping season. Alarigeta is 21 km away from Bonga town to South, which is 449 km south west of Addis Ababa. The site an altitude of 2474 masl and is experienced ***one long rainy season lasting from March /April to October.*** The mean monthly rain fall received the area was 109 mm in 2013 and 156 mm in 2014. The mean monthly minimum and maximum temperature was 19^{O}C and 29^{O}C in 2013, and 18^{o}C and 27 ^{o}C in 2014 according to South west Jima meteorological stations data. The soil of the area is characterized by sandy clay loam as determined by Jima Agricultural research Center soil and Water research processes soil laboratory.

2.2 Experimental Treatments, Design and Procedures: Seven varieties were used for evaluation namely; Gudanie, Jallanie and Belete varieties obtained from Holeta Agricultural Research Center and Bule, Dancha, Marachare and Wochecha varieties obtained from Awassa Agricultural Research Center were used as a treatment. Treatments were arranged in randomized complete block design with three replications. Land was ploughed three times and all other management practices, such as seed and fertilizer rate, weeding, insect pest and disease control were applied as per the general recommendations for potato production [6]. The experimental field was divided in to three Blocks and each containing 7 plots with a distance of 1 m between block and 0.75 m between plots. Spacing between row 75cm and between plants 30 cm was used. Planting was done in November 2013/2005 and 2014/2006.

Table-1: Description of the varieties

No.	Variety	Released year	Breeder/Maintainer	Yield t/ha	
				On station	On farm
1	Gudanie	2006	HARC/EIAR	29.2	21
2	Jallanie	2002	HARC/EIAR	44.8	29.1
3	Belete	2010	HARC /East Africa	47.19	-
4	Dancha	2009	SARI/AWARC	31.8	35.9
5	Marachare	2005	AwARC/ SARI	33.3	28.4
6	Bule	2005	AwARC/ SARI	39.3	38.3
7	Wechecha	1997	HARC/EIAR	21.8	19

Source: Root and Tuber crops: The untapped resources (2008) and Haramaya University (HU*) Potato Improvement Programme section (2012)

2.3 Data collection and analysis: Data were collected on yield and yield components such as average tuber diameter, average tuber number, average tuber weight, marketable tuber number, unmarketable tuber number, total tuber number, marketable tuber yield, and unmarketable tuber yield and subjected to analysis of variance using GLM model in SAS software version 9.0 statistical packages. For factors showing significant difference, mean comparisons were made using LSD value at 5% significant level.

3. RESULTS AND DISCUSSION

Analysis of variance (ANOVA) for yield and yield components were showed significant ($p<0.05$) difference among the varieties for all traits except average tuber diameter and marketable tuber number in 2013 (Table-1) and average tuber diameter and unmarketable tuber yield in 2014 (Table-3).

Based on the analysis highly significant ($P<0.05$) difference was observed among the varieties for average tuber number per hill in each year. Significantly highest average tuber number per hill was recorded by variety Marachare (18.8), while the least was recorded by Dancha (7.7), though Dancha and the second high yielded variety Bule were statistically not significant in 2013. The highest average tuber number per hill in 2014 was also recorded by Marachare (21.41) followed by Gudanie, while the least was recorded by Wochech (8.4).The average tuber number per hill was higher in 2014 than 2013 possibly reflects the climatic factors more favorable in 2014 than 2013 during the tuber initiations stage.

Belete (0.91 kg) produced highest and significantly different average tuber weight per hill, while variety Gudanie (0.41kg) produced the least average tuber weight in 2013 (Table-2). Variety Belete (1.4 kg) was produced significantly highest average tuber weight followed by Marachare, Gudanie and Blue, while Wochecha (0.49) was produced the least average tuber weight in 2014 (Table-4). Variety Belete was showed consistent average tuber weight in both seasons even though there was certain variations of rain fall in amount and

distribution, and temperature in the area. In contrast, all varieties gave better average tuber weight in 2014 than 2013, indicating the season in 2014 was favorable for potato growth and development.

There was non-significant (P< 0.05) difference among varieties for marketable tuber number in 2013 (Table-1), whereas highly significant difference was observed among varieties in 2014 (Table-3). Bule (337449) and Dancha exhibited the highest and the least marketable tuber number per hectare respectively in 2013. Marchare (696914) was given high and significant marketable tuber number, while Wochecha was given the least marketable tuber number in 2014.

Varieties were showed highly significant (P<0.05) difference for unmarketable tuber number per hectare in both season (Teble-1, 3). Marachare (486831) had scored significantly highest unmarketable tuber number, while Dancha (61728) was recorded lowest unmarketable tuber number though Dancha, Wochecha, Belete and Bule were statistically not significant in 2013 (Table-2). Variety Belete (53704) had high unmarketable tuber number though it was not statistically significantly different from Dancha and Jallanie, while Marachare (8025) had lowest un marketable tuber number though Marachare and Gudanie were statistically not different in 2014 (Table-4). The highest overall mean unmarketable tuber was observed in 2013 (199941) than 2014 (30776) might be due to the shortage of rainfall during early stage and the presence of high rain fall around the harvesting time that result in tuber rote in turn increased unmarketable tuber number.

Varieties showed highly significant (P<0.05) difference for total tuber number in both years (Table-1, 3). Marachare (817284, 704938) had significantly the highest total tuber number in 2013 and 2014 respectively, while Dancha (312757) was recorded the least total tuber number in 2013 though Danch, Wochecha and Belete were statistically not significant. On the other hand, Wochecha (171296) had also recorded the least total tuber number in 2014 though it was not significantly different from Danch and Jallanie. Although higher overall mean total tuber number exhibited in 2013, it was not as good as 2014, which had resulted in better overall mean marketable tuber number.

Among the varieties there was highly significant (P<0.05) difference for marketable tuber yield in each year (Table-1, 3). Bletete (36.46 t/ha) had showed significantly highest marketable tuber yield in 2013; while the least marketable tuber number was obtained by Gudanie (13.53 t/ha), though Gudanie, Marachare, Jallanie and Dancha were not significant (Table-2). Belete (34.41 t/ha) had scored the highest marketable tuber yield though Belete, Gudanie and Marachare were statistically not different, whereas Wochecha (7.45 t/ha) had scored significantly lowest marketable tuber yield in 2014 growing season (Table-4). In contrast, highest overall mean marketable tuber yield was exhibited in 2014 (22.78 t/ha) than 2013 (21.88 t/ha) might be due to the better climatic conditions in the former year. Varieties were showed marketable tuber yield variation over the years. This result is consistent with that of [7] who reported that marketable tuber yield is influenced by year X variety interaction.

Varieties showed non-significant difference for unmarketable tuber yield in 2014, while highly significant difference was observed among the varieties in 2013 (Table-1, 3). Even though there was no significant difference among the varieties for unmarketable tuber yield high yield los was observed in Marachare (6.63 t/ha) and low in Wocheacha (2.01t/ha) in 2014 (Table-4). In 2013 significantly highest yield loss was observed in Belete (5.5 t/ha), whereas the least yield loss was observed in Marachare (0.52t/ha) (Table-2). The significant difference among the varieties in 2013 indicates the varieties response differently to different extent of climatic variations. The very high and low occurrence of climatic factors such rain fall, temperature and humidity would affect the crop yield negatively. Similarly, [3] reported that unmarketable tuber yield variation could be due to varietal differences. Moreover, it might be controlled more importantly by manipulating other factors such as disease incidence and harvesting practice, etc.

Among the varieties highly significant (P<0.05) difference was observed for total tuber yield in 2013 and 2014 (Table-1, 3). Belete (40.54 t/ha and 39.98 t/ha) had scored the highest total tuber yield in 2013 and 2014 respectively, whereas the least total tuber yield attributed in variety Gudanie (18.23 t/ha) and Wochecha (10.1 t/ha) in 2013 and 2014 respectively. The highest overall mean total tuber yield was found in 2013 which was 25.97 t/ha, while 25.26 t/ha had got in 2014. As the overall mean indicated the total tuber yield was almost similar in both years even though some varieties showed yield difference across the years. Variety Belete was showed the highest and consistent tuber yield over years followed by Bule which was the second high yielded and consistent tuber yield (Figer-1). In contrast, all varieties were scored far below than the national total tuber yield level [6] and the yield loss was ranged from 14.69 % up to 51.02 %. The reason might be due to the shortage of rain fall during the initial growth and development stage, occurrences of late blight disease and high rain fall occurrence around physiological maturity that can enhance different disease like root rot. In general, Belete and Bule were showed consistence and better adaptability in the area.

Table-1: analysis of variance (ANOVA) for yield and yield components of potato at Alarigeta in 2013

2	0.66	38.8	0.01	4715381773	9744667772.9	22635996008	13.93	0.04	2.03
6	0.77^{NS}	8.91**	0.08***	4064711362^{NS}	62524925363***	76495767797**	170.08**	8.94***	148***
12	0.47	5.75	0.01	6967833200.7	5136206581.8	10050430333	22.60	0.55	13.85
20	11.66	319.65	0.56	117433030123	456273366703	624851762801	1319.58	60.37	1062

ATD= average tuber diameter, ATN= average tuber number, ATW= average tuber weight, UMTN= unmarketable tuber number, TTN= total tuber number, MTY= marketable tuber yield, UMTY= unmarketable tuber yield, TTY= total tuber yield.

Table-2: mean separation of potato yield and components at Alarigeta in 2013

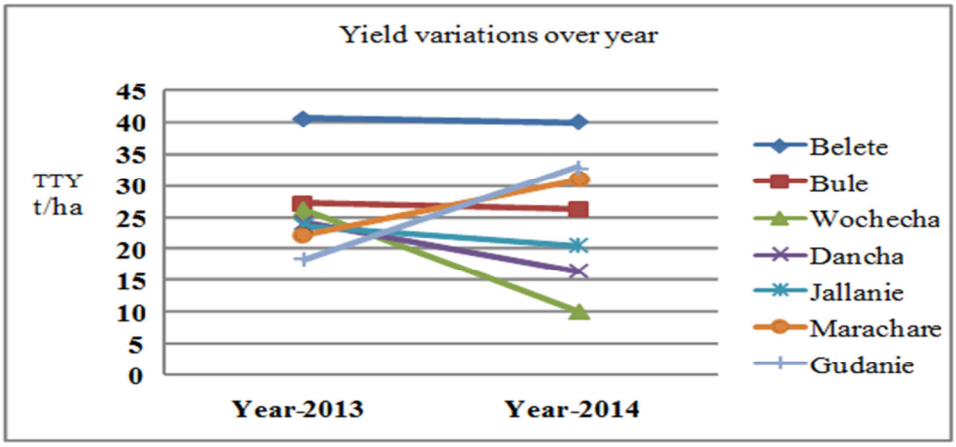
5.48a	10.5a	0.913a	334979a	131687bc	466667bc	36.46a	4.077a	40.54a
4.06a	11.73b	0.623bc	337449a	186008bc	523457b	23.87bc	3.287a	27.16b
4.93a	8.44b	0.68b	304938a	70370c	375309bc	24.08b	2.013a	26.1b
4.61a	7.72b	0.597bc	251029a	61728c	312757c	20.58bcd	3.497a	24.07bc
4.28a	11.41b	0.543bcd	264198a	229218b	493416b	19.08bcd	4.38a	23.46bc
4.11a	18.77b	0.51cd	330453a	486831a	817284a	15.6cd	6.627a	22.22bc
4.76a	11.34b	0.407d	270370a	233745b	504115b	13.53d	4.7a	18.23bc
NS	4.27	0.15	NS	127496	178347	8.46	NS	6.62
14.96	21	13.55	27.92	35.84	20.09	21.72	40.72	14.33

Table-3: analysis of variance (ANOVA) for yield and yield components of potato at Alarigeta in 2014

2	0.32	12.46	0.01	10217700323	186205830	13148794943	2.05	11.24	1.62
6	0.53^{NS}	60.73***	0.26***	112773458960***	924088832***	99553928111***	320.19***	6.66^{NS}	320***
12	0.25	1.7	0.02	2360110208	103329741	2240326151.2	6.51	2.76	6.2
20	6.84	409.68	1.83	725397476905	7156901550	650505072364	2003.36	92.26	2000

Table-4: mean separation of potato yield and components at Alarigeta in 2014

5.14	14.28c	1.373a	380370c	53704a	434074c	34.41a	5.57a	39.98a
4.51	15.02c	0.903bc	408333c	28086c	436420c	24.02b	2.183b	26.2c
3.89	8.367de	0.49d	141667e	29630bc	171296e	7.447e	2.643b	10.1e
4.58	10.02de	0.67cd	200309de	47531ab	247840de	12.93d	3.4b	16.33d
4.5	11.76d	0.773	270370d	38889abc	309259d	18c	2.433b	20.43d
4.56	21.41a	1.067b	696914a	8025d	704938a	30.39a	0.527c	30.91b
5.09	17.59b	1.067b	532716b	9568d	542284b	32.31a	0.593c	32.9b
NS	2.32	0.26	86425	18084	84203	4.54	1.32	4.43
10.9	9.27	16.28	12.93	33.03	11.64	11.2	30	9.85



Figer-1: Performance of improve potato varieties in belge growing season over two years

4. SUMMARY AND CONCLUSION

The analysis of variance for yield and yield components had showed highly significant (P<0.05) difference

among the varieties for all studied traits except tuber diameter and marketable tuber number in 2013, and tuber diameter and unmarketable tuber yield in 2014. The presence of significant differences among the varieties indicates the difference in potential for yield, disease resistance and response to different climatic factors. The significance of traits in one year and not in another year indicates the extent of variation of response of traits to the existing variations of climatic factors in different year.

The result has indicated that no superior varieties for all tested characters in the analysis suggesting the traits are differently affected by genetic, agronomic and climatic factors. The mean performance of tested Varieties over testing years for total tuber yield ranged from 40.257 t/ha for Belete in 2013 to 18.097 t/ha for Wochecha in 2014. All the varieties were scored far below than the national total tuber yield level and the yield loss was ranged from 14.69 % to 51.02 %. This might be due to the presence of high rain fall on ward to flowering stage and resulted in late blight and root rot disease, which obviously reduce the crop yield.

Although certain variations observed across the years in tuber yield for different varieties, Belet and Bule were showed high and consistent yield over years. Therefore, on the basis of present study Belete variety, which was given high yield in both years, could be used instated of currently using varieties to increase production and productivity of the crop for better enhancement of food security and livelihood income. In the shortage of Belete, Bule could be used, which was second high yielded variety.

The research gap and future directions; agro ecological characteristics and soil fertility status of the area is being different from other area, planting date and fertilizer rate determination, seed degeneration study, new genotype introduction to release high yielding and disease resistant variety, pre extension and demonstration activity should be done.

5. ACKNOWLEDGEMENT

I would like to thank Bonga agricultural research center for overall facilities provided during the execution of this trail.

6. Reference

[1] AdaneHirpha, M.P.M. Meuwissen, AgajieTesfaye, W.J.M. Lommen, A.O. Lansink, Admasu Tsegaye, and P. C. Struik (2010). Analysis of Seed Potato Systems in Ethiopia.American Potato Journal. 87:537–552.

[2] Asresie Hassen, Alemu Worku, Molla Tafere, Mekonen Tolla, Abel Ahmed, Seferew (2015). Best Fite Practice Manual for potato Production and Utilization. Applicable for mid-altitude areas including South Achefer, Burie and Jabitehenan Districts of North-Western Ethiopia.

[3] Berga L, Gebrehiwot H, Gebremadhin W (1994). Prospects of seed potato production in Ethiopia. pp. 254-275. In: Edward, H and Lemma Dessalegn. eds. Horticulture Research and Development in Ethiopia.

[4] Central Statistical Agency (CSA), (2013). Agricultural sample survey of area and production of crops of 2012/2013 (2005 E.C.) in Ethiopia. September to December 2012. Volume III. Report on area production. Private peasant holdings-Meher season. Addis Ababa, Ethiopia, p.251

[5] Central Statistical Agency (CSA), (2014). Ethiopian Agricultural SampleSurvey Report of 2013/2014. Statistical Report on Farm Management Practices Private Peasant holdings, Meher season, Addis Abeba, Ethiopia, Volume III, 17-19.

[6] GebremedhinWoldegiorgis, EndaleGebre and BergaLemaga (2008). Root and Tuber crops: The untapped resources. Ethiopian Institute of Agricultural Research (EIAR). Addis Ababa, Ethiopia. Pp 29.

[7] Gedif, M. and Yigzaw, D. (2014) Genotype by Environment Interaction Analysis for Tuber Yield of Potato (Solanumtuberosum L.)Using a GGE Biplot Method in Amhara Region, Ethiopia. Agricultural Sciences, 5, 239-249. http://dx.doi.org/10.4236/as.2014.54027.

[8] GirmaAbera, HailuGudeta and Gebremedhin Woldegiorgis, (20005). Research experience and recommended technologies for potato production in Wetern Oromia. Research Report. Oromia Agricultural Research Institute (OARI), Bako Agricultural Research Center, Oromia, Ethiopia.

[8] Lung'aho C., Lemaga B., Nyongesa M., Gildermacher P., Kinyale P., Demo P., Kabira J., (2007) Commercial seed potato production in eastern and central Africa. Kenya Agricultural Research Institute, p.140

[9] Mengistu Urge, NigussieDechassa, MengistuKetema, MulugetaYitayih and GetachewAnimut (2012).Maintenance of Potato Genotypes at Haramaya University. In: Proceedings of the 29th Annual Research and Extension Review Workshop, March 2012, Haramaya University

[10] MoARD (Ministry of Agriculture and Rural Development), (2010).Crop Variety Register.Issue No.Crop development Department. Addis Ababa, Ethiopia. Pp

[11] Struik P.C., Wiersema S.G., (1999). Seed potato technology. Wageningen University Press.

[12] Tesfaye Getachew, DerbewBelew and Solomon Tulu, (2012). Yield and Growth Parameters of Potato (*Solanumtuberosum*L.) as Influenced by Intra Row Spacing and Time of Earthing Up: In BoneyaDegem District, Central Highlands of Ethiopia. International Journal of Agricultural Research, 7: 255-265.