Original Research Article

Evaluation of Growth Parameters and Yield Parameters of Three Cultivars of Potato Grown In Hamelmalo, Eritrea

ABSTRACT

Potato is one of the most stable vegetable crops in the world and in Eritrea, where potato is ranked second among the vegetables in terms of area and production. Experiments on potato cultivars are important since potatoes are very sensitive to their growing environment and not all varieties/cultivars are adapted to all potato growing areas. In Eritrea, farmers are more interested in the cultivars that produce consistently high yields under their growing conditions. There is limited research on growth and yield parameters. It is, therefore dread timely to conduct this research in order to address to evaluate of growth performance and yielding potentiality of three cultivars (*Picasso, Ajiba* and *Zafira*) grown in Hamelmalo of Zoba Anseba. The experiment was conducted at Hamelmalo Agricultural College farm station. The design of the experiment was randomized complete block in triplicate. The growth parameters (plant height, stem number, leaf number at 30 and 60 days after planting) and yield variables were recorded in ton/ha. Among the cultivars; *Zafira* scored the highest number of plants per plot (32.6 plants/plot) as compared to *Picasso* (25.53 plants/plot) and *Ajiba* (22.07 plants/plot). The highest growth and yield parameters were obtained from cultivars *Ajiba* (29.33ton/ha) followed by *Zafira* 27.99ton/ha) though both cultivars had the highest incidences of blights and collar rot diseases. The correlation analysis indicated, there was no significant association among insect pests and yield ha^{-1}. However, the growth parameters showed significant correlations with yield ha^{-1} at 0.01level of significance.

Keywords: *Growth and Yield Parameters, Ajiba, Zafira* and *Picasso* potato cultivars.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is nutritionally enhanced vegetable due to its edible energy and edible protein. It produces more quantity of dry matter, edible energy and edible protein in lesser duration of time as compared to cereals like rice and wheat. According to Donnelly and Kubow (2011), potato contains different nutrients like carbohydrates 10-30%, proteins 1-1.5% and lipids and dietary fibre 1-2% of total fresh mass and also it is a source of different minerals, vitamins, and other phytochemicals. It is an out of the ordinary crop which is vegetatively propagated over the largest area in the world (Struik and Wiersema, 1999). The produce of this solanaceious vegetable is supplementing meat and milk products by lowering energy intake and also by reducing food cost (Bhajantri, 2011). Though the South America is known to be native of potato, it is grown in more than 100 countries globally. China ranks first, followed by Russia and India. Worldwide potato production in 2009 was harvested as 329.581 million tons from 18.652 million hectare. Highest production per

hectare was found from the central Europe (43.94 ton/ha) followed by North America (42.43 ton/ha); whereas lowest production was from Africa 9.98 ton/ha (Faulkner, 2012).

1.1 Status of Potato in Eritrea

Potato is one of the major vegetable crops after tomato and onion in Eritrea. Even though highland areas are suitable for potato cultivation and its total production is very low as compared to the demands of the consumers. Besides potato cultivars differ markedly in their yielding ability. Potato variety/cultivar experiments are important since potatoes are very sensitive to their growing environment and not all varieties/cultivars are adapted to all potato growing areas. Farmers are more interested in the cultivars that produce consistently high yields under their growing conditions. Total yield, number and weight of tubers per plant and average tuber weight and tuber quality such as specific gravity and starch content showed large variations among potato cultivars (Samih *et al.,* 2011). The germplasms well adapted to a particular set of conditions will be best suited for a locality for cultivation. In of the researches (Santerre *et al*., 1986) it is revealed that different potato varieties differ markedly in yielding ability. A mixture of many locally grown varieties (*Carnetiom* and *Shashemene*) and cultivars (*Picasso*, *Condor, Ajaba, Zafira, Cosmos, Spunta*, etc) are used in Eritrea. *Picasso* and *Condor* are top yielding varieties however due to their pinkish skin color; they are fetching lesser price and have less demand in the market as compared to *Zafira* and *Ajiba* which are ranking third and fourth in production, and first and second in their market values Anonymous (2009).

1.2 Growth and Development of Potato:

There are no fixed development stages in potatoes as these are influenced by varieties, cultivars, stem size, soil fertility, weather conditions etc. Unlike another crops, phenological stages of potato overlap with each other making it difficult to distinguish between stages. For example, sometimes during the early growth stage, developing tubers have already begun to grow from the roots. According to Bohl *et al*. (2000), regardless of the seed piece size, physiologically old seeds generally produce more stems per seed piece than less-aged seed pieces. Potatoes planted from tuber seed have five stages sprout development, vegetative growth, tuber initiation, tuber bulking and tuber maturation stage (Rana, 2008).

In Eritrea; the total production area and yield of 2632 ha and 17.1mt/ha respectively, whereas, the total production area and yield of potato in Zoba Anseba is 71 ha and 6mt/ha respectively (MoA, 2012). The crop is used as a food for consumption by the traditional farmers but in some cases it is considered as a source of income for the family. But its production is much lower as compared with other countries of the world. Therefore, this study was compulsive on the evaluation of growth performance and yielding potentiality of three cultivars grown in Hamelmalo of Zoba Anseba.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted in the experimental fields of Hamelmalo Agricultural College in sub zoba Hamelmalo of Zaba Anseba which is located around 13km from Keren to the north in Eritrea. It has the altitude 1280 m above sea level with 15° 55' 12.92'' N latitude and 38° 27' 46.9''E longitudes. The study area receives an average annual rain fall of 459mm and has an average temperature of 24°C. The area has sandy loam soil with pH of 6-7 (MoA, 2005).

2.2 Cultivars of Potato

Potato samples (Table 1) used in this experiment were *Ajiba, Zafira* and *Picasso* which are grown commonly in Hamelmalo (Figure 1).

Table 1. Cultivars of Potato Grown in Hamelmalo and their Characteristics

Properties of Cultivars	*Ajiba**	*Zafira**	*Picasso*[#]
Crop	Early crop	Early crop	Very long dormancy
Foliage	Medium to intermediate type with light to normal green leaves and average to strong anthocyanin colouration on the inner side of the flower corolla	Light to normal green leaves	Stem is upright and weak anthocyanin colouration; medium to large light green leaves and very less flowers and sprouts
Shape	Round to oval	Oval shaped and long tubers	Oval and uniform in shape
Skin	Yellow and rough	Yellow coloured skin	Yellow skin and red eyes
Flesh	Yellowish-white flesh and shallow eyes	Light yellowish flesh	Yellowish flesh
Yield	Good to moderate	High	
Size	Larger	Larger	Very large tuber size
Dry matter	Dry matter content is medium	Content is low	Medium

*Sources: * Agrico.UK, 2014; [#] Netherlands Potato Consultative Foundations, 2011*

A B C

Figure 1. Tubers of Ajiba(A), Zafira (B) and Picasso (C) cultivars

2.3 Experimental Design

The experimental trial was conducted from 1st September 2014 to 15thJanuary 2015 with three potato cultivars in two way RCBD factorial experimental design under irrigation and all necessary cultural practices. The experimental plot size was 3m x 2.8m, with 0.7m space between rows, 0.3m between plants, 0.8m space between plots and 1m between replications.

2.4 Field preparation and Sowing

The experimental field was prepared with normal agronomic practices, FYM @ 50 quintals/ha was mixed in the soil before ploughing. In addition the fertilizers DAP and Urea were used before and after planting at the rate of 120kg and 225kg per hectare respectively. Field was leveled and then the plots were made as per the requirement of the experimental design. Sowing of the potato tubers was done in the spacing of 30cm and 70cm between plants and rows respectively and the seed were sown in the depth of 10-15cm.

2.5 Earthing up, weeding and irrigation

Earthing up was done two times at 30 and 45 days after emergence of the crop. The experimental units (plots) were irrigated and weeds were removed at an interval of 5 and 15 days respectively. All the above mentioned activities were done for the three cultivars uniformly.

2.6 Experimental Data

2.6.1 Growth Studies:

The growth parameters (stand count, plant height, stem number, leaf number and yield) deliberate and simple random sampling was used. Samples were taken from the two middle rows.

2.6.1.1 Stand count:

The numbers of plants per plot (3m x 2.8m) were taken from each of the experimental plots after the date of emergence of the crop. The available plants per plot were counted and average number of plants per plot was calculated.

2.6.1.2 Plant height (cm):

Plant height was measured with the help of meter scale from soil surface up to top growing point. Three plants from each plot were taken and measured with the help of meter scale and the average height of the plants was calculated. The data were recorded at the age of 30 and 60 days from the date of planting.

2.6.1.3 Stem number:

The number of stems from each sample plant (three plants) was counted and the average stem number per plant was calculated for each plot.

2.6.1.4 Leaf number:

To determine the average leaf number a sample of ten stems from 5 sampled plants were taken from each plot. Total numbers of leaves from the sample stems were divided by the sample number and average number of leaves per stem was calculated.

2.6.2 Yield:

The yield was measured by weighing the tubers of 10 sample plants from each plot in kg using a weighing balance and divided in to the number of sampled plants to get the average tuber weight per plant (Tantowijoyo and van de Fliert, 2006). Finally the yield in kg per plant was converted to tons per hectare.

2.6.2.1 Yield parameters:

In addition to that tubers from the sample plants were graded as marketable and unmarketable and weighed separately.

2.8 Statistical analysis

Data recorded on different parameters were analyzed using statistical software Genstat and mean comparison were performed using the least significant difference (LSD) at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Growth Studies

3.1.1 Stand count:

Plant count was done for each of the three cultivars to determine the capacity of the cultivars to with stand the given environment. The table of analysis of this research showed highly significant difference in the stand count of the plants per plot due to cultivars influence at 5% level of significance. Among the cultivars; *Zafira* scored the highest number of plants per plot (32.6 plants/plot) as compared to *Picasso* (25.53 plants/plot) and *Ajiba* (22.07 plants/plot) (Fig. 2).

The lowest value of the *Ajiba* cultivar was because of its much softened seeds of potatoes. Moreover, the highest sprouting accelerates the early emergence of the plant, more rotting was observed once the seeds were inserted in the soil. In addition to that the lower number of plants per plot in *Ajiba* was due to the exhaustion of the stored food before sprouts emerge as the potato seed were sown in the depth 10-15cm. This result is supported by Chehaibi *et al.* (2013), it was reported that shallow planting is preferred in wet and heavy soils because in such soils deep planting of the tubers may lead to exhaustion of stored food before the sprouts emerge above the soil. It is therefore, suggested that the cultivars which are highly sprouted before planting should be shallow planted.

3.1.2 Plant height at 30 days after planting:

There was highly significant difference among the cultivars with regard to plant height at 5% level of significance. The cultivar *Ajiba* scored the maximum plant height 32.6cm followed by *Zafira* 31.67cm where as the lowest plant height value was obtained from *Picasso* cultivar 22.69cm. The cultivars *Ajiba* and *Zafira* were found at par but significantly different from the *Picasso* cultivar (Fig. 2).

3.1.3 Stem number per plant at 30 days after planting:

The analysis of variance provided a highly significant difference among the cultivars at 5% level of significance because of the cultivar effect. The cultivars *Ajiba* and *Zafira* scored the highest number of stems per plant (3.8).where as the *Picasso* showed less number of stems per plant (2.78) as compared the above listed two cultivars (Fig. 2).

The more number of stems in the *Ajiba* and *Zafira* cultivars was due to the aged tubers (stored for long) as compared the third cultivar *Picasso* which had the lower number of stems per tubers. These findings are supported by the results of Bohl *et al*. (2000) who mentioned that regardless of the seed piece size and physiologically old seeds generally produced more stems per seed piece than less-aged seed pieces.

3.1.4 Leaf number per stem at 30 days after planting:

Highly significant variation was observed in number of leaves per stem in the three different potato cultivars at 5% level of significance due to cultivar effects. The maximum number of leaves per stem was recorded from the *Zafira* cultivar (14.69) where it showed significantly higher number of leaves as compared to *Ajiba* (12.66) and *Picasso* (11.69) which was found at par with respect to the number of leaves per stem (Fig. 2).

3.1.5 Plant height at 60 days after planting:

Plant height was recorded at 60 days after planting. The analysis showed that the cultivars had highly significant difference due to cultivar effect with regard to the plant height of the cultivars at 5% level of significance. The cultivars *Ajiba* and *Zafira* showed the maximum mean plant height 34.39cm and 34.29cm respectively which showed high variation from *Picasso* cultivar 25.34cm (Fig. 2). The two cultivars (*Ajiba* and *Zafira*) were found at par, behave similarly as it was in case of plant height at 30 days after planting.

3.1.6 Stem number per plant at 60 days after planting:

It was observed that all the cultivars differed significantly due the effect of variety with regard the stem number at 5% level of significance. The cultivar *Ajiba* scored the highest stem number 4.84 per plant followed by *Zafira* 3.91 per plant. The lowest stem number was recorded from the cultivar *Picasso* 2.81 per plant.

3.1.7 Leaf number per stem at 60 days after planting

Highly significant variation was observed in the mean number of leaves per stem in the potato varieties/cultivars at 5% level of significance due to the effect of the variety on the number of leaves. The maximum numbers of leaves per stem were obtained from the *Zafira* cultivar (17.56) which showed significant difference from the other two cultivars. This is because of its vigorous vegetative growth. *Ajiba* and *Picasso* scored the minimum number of leaves per stem (16.02) and (15.31) respectively.

The present finding is supported by the work of Belay (2014), where *Zafira* cultivar had maximum leaf number when planted in the month of September. Younger seed tubers produced higher foliage than older seed tubers. These results are in agreement with the findings of Stuik and Wiersema (1999), but the finding is in opposite for Picasso cultivar as it had lower leaf number. The analysis also indicated that there was no significant difference among the chemicals and interactions for leaf number (Fig 2).

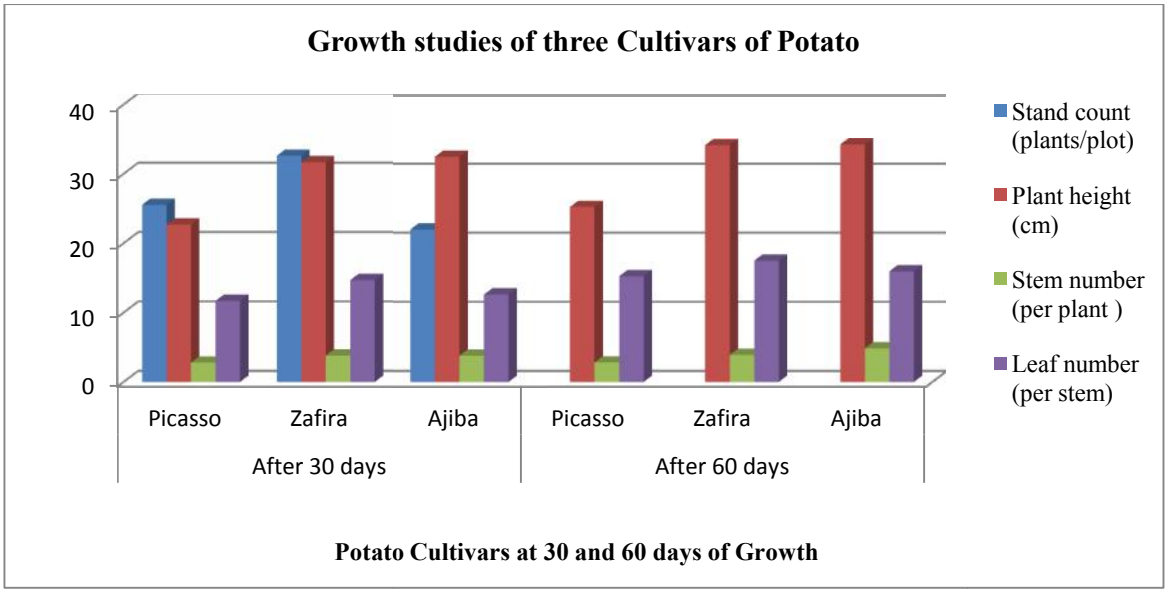

Fig 2. Growth studies of three cultivars of potato grown in Hamelmalo at 30 days interval

3.2 Yield Parameters:

3.2.1 The effect of variety on total yields:

The effects of cultivar on total yield were analyzed and the yield was recorded in ton per hectare to compare the response of the three cultivars. The cultivars showed highly significant difference at 5% level of significance in yield production. This result was in agreement with the report given by Santerre *et al*. (1986). Maximum yield was obtained from the *Ajiba* (29.33 ton/ha) followed by *Zafira* (27.99 ton/ha). More or less similar results from *Zafira* cultivar (26 ton/ha) were reported from NARI (2011). Based on the field observations it was noticed that the *Ajiba* and *Zafira* cultivars maintained vigorous vegetative growth. Both the cultivars found at par but showed significantly higher yields to the *Picasso* cultivar which had minimum production (19.49ton/ha). This was probably because of the

late emergence and poor performance of the *Picasso* cultivar in the study area. Even though *Ajiba* cultivar gave the high production, the production was found lower as compared to the result reported by Belay (2014) which was 73.5 ton /ha (Fig 3).

3.2.2 The effect of variety on marketable yields:

The yield was recorded in tons per hectare to know the response of the three cultivars and analysed to assess the effects of cultivar on total marketable yield. The cultivars showed highly significant difference due to cultivar effects at 5% level of significance. Maximum marketable yield was obtained from the *Ajiba* (26.61 ton/ha) followed by *Zafira* (26.16 ton/ha). Both the cultivars behaved equally and showed significant difference from the *Picasso* cultivar which gave minimum production (17.77 ton/ha). Inspite of the some disease incidences which were noticed during the growth period, the *Ajiba* and *Zafira* cultivars gave maximum production as compared the *Picasso* cultivar. This might be due to the high vegetative growth of these cultivars in the field condition and their early emergence to *Picasso* which helped them to become resistant to biotic and abiotic conditions.

3.2.3 The effect of variety on unmarketable yields:

The results showed that there was significant difference in unmarketable yield of the cultivars at 5% level of significance. The maximum unmarketable yield was recorded from the *Ajiba* cultivar (2.72 ton/ha) which was significantly different from the cultivars *Zafira* (1.84 ton/ha) and *Picasso* (1.724 ton/ha). The high unmarketable produce from *Ajiba* cultivar was due to the high percentage incidences of collar rots and blights which were occurred in the crop (Fig. 3).

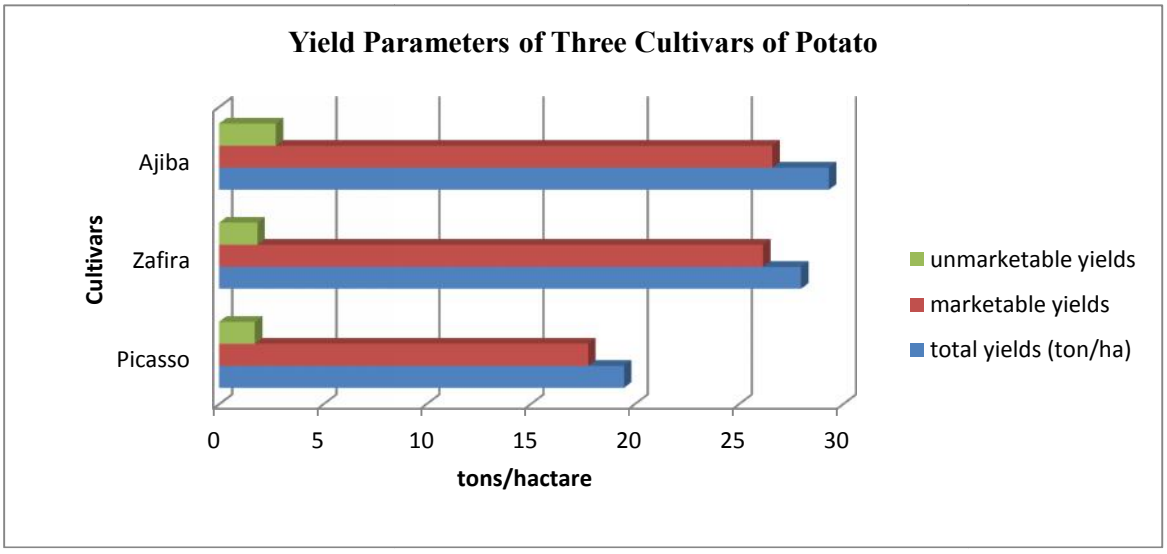

Fig 3. Yield parameters of three cultivars of potato grown in Hamelmalo

3.3 Correlations

Among the growth parameters and yield was correlated. The correlation between 'yield' and 'plant height at 60 days after planting' and 'stem number at 60 days after planting' were found highly

significant. Among the growth parameters 'plant height at 60 days after planting' showed highly significant correlation with 'stem number at 60 days after planting' and 'leaf number at 60 days after planting' (Table 2).

Table 2. Correlations among Growth Parameters with Yield

Growth parameters[1,2,3,4]	[1]PH60	[2]SN60	[3]LN60	[4]T.Y ton/ha
PH 60	1			
SN 60	.522**	1		
	.000			
LN 60	.570**	.065	1	
	.000	.670		
T.Y ton/ha	.546**	.520**	.073	1
	.000	.000	.635	

[1]*PH 60* : *plant height at 60 days after planting*
[2]*SN 60* : *stem number at 60 days after planting*
[3]*LN 60* : *leaf number at 60 days after planting*
[4]*T.Y ton/ha* : *total yield in ton per hectare*

4 CONCLUSIONS

In the early experimental periods the cultivars showed good vegetative growth, but their productions were not as much as expected. This might probably be due to the variation in the ecological conditions such as soil types, soil condition and time of planting (photoperiod). The cultivars *Ajiba* and *Zafira* scored the highest vegetative growth (plant height and stem number) at 30 days after planting where the maximum leaf number was recorded from *Zafira* cultivar at 30 and 60 days after planting. Both the *Ajiba* and *Zafira* cultivars gave the highest plant height, where as maximum stem number was obtained from Ajiba cultivar at 60 days after planting. The cultivars showed high variation in yield production. The correlation between yield and PH 60 and SN 60 were found highly significant.

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