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# Effect of Planting Date on Growth and Tuber Yield of Potato (*Solanum tuberosum* L.) Varieties at Anderacha District, Southwestern Ethiopia

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***Abstract* – An experiment was conducted to assess the effect of planting date and variety on growth and yield of potato at Anderacha district, Western Zone of SNNPRS, from October 2011 to March 2012. Five planting times (October 20, October 30, November 9, November 19 and November 29) and three varieties (Jallene, Guidene and local) were combined in 3x5 factorial arrangement and laid out in randomized complete block design with three replicates. Data were collected on growth and yield parameters and analyzed using SAS Version 9.2 statistical software. The result showed that early planting (October 20) delayed emergence and flowering by about 4 and 15 days, respectively and increased plant height by 10.68cm than the latest planting on November 29. The number of stems per plant increased with delayed plantings however tuber number decreased in late plantings. Early planting produced significantly heavier tuber weight (83.80g) which progressively reduced in subsequent plantings, whereas delay in planting resulted in higher unmarketable yield. Guidene took significantly longer days to emerge and flower (19.2 and 65.6 days, respectively) and plants were significantly taller (77.77cm) than Jalene and local variety. Jalene produced significantly ($P<0.05$) the highest stem number and consequently produced highest tuber numbers per plant. It also showed increased average tuber weight by 29.12% as compared to the local variety. Variety Jalene planted on October 30$^{th}$ produced the highest harvest index (0.84), marketable and total tuber yield (34.82 and 38.6 ton/ha), respectively. The two earlier plantings and variety Jalene showed superior performance in most studied growth and yield parameters. Therefore, based on the findings of the current study, early planting (October 20 up to 30) and potato variety Jalene can be used for optimum growth and high marketable tuber yield.**

***Keywords* – Planting Date, Growth Parameters, Potato Variety, Potato Tuber Yield.**

## I. INTRODUCTION

Potato (*Solanum tuberosum* L.) is the world's fourth most important food crop (after rice, wheat and maize) in terms of production (Razdan and Mattoo, 2005). Worldwide more than 320 million tons of potatoes are being cultivated annually on 20 million hectares of land (FOA, 2010). Potato is regarded as a high-potential food security crop because the crop produces large quantities of dietary energy (30-35 ton/ha starch based produce in 3-4months) and has relatively stable yields under conditions in which other crops may fall (Gebremedhin *et al*., 2008; FOA, 2010). Recently the world food price inflation was higher and more widespread for cereals than for potato and other root crops (FAO, 2010). In Ethiopia also the price of roots and tubers remained relatively low during the entire food crisis (Adane*et al*., 2010). This shows that root and tuber crop in general, potato in particular is a highly dependable food security crop.

In Ethiopia, the potato was introduced in 1858 by a German immigrant named Wilhelm Schimper (Nunn and Qian, 2011). Since then, it became one among the most economically important crops as a source of food and cash in the country (Gildemacher *et al*., 2009; Adane *et al*., 2010). As FAO (2008) estimated in Ethiopiaproduction has increased from 280 000 tons in 1993 to around 525 000 tons in 2007 and it can potentially be grown on about 70% of arable land in the country. However, area cropped with potato (about 0.16 Mha) is small and the average yield (less than 10 Mg $ha^{-1}$) is far below the potential (Adane *et al*., 2010). The low acreage and yield are attributed to many factors, such as lack of improved crop variety and high-quality seed potatoes, inappropriate agronomic practices, late blight and absence of proper pest management practices, unavailability of proper transport, storage and marketing facilities are the prominent ones (Tekalign, 2005; Habtamu*etal*., 2012). In addition, cropping season and inadequate moisture supply are also production constraints of potato.

In most of the potato farming zones, two rainy seasons can be identified, the main (*Meher*) season and a short rainy season (*Belg*) (Gildemacher*et al*., 2009). However, potato growers in most high land areas do not benefited from the most reliable rain fall of the *Meher* season due to the threat of late blight (Geremedin *et al*., 2008). In Anderacha district potato production is totally dependent on natural rainfall. Further observations in this study showed that, farmers in Aderacha plant potatoes in November, regardless of the crops sensitivity to biotic and abiotic stresses and rainwater availability. This is to escape from late blight during the wettest months of the year (May to September/October). Though planting at this time enables to the crop escape severe damage from late blight, productivity of potatoes under farmers' field has remained even less than the national average due to moisture and temperature stress. High evaporative demands that prevail in hot growing season increases the crop water requirement and may even compound the sensitivity to water stress, resulting in greater yield decline than that

from similar water stress under cooler conditions (Steyen *et al*., 2007).

Like other crops, the optimum date of planting for potato is highly location specific and every production region has an "optimum" planting period during which conditions are most favourable for producing the highest potential yield in a given season (Thornton and Nolte, 2005; Singh and Lal, 2009). However, there are no research recommendations pertaining to adaptable cultivars and their optimum planting date with due consideration of the environmental condition of Anderacha area. Planting dates affect directly the match between rainwater supply and crop water demands leading to yields deceasing. Hijmans (2003) predicted yield losses globally for potato in the range of 18 to 32% without adaptation in production methods, or 9 to 18% without adaptation in terms of planting time and use of heat tolerant cultivars.

There is ample evidence to suggest that the low productivity in rain-fed agriculture is generally more due to management aspects than to low physical potential (Tittonell *et al*., 2007). As the result, perfect timing of planting date is one of the key factors which strongly affect crop production in rain fed agriculture (Wang *et al*., 2008). Similarly, it is reported that in some parts of Ethiopia potato yields are affected significantly by planting dates (Berga*et al*., 1994, Tesfaye and Anteneh, 1999; Tesfaye*et al*., 2006). Therefore, manipulation of planting date is one measure to overcome the negative impact of environmental problem on potato production in Anderacha area. The present study was, therefore, conducted to determine the optimal planting time for potato varieties which can allow optimum plant growth and produce maximum tuber yield under rain-fed condition of Anderacha.

## II. MATERIAL AND METHODS

### *Description of Experimental Site:*

The experiment was conducted in Anderacha district in Southwestern Ethiopia during 2011/2012 cropping season on farmers' field under rain-fed condition. The area is 712km away from southwest of Ethiopia from Addis Ababa, located at about 7°24'–7°52' N latitude and 35°13'–35°35' E longitude and at elevation of 1960 m. a. s. l. The soil of the area is characterized by Acrisol with sub surface layer of accumulated Kalonitic clay in the order Oxisol, low Cation exchange capacity, low base saturation and low pH values (Berhane and Sahlemedhin, 2003). This may be due to the high rainfall and hot climate, which result in intensive leaching. The soils are deep, well-drained and reddish brown when moist and dark red when dry (Berhane and Sahlemedhin, 2003).

The area receiving an average annual rain fall of 1800–2200 mm and annual mean temperature ranges between 15.1-27.5$^{o}$C (Tadesse and Masresha, 2007). During the experimental period the lowest amount of precipitation (42.9 mm) was in months of February, while the highest (165.3 mm) was in November which was higher than the ten years' average by 20.81 mm. The amount of precipitation in January (107.6 mm) was 39.73 mm higher than the average. Amount of precipitation was about the ten years average in December and February, but the monthly amount precipitation in October (96.1 mm) almost the half of the average. Precipitation in March (66.73 mm) was 29.34 mm lesser than the ten years' average. The average monthly temperature in February (21.09$^{o}$C) and March (19.62$^{o}$C) is higher than optimum temperature for potato tuber initiation and growth (15-19$^{o}$C) (Jimma sub-branch meteorological office, 2012).

### *Experimental Treatments, Design and Procedures:*

Potato varieties namely Jalene, Guideneand local obtained from Holleta Agricultural Research Center were used for the experiment. Jallene and Guidene potato varieties are relatively resistant and both have wide-range of environmental adaptation in Ethiopia (Geremedin*et al*., 2008).Five planting times (October 20, October 30, November 9, November 19 and November 29) in factorial combination with three varieties (Jallene, Guidene and Local) arranged in randomized complete block design with three replicates. These planting dates were chosen in such a way that the extremes enclosed the period normal in practice in the area. The experimental land was cleared and ploughed five times by oxen plough according to farmers' practice. The whole field was divided into three blocks each containing 15 plots. The size of each unit plot was 9m$^2$ (3mX3m), having intra and inter row spacing of 0.3m and 0.75m, respectively. A distance of 0.5m and 1m was maintained between unit plot and blocks, respectively. Each plot had four rows which consisted of ten hills. Seed tubers of each variety were planted by hand five times at ten days interval starting from October 20 to November 29 in furrows. Fertilizers were applied as per the general recommendation of (EARO, 2004), accordingly, 110 Kg N and 90 Kg of $P_2O_5$ ha-1. Nitrogen was applied in the form of Urea (46% N) 165 Kg/ha (split: half at planting and the rest during flowering) and $P_2O_5$ in the form of DAP (46% $P_20_5$ and 18% N) 195 Kg/ha side dressing at the time of planting (EARO, 2004). Management practices such as weeding; cultivation and ridging were practiced as per the general recommendation for potato (Gebremedhin*et al*., 2008), but no irrigation as the experiment was set for under rain-fed condition. Harvest was under taken by hand when the leaves of 50% the plants in the plot turned yellowish.

### *Data Collected and Analysis:*

To evaluate the effect of variety and planting date on tuber yield of potato; data were collected for growth parameters such as days to 50% emergence and flowering, number of stem per hill, plant height, days to physiological maturity and disease incidence, and yield parameters such as number of tubers per plant, average tuber weight, marketable tuber yield, unmarketable tuber yield, total tuber yield and harvest index from the two harvestable middle rows of each plot. The data were checked for meeting all ANOVA assumptions and subjected to Analysis of variance (ANOVA) using SAS Version 9.2 statistical software (SAS Institute, 2008). Means were compared by using least significant difference (LSD) test at 5% probability level.

## III. RESULTS AND DISCUSSION

### *Effect of planting date and variety on growth parameters and disease incidence of potato:*

The effect of both planting date and variety were found highly significant (P< 0.01) on studied parameters such as days to 50% emergence and flowering and plant height. Average stem number per hill was affected highly significant (P< 0.01) by planting date and significantly (p<0.05) by variety. The interaction effect of variety and planting date on disease incidence was highly significant (P<0.01) and significantly (P< 0.05) on days to physiological maturity.

### *Days to 50% emergence:*

The result revealed that variety Guidene took significantly longer days to 50% emergence (19.2) than Jalene and local variety which took 16.87 and 15.87 days, respectively (Table 1). This could be attributed to the genetic variation among different varieties used (Abubaker*et al*., 2011). It was observed that as planting date was delayed, the number of days from planting to 50% emergence was shortened (Table 1).Earlier planted tubers produced lesser sprouts before planting while tubers planted later had already sprouted and produced maximum number of sprouts before planting, which finally resulted in fast emergence in late plantings.In contrast, Mikitze and Knowles (1990) observed that seed-tuber age apparently had no effect on time to emergence. However, no statically significant different was observed among potato planted at first and second plantings dates and also between the late three planting dates in respect of days to 50% emergence.This might be due to nearly the same number of sprouts prior to planting.

### *Days to 50% flowering:*

Variety Guidene took longer days to 50% flowering (65.6) which was significantly longer period than local and Jalene that required 57.4 and 58.48 days to flower, respectively (Table 1). The observed variation in terms of flowering date could be attributed to intrinsic or genetic variation among varieties in completing their vegetative growth and commencing reproductive phase by mobilizing assimilates to the sink sites. In agreement with this finding, Musa *et al*. (2007) observed considerable differences with respect to the vegetation period, depending on the varieties peculiarities. Days to 50% flowering was significantly delayed by early planting of potato. Early planting of potato on October 20 delayed flowering by 15 days than November 29 planting. In general, as planting date was delayed, the number of days to flowering was significantly decreased. This early flowering is also related with days to emergence; potatoes which emerged earlier did also flower earlier than those emerged later. The physiological condition of potato seed tuber affects emergence and growth of potato crop (Wiersema, 1987).

### *Number of stems per hill:*

The highest number of stems was recorded for Jalene (3.75) on average per plant and this value was statistically not significant with stem numbers obtained from local, while the lowest was obtained from Guidene (3.49). Production of higher stem number per hill by Jalene was probably due to the greater number of sprouts observed in Jalene at planting which might have resulted from its genetic potential for sprouting capacity. Delayed planting from October 20 to November 19 increased stem number per hill from 2.88 to 4.31 (Table 1).Earlier planted tubers produced lesser sprouts before planting while tubers planted later had already sprouted and produced maximum number of sprouts before planting, which finally resulted in higher number of stems per plant at late plantings. These results are also in conformity with finding of Firman and Daniels (2011) and Khan *et al*. (2011) who obtained increased number of stem per plant in delayed plantings.

Table 1. Effect of variety and planting date on days to 50% emergence, days to 50% flowering, average stem number and plant height of potato

| Treatments | Days to 50% Emergence | Days to 50% Flowering | Average stem number/hill | Plant height (cm) |
|---|---|---|---|---|
| Varieties | | | | |
| Local | 15.87$^{b}$ | 57.4 $^{b}$ | 3.62$^{ab}$ | 65.39$^{c}$ |
| Guidene | 19.2$^{a}$ | 65.6 $^{a}$ | 3.49$^{b}$ | 77.77$^{a}$ |
| Jalene | 16.87$^{b}$ | 58.48 $^{b}$ | 3.75$^{a}$ | 69.14$^{b}$ |
| LSD (5%) | 1.3044 | 2.549 | 0.217 | 2.5384 |
| Planting dates | | | | |
| October 20 | 19.56$^{a}$ | 68.67 $^{a}$ | 2.88$^{c}$ | 75.77$^{a}$ |
| October 30 | 18.56$^{ab}$ | 65.33 $^{b}$ | 3.2$^{b}$ | 75.28$^{a}$ |
| November 9 | 16.89$^{bc}$ | 59.33 $^{c}$ | 3.47$^{b}$ | 70.63$^{b}$ |
| November 19 | 15.44$^{c}$ | 55.00 $^{d}$ | 4.31$^{a}$ | 67.09$^{c}$ |
| November 29 | 16.11$^{c}$ | 54.11 $^{d}$ | 4.24$^{a}$ | 65.09$^{c}$ |
| LSD (5%) | 1.684 | 3.291 | 0.278 | 3.277 |
| CV (%) | 10.07 | 5.63 | 8.01 | 4.79 |

Means followed by the same letter per column are not significantly different at p > 0.05

Table 2. Mean squares for potato growth parameters and disease incidence

| Source of Variation | Df | Mean Squares | | | | | |
|---|---|---|---|---|---|---|---|
| | | Days to 50% Emergence | Days to 50% Flowering | Days to maturity | Average stem number/hill | Plant height (cm) | Disease incidence (%) |
| Block | 2 | 32.09 | 8.02 | 7.22 | 0.01 | 51.81 | 23.66 |
| Variety | 2 | 43.89** | 298.15** | 1132.69** | 0.24* | 604.53** | 769.41** |
| Planting date | 4 | 26.3** | 365.59** | 485.24** | 3.64** | 205.21** | 2276.21** |
| Variety* Planting date | 8 | $0.17^{ns}$ | $8.15^{ns}$ | 33.83* | $0.07^{ns}$ | $11.49^{ns}$ | 182.96** |
| Error | 28 | 3.04 | 11.62 | 13.913 | 0.084 | 11.52 | 17.17 |
| SE± | | 1.74 | 3.41 | 3.73 | 0.29 | 3.39 | 4.14 |
| CV (%) | | 10.07 | 5.63 | 3.67 | 8.01 | 4.79 | 19.57 |

*= significant,**= highly significant, ns= non-significant, Df=degree of freedom

*Plant height:*

Recorded plant height of Guidene was higher by 12.38cm and 8.63cm than local and Jalene, respectively.On the other hand, time of planting resulted to difference in plant height. Early planting on October 20th increased plant height by 10.68cm than the last planting date. Generally, as planting delayed decreasing trend on plant height was observed (Table 1). This might be due to early stage moisture stress at late planted potatoes. Similarly, Fleisher *et al*. (2008) observed the reduction in plant height and elongation rates with water stress.Water stress during the vegetative growth stage reduces leaf area, vine and root expansion, plant height, and delays canopy development (King *et al*.,2003).

*Days to maturity:*

In the local agro-ecological condition of Anderacha, the vegetation period for potato varied from 90 to 124 days depending to varieties used and planting time. The longest days to maturity was recorded from early planted Guidene while the late planted local and Jallene matured early. The maturity is a varietal characteristic which of course can be influenced by planting date, climatic condition and adopted cultivation practices (Musa *et al*., 2007). As planting was delayed, time required to reach maturity progressively shortened in all tested varieties (Fig.1). Early maturity in this experiment was observed to be related with early emergence and flowering. Early maturity in late planted potatoes might be due to water and temperature stress at later stages of the growing season. Water stress causes early falling of leaf and senescence (Knowles and Botar, 1992; Shiri-e-Janagard *et al*., 2009).

*Disease incidence:*

The highest incidence was observed on first planted local variety (48.37%) which is statistically not significant different with second planting (45.97%) (Fig.2). The highest disease incidence on early planted local variety was probably due to the susceptibility of local variety and the prevailed conducive weather conditions for late blight development in this growing.Disease incidence depends on meteorological conditions, cultivars susceptibility to potato late blight, and growth stage of the potato during disease attack (Razukas*et al*., 2008).Disease incidence was also significantly lower in all planting dates for late maturing variety (Guidene) than Jalene (early maturing). In contrary, Jalene showed early luxuriant vegetative growth following its early emergence which caused early ground cover than late matured Guidene, as the canopy formed across rows creates a humid microclimate which promotes the spread of disease.This is because of the fact that potato blight development intensity in various potato cultivars depends on their maturity group, genetic and biologic features (Razukas*et al*., 2008).

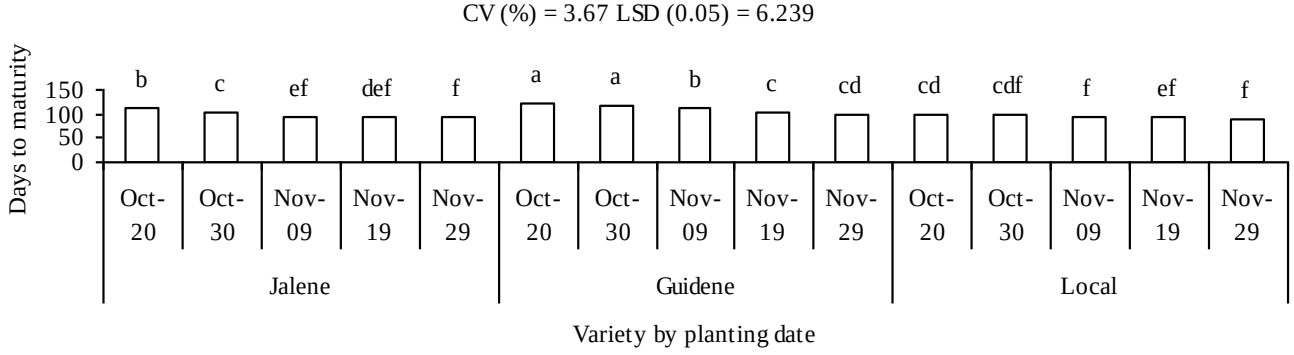


Fig.1. Days to maturity as influenced by the interaction effect of variety and planting. Means followed by the same letter are not significantly different at p<0.05.

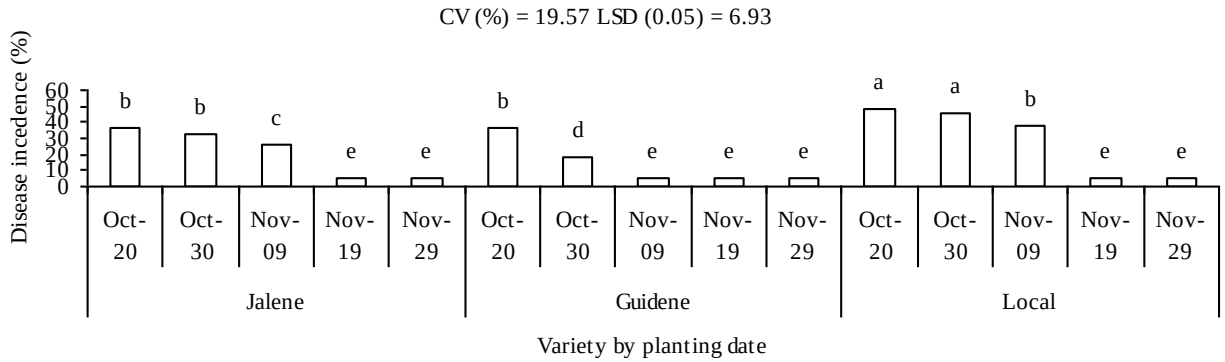


Fig.2. Late blight incidence as influenced by the interaction effect of variety and planting date.Means followed by the same letter are not significantly different at p<0.05

*Effect of planting date and variety on yield parameters:*

The effect of both variety and planting were found highly significant (P< 0.01) for unmarketable tuber yield and average tuber weight of potato. The effect of variety on total tuber number per hill was highly significant(P<0.01) and planting dates influenced this parameter significantly (P<0.05). The interaction effects of variety and planting date was highly significantly (P< 0.01) on marketable and total tuber yield and significantly (P<0.05) influenced harvest index of potato.

*Total number of tubers:*

Jalene was superior in tuber number per plant (8.09) followed by local variety with 7.96 tubers per plant; while Guidene produced the lower number of tubers per plant (6.92) (Table 3). The apparent variation could be due to the difference in genetic potential among potato varieties. The potential tuber number that can be successfully produced by a plant varies with the genotype (Mihovilovich*et al*., 2009). On the other hand, second planting increased total tuber number by 8.04% from first and 14.21% from the last planting date. Probably because of optimal environmental condition like temperature and rain fall for plant growth during the first few weeks of crop development reflected in good tuber count. Even though the environmental condition was favourable, potato planted at first planting date produced lower tuber number than the second planted and this might be related with the limited number of stem at first planting. The number of stems per plant generally increased with delay in planting so that stem populations were greater at later plantings. However, this did not account for differences in the number of tubers; it rather resulted in decreased tuber number in late plantings. Decrease in tuber number in late plantings probably because of moisture and temperature stress starting late December which corresponding to the stages of growth of tuber initiation and bulking.Firman and Daniels (2011) and Khan *et al*. (2011) observed the same phenomenon.

*Average tuber weight:*

Irrespective of the planting dates, Jalene produced the heaviest tuber weight (82.89g) followed by Guidene (77.89g) compared to local variety (64.34g) which had significantly the lowest average tuber weight among all the varieties (Table 3). Using improved variety Jalene increased average tuber weight by 29.12% as compared to the local variety. The variation may be attributed to the inherent genetic variation on tuber bulking among potato varieties. Regarding planting date the two early plantings resulted to production of heaver tubers.

Table 3: Effects of variety and planting date on total tuber number /hill, unmarketable tuber yield and average tuber weight of potato

| Treatments | Total tuber number (count/hill) | Unmarketable tuber yield (ton/ha) | Average tuber weight (g) |
|---|---|---|---|
| varieties | | | |
| Local | 7.96$^{a}$ | 6.02$^{a}$ | 64.34$^{b}$ |
| Guidene | 6.92$^{b}$ | 3.35$^{c}$ | 77.89$^{a}$ |
| Jalene | 8.09$^{a}$ | 4.15$^{b}$ | 82.89$^{a}$ |
| LSD (5%) | 0.44 | 0.59 | 5.02 |
| Planting dates | | | |
| October20 | 7.59$^{b}$ | 3.66$^{d}$ | 83.80$^{a}$ |
| October 30 | 8.20$^{a}$ | 3.89$^{cd}$ | 80.35$^{ab}$ |
| November 9 | 7.58 $^{b}$ | 4.57$^{bc}$ | 74.63$^{bc}$ |
| November 19 | 7.43 $^{b}$ | 5.03$^{ab}$ | 70.28$^{cd}$ |
| November 29 | 7.18 $^{b}$ | 5.39$^{a}$ | 66.11$^{d}$ |
| LSD (5%) | 0.57 | 0.76 | 6.48 |
| CV (%) | 7.78 | 17.58 | 8.95 |

Means followed by the same letter per column are not significantly different at p <0.05

Early planting on October 20 increased average tuber weight by 26.76% than the last planting (November 29). The achievement of producing the heaviest tubers in the first two earlier plantings might be due to the favourable soil moisture and temperature for tuber growth with early planting than late planting under rain-fed ecosystem. Production of lower number of tubers/hill with low average tuber weight in late plantings in present study could be attributed to water and temperature stress prevailed at tuber initiation up to bulking stages of potato planted in delayed plantings. After initiation, either the weight and volume of the tubers increase almost linearly, but either water or temperature stress interrupt this process (King *et al.*,2003). Water and temperature stress during tuber initiation and bulking growth stages have also been shown to decrease the number of tubers set per plant and average tuber weight or size (Levy and Veilleux, 2007; Modisane, 2007).

*Unmarketable tuber yield:*

Guidene and Jalene produced reduced unmarketable tuber yield by 44.35% and 31.06 %, respectively as compared to local variety. Variation among genotypes respects of nonmarketable yield could be attributed to their genetic makeup which influenced tuber size. The observed maximum yield of small size tubers (unmarketable) might be due to presence of more number of tubers as well as varietal character and adaptability or establishment effect of other growth attributes (Kumar *et al*., 2007). Moreover, higher number of malformed tubers and pre-harvest sprouting on tubers was observed in late plantings resulted to higher unmarketable tuber yield in late planting. When high temperature stress is combined with drought stress under field conditions, tuber malformation and tuber sprouting are aggravated (Levy, 1986; Levy and Veilleux, 2007).

Table 4: Mean squares for potato yield parameters

| Source of Variation | Df | Mean Squares | | | | | |
|---|---|---|---|---|---|---|---|
| | | Total tuber number (Count/hill) | Marketable tuber yield (ton/ha) | Unmarketable tuber yield (ton/ha) | Total tuber yield (ton/ha) | Average tuber weight (g) | Harvest index |
| Block | 2 | 2.19 | 20.95 | 0.02 | 9.74 | 188.65 | 0.004 |
| Variety | 2 | 5.43** | 332** | 28.23** | 240.94** | 1380.89** | 0.028** |
| Planting date | 4 | 1.29* | 153.40** | 4.86** | 107.57** | 467.05** | 0.014* |
| Variety* Planting date | 8 | 0.49$^{ns}$ | 17.59** | 0.27ns | 18.68** | 68.23$^{ns}$ | 0.011* |
| Error | 28 | 0.35 | 4.58 | 0.63 | 1.60 | 45.08 | 0.003445 |
| SE± | | 0.59 | 2.14 | 0.79 | 1.26 | 6.71 | 0.058694 |
| CV (%) | | 7.78 | 10.29 | 17.58 | 5.00 | 8.95 | 7.87 |

*= significant,**= highly significant, ns= nonsignificant, Df=degree of freedom

*Marketable tuber yield:*

The highest marketable tuber yield (34.82 ton/ha) was produced by planting the potato variety Jalene on October 30, while the lowest (12.69 ton/ha) was obtained from late planted (November 29) Guidene and local (Fig. 3). The variation might be attributed to different effect of genetically variation among potato varieties and environmental factor on tuber bulking. The duration and rate of tuber bulking vary among varieties and depend on environmental conditions (Levy and Veilleux, 2007). Tubers planted at earlier dates received more time of optimum moisture and temperatures than the late plantings, which resulted in higher marketable tuber yield. The phenomenon is well supported by Yenagi*et al*. (2004) and Khan *et al*. (2011) who recorded reduced marketable yield with delay in planting due to unfavourable climatic condition for tuber growth. In the present study early plantings provided maximum period of optimal temperature and rainfall for crop development which resulted in excellent foliage growth and longer maturation time with improved photosynthesis which ultimately helped increasing the size of tubers.

*Total tuber yield:*

The observed higher incidence of late blight on early planted potato was not attributed to clear yield reduction, might be due to occurrence of the disease incidence at a later growth stage and dried up of the initial infection.In particulars, Jalene was the highest yielding (38.6 ton/ha) cultivar but only in the earlier plantings.The higher total yield in early planted Jalene might be due to favorable climatic condition and the ability of the variety to produce faster and early top growth followed by formation of large sized and higher number of tubers per plant. Jaleneplanted at earlier dates showed high number of stems and tubers per plant, and highest average tuber weight and consequently the highest total yield. It is in agreement with Mehdi *et al*. (2008) finding who concluded the increase in yield was mainly on account of higher number of tubers/plant and tuber size. Moreover, potato planted at earlier dates received more time of optimum moisture and temperatures than the late planting, which resulted in longer crop cycle consequently resulted to longer tuber bulking period resulting to higher tuber yield. Water stress usually causes early senescence of leaves there by shorting the growing season, resulting in lower tuber yield (Shiri-e-Janagard *et al*., 2009).

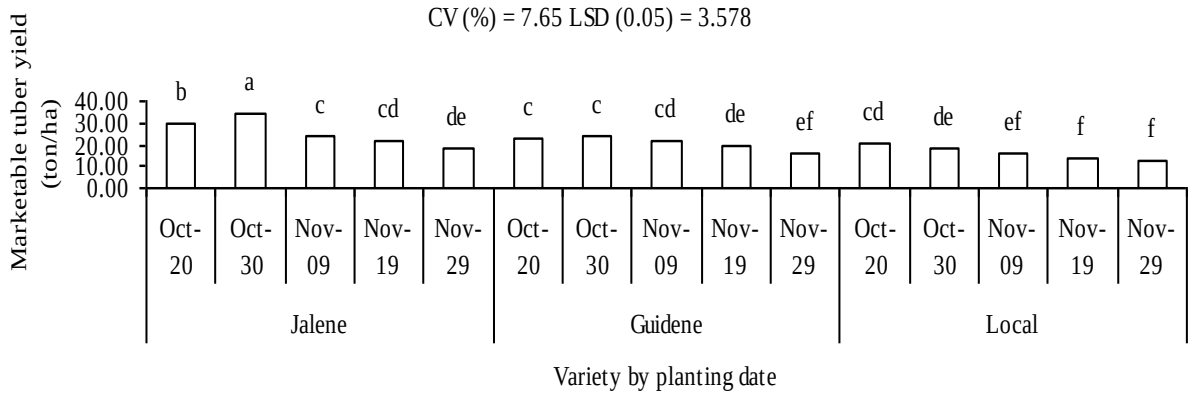


Fig.3. Marketable tuber yield as influenced by the interaction effect of variety and planting date. Means followed by the same letter are not significantly different at $p<0.05$

*Harvest index:*

The maximum harvest index (0.84) was observed by planting Jalene on October 30 while the lowest harvest index (0.58) was obtained by planting local variety on November 29th (Fig 5). In the present study, treatments which produced the higher yield had also produced the maximum harvest index. As Levy and Veilleux (2007) described tuber bulking restricts shoot and root growth, acting as an alternative and strong sink for plant resources. In delayed plantings potato varieties showed lower harvest index probable due to increased temperature in late planting resulted to excessive top growth than tuber bulking. Numerous research reports shown that temperature stress accelerate haulm growth and assimilates partitioned more towards the haulm which retard tuberization (Hijmans, 2003; Levy and Veilleux, 2007 and Modisane, 2007).

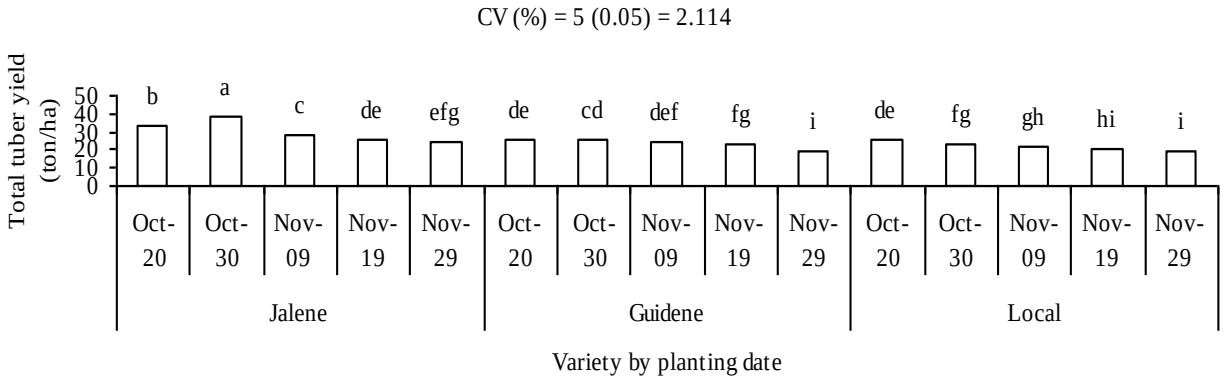


Fig.4. Total tuber yield as influenced by the interaction effect of variety and planting date. Means followed by the same letter are not significantly different at $p<0.05$.

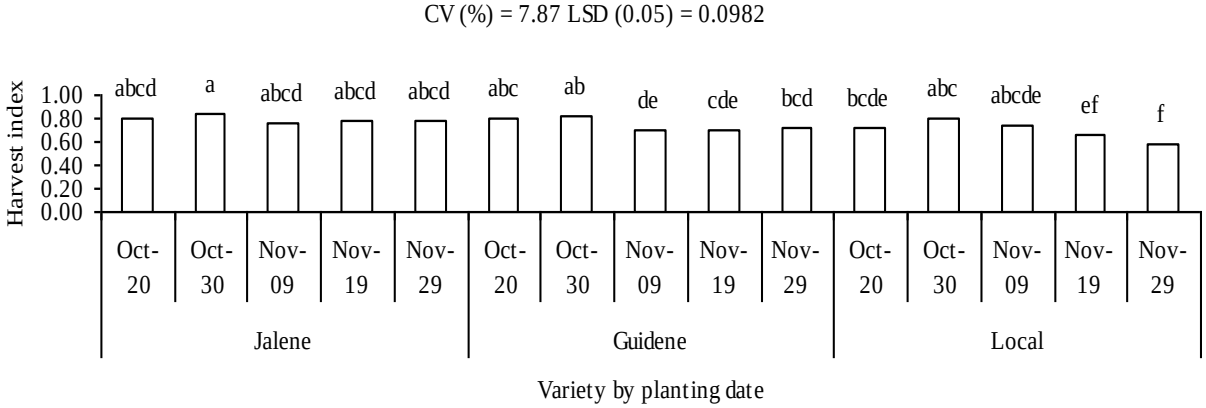


Fig.5. Harvest index as influenced by the interaction effect of variety and planting date.Means followed by the same letter are not significantly different at $p<0.05$.

## IV. CONCLUSION

The result of the study revealed that all of the parameters considered were significantly affected by the treatments or their interaction effects.Guidene took significantly longer days to emerge and flower, while Jalene produced the highest stem number than other varieties used. Similarly, date of planting significantly affected days to 50% emergence, days to 50% flowering, plant height and stem number per plant. Planting potato at earlier dates resulted to delayed emergence and flowering and maximum plant height. The longest days to maturity was recorded from early planted (October 20 and 30) Guidene while the late planted (November 29) local and Jallene matured early (90 days). Plant height shown decreasing trend for delayed planting, while early planting on October 20 increased plant height by 10.68cm than the last planting date. The number of stems per plant generally increased with delay in planting. However, this did not account for differences in the number of tubers; moreover decreased tuber number was observed in late plantings. The combined effect of planting date and variety showed a significant variation on marketable tuber yield, total tuber yield and harvest index. The highest value of marketable and total tuber yield (34.82 and 38.6 ton/ha, respectively) were recorded from Jalene planted on October 30$^{th}$. In the present study treatments which produced the higher yield had also produced the maximum harvest index. Jalene was superior in its tuber number per plant and also produced the heaviest tuber weight. Using improved variety Jalene resulted in increased average tuber weight by 29.12% as compared to the Local variety. On other hand, Guidene and Jalene showed reduced unmarketable tuber yield by 44.35 and 31.06 %, respectively compared to local variety. With regard to planting time, unmarketable tuber yield from plots planted on October 20 was lower by 32.1% than obtained from plots planted on November 29. In conclusion, the two earlier plantings and variety Jalene showed superior performance in most studied growth and yield parameters. Therefore, according to the current study, early planting (October 20 up to 30) and Jalene variety can be used for optimum growth and higher marketable tuber yield of potato at Aderacha area.

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