ORIGINAL ARTICLE

Effect of curing period and time of planting on growth and yield responses of pineapple (*Ananas comosus)* at Gojeb, Southwest Ethiopia

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ABSTRACT

Pineapple is a potential crop in Ethiopia that ensures food and nutrition security. However, the average fruit yield of the crop is nearly one-third of the global average of 63 t/ha, which is partly attributed to a lack of appropriate or optimal pineapple production technologies, such as the curing of planting materials and planting time. This study aimed to assess the effects of the curing period and planting time on the growth and yield of pineapple at Gojeb, Southwest Ethiopia. Planting materials (slips) of improved variety of pineapple (Smooth Cayenne) were cured for different weeks: control (CW0), one week (CW1), two weeks (CW2), three weeks (CW3), and four weeks (CW4) and planted at three different times: end of March (P1), end of April (P2) and end of May (P3). The experiment was laid out as a 3x5 factorial arranged in a Randomized Complete Block Design (RCBD) with three replications for two growing seasons. Data on yield and related traits were collected and analyzed. The study revealed that the time of planting and curing periods had significant effects ($P<0.05$) on fruit length and diameter, plant height, and fruit fresh weight. The interaction effects of planting time and curing periods also significantly affected fruit length and diameter, while the curing period affected all traits considered in this study. Time of planting also significantly ($P<0.01$) affected the plant height. Two weeks curing period (CW2) of pineapple slips produced a higher fresh fruit yield than cured for a more extended period. Curing the planting materials for two weeks and earlier planting of pineapples in March and April produced a higher fruit yield. Therefore, pineapple growers in the study area can achieve the highest fruit length, diameter, and fresh fruit yield by implementing two weeks of curing and early *Belg* season (March and April) planting.

Keywords: Cuttings, fruit yield, healing, slips, traits.

INTRODUCTION

Pineapple (*Ananas comosus* (L.) Merr) is a perennial herb that belongs to the botanical family *Bromeliaceae* (Bartholomew *et al*., 2002). It is native to South America, where the original seed species (wild) are still found (Tewodros *et al.,* 2018). Pineapple is usually eaten fresh or processed into fruit juices and canned slices and ranks third after banana and citrus (Animola *et al*., 2021). Worldwide, the total pineapple production was estimated at 28.18 million metric tons in 2019 (Andreea-Roxana *et al*., 2021), and it ranks third after banana and citrus (Animola *et al*., 2021). It is consumed fresh or processed into juice and canned slices. It is a vital source of sugars, essential minerals, organic acids, vitamins, antioxidants, and dietary fiber (Assumi *et al*., 2021). Additionally, pineapple is a good source of fiber which is used for the manufacture of high-value garments, the production of fine and flexible sheets of paper, and used for ornamental purposes (Spironello *et al*., 2004).

Pineapple is a potential crop in Ethiopia to ensure food and nutrition security (Wondifraw *et al*., 2008; Tewodros *et al.,* 2018). It successfully grows in the South, Southwestern, and Western parts of the country at small-scale farming, and the average yield of the crop is low, about 22.54 t/ha (CSA, 2018), as compared to the global average fruit yield of 63 t/ha (Angeles *et al*., 1990; Adimar *et al.,* 2004). Lack of improved pineapple technologies adapted for diverse environmental conditions, low multiplication rate, low access to multiply planting material through tissue culture, and low fertility status of the soil are significant factors that contribute to low yield (Spironello *et al*., 2004; Orluchukwa and Adedokun, 2015). Additional factors include longer maturity, poor agronomic practices, the presence of diseases and insect pests, and a lack of improved post-harvest handling technologies (Tewodros *et al*., 2014).

Pineapple is propagated mainly by using vegetative propagules like crowns, slips, or suckers (Delali, 1995; Pineapple Technical Group, 1999; Bartholomew *et al*., 2002; Orluchukwa and Adedokun, 2015). Fruit yield and quality, time taken for bearing, and fruit size vary with the type of planting material used (Tewodros *et al*., 2014). Most of the world's production (about 70%), and most of the canned pineapple (about 95%), comes from the variety 'Smooth Cayenne' (CABI, 2003). Smooth Cayenne is the principal variety grown commercially in Ethiopia, and slips are the most preferred propagules, especially for commercial production (Wondifraw *et al*., 2008). Slips are relatively abundantly produced and are more uniform than other propagule types of pineapple. Before planting, all types of planting materials are cured in the sun or partial shade for one to several weeks after being separated from the mother plant and after stripping off the lower leaves (Tewodros *et al*., 2014). Curing allows a callus layer to develop over the cut surface, reducing losses from decay organisms after they are planted (Omotoso and Kinrinde, 2013).

Pineapple planting is done during the start of rainy months on non-irrigated land (Wondifraw *et al*., 2008; Tewodros *et al*., 2014). Where irrigation is available, planting can be done at any time of the year. Pineapple production at Gojeb farm (study site) and its vicinity is grown predominantly under rain-fed. The Gojeb area receives an average rainfall of 1430mm annually (Tewodros *et al*., 2019). The rainfall pattern in the area is bimodal, wherein *Belg* rain occurs during the March-May months, while the main rainy season is spread between June and September. Though the curing period and planting time are the major factors that affect the growth and yield of pineapple in Southwest Ethiopia (Wondifraw *et al*., 2008; Tewodros *et al*., 2014); however, no research has been conducted in the study area to address these aspects so far. Therefore, this study was initiated to determine the effects of the curing period and planting time on the growth and yield of pineapple.

MATERIALS AND METHODS

Study site and plant materials

The experiment was conducted at Gojeb farm in Southwest Ethiopia. The farm is located at latitude 7°42.36' N, longitude 36°51'66' E, and an altitude of 1553 meters above sea level. The area receives a mean annual rainfall of 1430 mm, which is spread from March to May (*Belg* season), and between June and September (main rainy season), with mean maximum and minimum temperatures of 25.4°C and 10.6°C, respectively. The study site is characterized by sandy loam soil with a pH of 6.5 (Tewodros *et al.,* 2019). Slips (shoots emerging at the base of the fruit on the fruit stalk) of an improved pineapple variety (*Smooth Cayenne*) were used for the study.

Experimental design and field establishment

The experiment was laid out as a 3x5 factorial, arranged in a randomized complete block design with three replications. Each treatment was assigned to one plot in each replication. The gross plot size of each treatment was 3 m×4.5 m. Slips of the same size were used as planting material and were cured for one (CW1), two (CW2), three (CW3), and four (CW4) weeks. Non-cured slips were also included as a control (CW0). Plantings were done at three different planting dates during the *Belg* rainy season (End of March, P1; End of April, P2; and End of May, P3). The slips were planted in a double row spacing of 90 x 60 x 30 cm, i.e., 90 cm between beds (double rows), 60 cm between rows, and 30 cm in the rows. All other recommended agronomic practices were applied according to the recommendations. Ten middle plants were tagged and sampled for data collection and final harvest.

Data collection

Data were collected from ten plants from each plot 18 months after planting, and the average values were used

for data analysis. The response variables (traits) that are considered for data collection were plant height (cm), fruit length (cm), fruit diameter (cm), and fruit weight with a crown (kg).

Data analysis

Data sets for two seasons were averaged and analyzed together as they were tested for homogeneity individually using the Fmax test. Analysis of variance was performed using SAS software (version 9.0 of SAS Institute, 1999). Treatment means were separated

using the Fisher's least significant difference (LSD) test at 1% and 5% probability levels.

RESULTS AND DISCUSSION

Variation of traits in response to curing period and time of planting

The time of planting and curing periods had significant effects on most pineapple traits assessed (Table 1). The traits that were significantly affected by the time of planting were plant height ($P < 0.01$), fruit length, and fruit diameter ($P < 0.05$), whereas the traits significantly affected by the curing period were plant height (cm) ($P < 0.01$), fruit length (cm) ($P < 0.01$), fruit diameter ($P < 0.01$), and fruit weight with a crown ($P < 0.05$).

Table 1. Analysis of variance of curing period and time of plant on yield and yield-related traits of pineapple grown at Gojeb farm for two seasons

Sources of variation	DF	PH	FL	FDi	FWt
Time of planting (TP)	2	1347.9**	8.08*	8.05*	1.048
Curing period (CP)	4	1142.8**	11.90**	8.57**	1.106*
TP x CP	8	169.02	10.61**	6.50*	1.042
Error	72	84.13	1.67	4.76	0.071
Total	86				
CV (5%)		24.71	6.94	5.50	19.16

** and ** indicate significance at 0.05 and 0.01% of the probability level, respectively. PH = Plant height (cm), FL =Fruit length (cm), FDi = Fruit diameter (cm), Fwt = Fruit fresh weight with crown (Kg)*

The significant differences considered in all the traits of pineapple planted at a different planting times and curing periods indicated that the performances of these traits were influenced by the time of planting and curing period and could therefore be optimized by exploiting these two factors (Wondifraw *et al.,* 2008). Of all the traits considered, fruit length and diameter were significantly influenced by the interaction of the curing period and time of planting. This interaction indicated the importance of the combined effect of the curing period and time of planting in determining pineapple fruit length and diameter. Consistent with the present study, Bartholomew *et al*. (2002) explained that stripping off the scale leaves from the basal portions of the planting materials (2-5cm) and curing them facilitate better rooting and also minimize mealybug (wilt-causing pest) infestation, especially in conventional pineapple production. The authors further stated that if fresh slips are planted in more moisture-containing soil (as in peak rainy season), they may begin to decay; curing, therefore, plays an important role in avoiding heart rot disease (decay) after planting, which usually occurs by planting fresh (uncured) pineapple planting material and planting during the periods of heavy rainfall. In the present study, curing of slips of pineapple and planting of the slips during the light rainy season (*Belg* season) might have facilitated better establishment and growth of the crop, resulting in an improved yield of the pineapple fruit, which is expressed as a better length and diameter of the fruit.

Performance of pineapple in response to time of planting

The mean performance results for the traits assessed revealed that the time of planting influenced crop yield individually and its performance collectively (Table 2). For example, early planting (end of March) produced the highest fruit diameter and plant height. In contrast, pineapple planting at the end of April produced the highest pineapple fruit yield per plant and the longest fruit. The highest fruit yield per plant and longest fruit produced at the end of April were due to the highest amounts of rainfall received in the area, contributing to better field establishment and further crop growth.

Planting of pineapple propagules, such as slips during the periods of peak rainy season, may cause decay (heart rot disease) (Bartholomew *et al*., 2002; CABI, 2003; Prakash *et al.,* 2008), which in turn affects field establishment, further growth, and productivity of the crop. In the present study, planting of the slips during the light rainy season (*Belg* season) has facilitated better establishment and growth of the crop and, in turn, resulted in improved fruit yield.

Table 2. Mean performance of pineapple for yield and related traits evaluated by three different planting times

Traits	Time of planting				
	End of March (P1)	End of April (P2)	End of May(P3)	**Mean**	LSD $_{0.05}$
Plant height (cm)	39.88^{a}	35.71^{a}	35.71^{a}	37.10	4.71
Fruit length (cm)	18.71^{a}	18.77^{a}	18.41^{a}	18.63	0.66
Fruit diameter (cm)	40.03^{a}	39.47^{a}	39.34^{a}	39.61	1.12
Fruit weight with a crown (kg)	1.35^{a}	1.43^{a}	1.40^{a}	1.39	0.13

$LSD_{0.05}$ = least significant difference at 5%; Means with the same letter are statistically non-significant

Performance of pineapple in response to curing period

Although most of the traits considered in this study, except fruit diameter, were significantly affected by the five curing periods used, slight visual differences for those traits were noted (Table 3). Pineapple material cured for two weeks (CW2) resulted in a higher fresh fruit yield than one week curing period (CW1). Two weeks curing period provided more favorable growth for the pineapple crop. Bartholomew *et al*. (2002) and Prakash *et al.* (2008) explained that stripping off the scale leaves from the basal portions of the planting materials and curing them for two weeks facilitated better rooting. This exposure to direct solar radiation (curing) also helps to reduce the population of mealybugs (*Dysmicoccus brevipes*). This is a very important global pineapple pest that transmits viruses, causing wilting of the plants (Haroldo *et al*., 2018) and, in turn, causing yield reduction. The authors further stated the contribution of curing in avoiding heart rot disease (decay) during field establishment and leading to better growth of the pineapple crop. In the present study, the curing of slips of pineapple has facilitated better establishment and growth of the crop and, in turn, resulted in an improved yield of the pineapple fruit. Therefore, pineapple growers in the study area can use two weeks curing period of pineapple planting material to obtain a high fruit yield.

Table 3. Performance of pineapple for yield and related traits evaluated across two phases and curing period as influenced by three different curing periods

Traits	Curing period						
	CW0	CW1	CW2	CW3	CW4	**Mean**	LSD $_{0.05}$
Plant height (cm)	38.92^{a}	36.87^{ab}	32.29^{ab}	38.48^{a}	51.13^{a}	39.54	6.09
Fruit length (cm)	18.59^{ab}	18.53^{ab}	19.15^{a}	18.63^{ab}	18.25^{b}	18.63	0.86
Fruit diameter (cm)	39.88^{a}	39.52^{a}	40.32^{a}	39.31^{a}	39.02^{a}	39.61	1.45
Fruit weight with a crown (Kg)	1.47^{ab}	1.37^{ab}	1.48^{a}	1.30^{b}	1.35^{ab}	1.39	0.17

$LSD_{0.05}$ = least significant difference at 5%. The values with different superscript letters in a row are significantly different ($p<0.05$), and means with the same letter are statistically non-significant

Performance of pineapple in response to the interaction of time of planting and curing period

Fruit length and diameter were the traits of pineapple, which were significantly affected by the time of planting × curing period interaction. The longest and widest fruit of 19.71 cm and 40.8 cm was obtained in March and April with two weeks of curing pineapple material (Table 4 and Table 5). This revealed that planting pineapple in March and April with two weeks of curing period resulted in the longest and widest fruits (Table 4 and Table 5). Therefore, growers should plant pineapples in March and April with two weeks curing period for better fruit length and diameter. Moreover, as shown in Table 3, two weeks of curing pineapple materials resulted in a higher fruit yield. Hence, early planting in April and two weeks curing period could enhance pineapple fruit yield. Though not significant, fresh fruit weight in the present study was higher where pineapple was planted in a combination of early planting and two weeks curing periods than where pineapple was planted in a combination of late planting and longer curing period.

Bartholomew *et al*. (2002) explained that stripping off the scale leaves from the basal portions of the planting materials and curing them facilitate better rooting and minimize mealy bug (wilt-causing pest) infestation, especially in conventional pineapple production. The authors further stated that if fresh slips are planted in more moisture-containing soil (as in the peak rainy season), they may begin to decay; curing, therefore, plays an important role in avoiding heart rot disease (decay), which usually occurs by planting fresh (uncured) pineapple planting material and planting during the periods of heavy rainfall period. In the present study, curing pineapple slips and planting of the slips during the light rainy season (*Belg* season) might have facilitated better establishment and growth of the crop, and in turn, resulting in an improved yield of the pineapple fruit (expressed in a better length and diameter of the fruit).

Table 4. Performance of pineapple for fruit length as it is influenced by the interaction of time of planting and curing period across the two phases

Time of planting	Curing period					
	CW0	CW1	CW2	CW3	CW4	Mean
End of March	19.29^{ab}	18.29^{abc}	19.71^{a}	18.63^{abc}	17.63^{bc}	18.71
End of April	18.45^{abc}	18.77^{abc}	19.37^{ab}	18.75^{abc}	18.50^{abc}	18.77
End of May	18.05^{bc}	18.52^{abc}	18.37^{abc}	18.51^{abc}	18.63^{abc}	18.41
$LSD_{0.05}$ planting time mean						0.67
$LSD_{0.05}$ curing period mean						0.86
$LSD_{0.05}$ planting time x curing period mean						1.60

$LSD_{0.05}$ = least significant difference at 5%; CW= Curing periods; The values with different superscript letters in a row are significantly different ($p<0.05$).

Table 5. Performance of pineapple for fruit diameter as it is influenced by the interaction of time of planting and curing period across the two phases

Time of planting	Curing period					
	CW0	CW1	CW2	CW3	CW4	Mean
End of March	39.44^{abc}	39.25^{abc}	40.44^{ab}	39.68^{abc}	37.88^{c}	39.34
End of April	39.87^{abc}	39.16^{abc}	40.8^{a}	38.08^{bc}	39.43^{abc}	39.47
End of May	40.35^{abc}	40.16^{abc}	39.71^{abc}	40.16^{abc}	39.77^{abc}	40.03
$LSD_{0.05}$ planting time mean						1.11
$LSD_{0.05}$ curing period mean						1.44
$LSD_{0.05}$ planting time x curing period mean						2.50

$LSD_{0.05}$ = least significant difference at 5%. The values with different superscript letters in a row are significantly different ($p<0.05$).

Correlation among the agronomic practices, yield, and yield-related traits of pineapple

The correlation results obtained for planting time and curing periods concerning pineapple traits assessed (Table 6) agreed with all the results explained in the sections above. The positive and significant correlation between time of planting and fruit diameter indicated that early planting of pineapple results in wider fruit, thus enhancing fruit yield of pineapple. The positive and significant correlation between curing periods and plant height indicated increasing the time of curing increases the size of individual plants, as shown in Table 3. This increment may be attributed to the curing of base planting material gives suberization (healing of the cut portion) (Bartholomew *et al*., 2002), which in turn gives better rooting. A plant with a better root system will give better growth for the plant. The number of roots produced after planting pineapple propagule is positively correlated with shoot weight and crop yield (CABI, 2003). On the other hand, the negative and significant correlation between the curing period and fruit length indicated that increasing the curing period decreases the length of individual fruits. This exposure of the planting material to direct solar radiation for an extended period might have casued poor growth performance, which in turn resulted in decreased fruit length.

Table 6. Correlations among yield and yield-related traits of pineapple averaged across three different times of planting and five curing periods.

Traits	Tim	Cur per	PH	FL	FDi	FFw
Tim	**1.00**	0.001**	-0.109	-0.087	0.003**	0.0702
Curper		**1.00**	0.0147*	-0.006**	-0.128	-0.160
PH			**1.00**	-0.230*	-0.033	-0.231*
FL				**1.00**	0.465**	0.433**
FDi					**1.00**	0.428**
FFw						**1.00**

** and** significant at 0.05 and 0.01 probability levels, respectively. Tim= Time of plant; Curper= Curing periods; PH = Plant height (cm), FL =Fruit length (cm), FDi = Fruit diameter(cm), Fwt = Fruit fresh weight with crown (Kg)*

CONCLUSIONS

The time of planting and curing period played a significant role in determining the overall performance of pineapple fruit. Slips of pineapple cured for two weeks increased the length and diameter of individual pineapple fruits than those cured for a more extended period, whereas stretched curing reduced the height of the pineapple plant. This result indicates that the time of curing influenced the plant heght.. Therefore, planting pineapples in March and April can be recommended to achieve the highest fruit length and diameter at Gojeb farm and its vicinity for the *Belg* season. Two weeks curing period (CW-2) of pineapple material produced a higher fresh fruit yield of pineapple than those cured for more extended periods. Time of planting and curing periods are fundamental agronomic practices used simultaneously in pineapple cultivation and therefore need to be carefully utilized to optimize pineapple fruit yield. Pineapple plant propagules such as slips need to be cured/ dried (suberized/healed) to produce roots. Planting time (early *Belg* season), especially in rain-fed pineapple production, is critical because propagules planted during the main rainy season are often subject to root decay.

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REFERENCES

Adimar S., Jose A.Q., Teixelra L.A. and Sigrist J.M.M. 2004. Pineapple yield and fruit quality affected by NPK fertilization in tropics. *Soil Science*, 38:263-274.

Ajayi. A.J.,, Agele, S. O., and Aiyelari, O. P. 2016. Growth, Yield, and Yield Components of Pineapple in a Pineapple-Pepper-Cowpea Intercropping System. *International Journal of Horticulture*. https://doi.org/10.5376/ijh.2016.06.0001

Angeles, D. E., Sumner, M. E., & Barbour, N. W. 1990. Preliminary nitrogen, phosphorus, and potassium DRIS norms for pineapple. *HortScience*, 25(6): 652-655.

Bartholomew D.P., Rohrbach, K.G. and Evans, D.O. 2002. Pineapple Cultivation in Hawaii, Cooperative Extension Service, College of Tropical Agriculture and Human Resources, University of Hawaii. https://www.ctahr.hawaii.edu/oc/freepubs/pdf/f_n-7.pdf

Bartholomew, D. P., Hawkins, R. A., and Lopez, J. 2012. Hawaii Pineapple: The Rise and Fall of an Industry. *HortScience Horts*, *47*(10): 1390–1398. https://doi.org/10.21273/HORTSCI.47.10.1390

Batamoussi, M. H., Xavier, B. S. F., Tokore, J. S. B. O. M., and Tovihoudji, P. G. 2015. Contribution to the improvement of the farming practices of production of pineapple in Benin: Case of the municipality of Alada in the department of the Atlantic. *European Scientific Journal*, *11*(36).

CAB International 2003. The Pineapple Botany, Production and Uses, Edited by D.P. Bartholomew R.E. Paull and K.G. Rohrbach, CABI Publishing, UK and USA.

CSA (Central Statistics Agency), 2018. The Federal Democratic Republic of Ethiopia. Agricultural Sample Survey. Report on Area and Production of Major Crops for Meher Season. 2017/18 (2010 E.C). Statistical Bulletin No 586. Addis Ababa, Ethiopia

Delali N. 1995. Influence of nitrogen and potassium fertilizer ratio on yield and quality of pineapple (*Ananas comosus* MERR L Var. *Smooth Cayenne*) in the southern forest-Savana ecotone of Ghana. MSc thesis presented at University of Ghana, pp.110.

FAO. 2014. Guidelines for on-farm plant nutrition and soil management trials and demonstrations. Rome, Italy.

FAO. 2013. Food and Agriculture Organization, Roma, Italy. www.fao.org

Haroldo D. R. C. Reinhardt Duane P. Bartholomew Fernanda Vidigal Duarte Souza Ana Cristina Portugal Pinto de Carvalho Tullio Raphael Pereira de Pádua Davi Theodoro Junghans Aristoteles Pires de Matos, 2018. Advances in pineapple plant propagation, Revisão • Rev. Bras. Frutic. 40 (6) https://doi.org/10.1590/0100-29452018302

Hossain MF. 2016. World pineapple production: an overview. Retrieved November 9, 2020, from https://www.ajol.info/index.php/ajfand/article/view/149223

Omotoso O.S. and Kinrinde E.A. 2013. Effect of nitrogen fertilizer on some growth, yield, and fruit quality parameters in pineapple [*Annanascomosus* (L.) Merr.] Plant at Ado-Ekiti Southwestern, Nigeria.*International Research Journal of Agricultural Sciences and Soil Science*. 3(1): 11-16.

Orluchukwa J. and Adedokun O.M. 2015. Response of growth and yield of pineapple (*Ananas comosus*) on Spent Mushroom substrates and inorganic fertilizer in South Nigeria. *International Journal of Plant and Soil*, 8(6): 1-5.

Prakash, Jai, Sankaran, M. and Singh N.P. 2008. Year Round Production of Pineapple in Tripura: A

Technology Bulletin for Tripura. ICAR, Research Complex for NEH region, Tripura Centre, Lembucherra, India, 34 p.

Reinhardt, D. H. R. C., Bartholomew, D. P., Souza, F. V. D., de Carvalho, A. C. P. P., de Pádua, T. R. P., Junghans, D. T., and de Matos, A. P. 2018. Advances in pineapple plant propagation. *Revista Brasileira de Fruticultura*. Sociedade Brasileira de Fruticultura. https://doi.org/10.1590/0100-29452018302

SAS Institute. 1999. SAS/STAT user's guide version 8(2) Cary, NC: SAS Institute Inc.

Spironello A., Quaggio J.A. Teixeira L.A.J, Furlani P.R. and Sigrist J.M.M. 2004. Pineapple yield and quality affected by NPK fertilization in a tropical soil. *Revista Baraosileira Jabticabal*, 26(1):155-159.

Tewodros M., Getachew E, Neim S, Getachew W. and Mesfin S. 2019. Determination of Inorganic N and P Fertilizers on Fruit Yield and Yield Components of Pineapple (*Ananas comosus* MERR L. Var. Smooth cayenne) at Gojeb, South Ethiopia. *Research Journal of Pharmacognosy and Phytochemistry. 11(3):160-166*

Tewodros M., Neim S., Mesfin S., Getachew W. and Ashenafi A. 2018. Effect of Mineral N and P Fertilizers on Storage Tuber Yield and Yield Components of Taro [*Colocasia esculenta* (L.) Schott] in Southwest Ethiopia. *Journal of Biological and Chemical Research*, 34 (2):688-695.

Tewodros Mulualem**,** Tadesse Eshetu Getachew W/micheal, Mesfin Seyoum and Addisu Bezabehe 2014. Production, Pre- and post-harvest, and marketing System of Pineapple in Amharic Version. Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia. pp.1-23.

Pineapple Technical Group. 1999. Pineapple production practices. Department of Horticulture, National Agricultural Research Institute, Mon Repos, East Coast Demerara, Guyana.

Wondifraw T., Dawit A, Hailab A., Amsalu N. and Tirfalem H. 2006. Effects of stand regulation on yield and quality of pineapple (*Ananas comosus* (L.) Merr. Var. *Smooth cayenne*), In Proceedings of the Inaugural and first Ethiopian horticultural science society conference, 27-30, March 2006, Addis Ababa, Ethiopia.

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