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Review on influence of genotypes and harvest stage on yield and yield components of sweet potato *Ipomoea batatas* (L) Lam

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ABSTRACT

Genotype and harvesting age are found to be an important factor which affects the yield and yield components of sweet potato. Knowing harvesting age in sweet potato production is essential for above ground fresh biomass yield, vine length, leaf number, marketable tuberous root number per plant, marketable tuberous root weight per plant, marketable tuberous root yield per hectare, tuberous root length, tuberous root diameter and tuberous root dry matter content. It was found that the yield and yield components of sweet potato is highly related to the harvest stage. Based on reviewed information almost all the above parameters increased to some extent as harvest stage delayed. Sweet potato genotypes have different above ground biomass yield and tuberous root yield and differences in yield components among the studied genotypes of sweet potato could be attributed to genetic diversity. This review article can be used as a reference resource for researchers, students, agricultural extension workers and smallholders working in elsewhere on sweet potato production.

Keywords: Tuberous root, Dry matter, Genotype, Harvest stage, Leaf number

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam) is an herbaceous dicotyledonous plant and belongs to the family *Convolvulaceae*. It is originated in central America or tropical south America and globally the seventh most important food security tuberous root crop after wheat, rice, maize, potato, barley, and cassava. Wider adaptability and beta carotene content of orange fleshed genotypes are special attributes of sweet potato unlike staple food crops. globally, production of 112.8 million tons (in 115 countries) reported in 2017 and China is the leading producer, followed by sub-saharan African countries. Asia (75.1%), Africa (20.8%), America (3.3%), Oceania (0.08%) and Europe (0.1%) are regions shared production of sweet potato from 2007 to 2017. Sweet potato is widely grown in Ethiopia with an average national tuberous root yield of 8 t/ha, which is low compared to the global average production 14.8 t/ha. Sweet potato has a potential of giving 50 t/ha to 60 t/ha but the yield obtained from farmer's field is lower than 6 t/ha to 8 t/ha. Teshome and Amenti reported that average yield of 37.1 t/ha obtained for the Belela variety. This indicates that national as well as regional yield is lower than attainable yield at research station (Ahmed M, 2012). The result obtained from Melkassa agricultural research center showed that Kudadie variety produced the highest total tuberous root yield (138.7 t/ha). Total tuberous root yield of 0.88 t/ha was obtained from Tulla variety at Jimma university college of agriculture and veterinary medicine. According to marketable tuberous root yield ranged from 4.6 t/ha for Kulfo variety to 111.06 t/ha for local variety at Borena zone (Ahn YO et al., 2010). This yield gap could be attributed to inappropriate land preparation, sub optimal plant population, lack of improved genotype, poor crop management practices, improper harvest stage and post harvest problems. Sweet potatoes have a different genotype and the productivity of these genotype were different even in the same environmental conditions. The stage of harvest is determined by consumers demand and market price (Alcoy AB et al., 1993). Optimum harvest stage is important for vine yield and tuberous root yield. It varies among genotypes, environmental conditions and market demand. Bertelson et al. reported that harvesting period ranges from 70 DAP to 150 DAP. Ehisiannya et al. also reported that harvesting stage ranges from 90 DAP to 240 DAP. Sweet potato is commonly harvested 150 DAP, but there is variability in harvest stages among genotypegenotype. Harvesting vines at 105 DAP gave optimum production of above ground fresh biomass without reducing yield of tuberous roots. Tuberous roots were smaller when harvested at 90 DAP than 120 DAP, 150 DAP and 180 DAP. Tuberous root yield of 12.77 t/ha was found when tuberous roots were harvested at 150 DAP and 9.0 t/ha at 1 20 DAP. Therefore the objective of this paper is: To review the effect of harvest stage on yield and yield components of sweet potato (Alvaro A et al., 2017).

LITERATURE REVIEW

Influence of Genotypes and Harvest Stage on Yield and Yield Components of Sweet Potato

Influence of harvest stage and genotype on above ground fresh biomass, vine length and leaf number: The objective of knowing harvesting age in sweet potato crop production is to optimize the biomass production and to harvest the crop before any deterioration on biomass, dry matter content and quality occurs. Above ground fresh biomass, vine length and leaf number per plant are parameters related to vine yield which is used for animals feed (Mekonnen B et al., 2015). As harvest stage delayed from 90 DAP to 120 DAP above ground fresh bomass increased and decreased after 120 DAP. As the report of vine growth was slow at 30 DAP, fastest at 60 DAP and slowed down at 90 DAP and 120 DAP. Decrease in above ground fresh biomass as harvest stages delayed is linked to senescence and leaf abscission, death of the whole plants and allocation of photo assimilates from above ground (shoots) to tuberous roots (Bhagsari AS et al., 1990). Reported that reduced growth of sweet potatoes is realized towards 120 DAP and 150 DAP and this might be due to reduced nutrient uptake and ageing of the vines further than 150 DAP which resulted in reduction of nutrient and dry matter accumulation. Genotype having longest vine, can also be used as a good vine source especially where production is aimed at producing vines for animals feed and planting material business especially at off season. Sweet potato continues to branching as long as environmental conditions are favorable which increases leaf number per plant (Caliskan ME et al., 2007). However, the leaves formed earlier in the growing season start to fall and the total number of leaves decreased to end of the growing season.

Influence of Harvest Stage and Genotype on Marketable and Unmarketable Tuberous Root Number per Plant

Early reported that marketable tuberous root number per plant increased from 75 DAP up to 120 DAP. Also reported that marketable tuberous root number per plant increased up to 120 DAP and declined at later harvest dates up to 180 DAP. Marketable tuberous root number per plant were lower when the crop harvested at 90 DAP than when harvested at 120 DAP and 150 DAP pointed out that the number of marketable tuberous roots number per plant increased as more time was allowed for tuber development before harvest meaning that at 105 DAP tuberous roots categorized as unmarketable due under sized turned to marketable category as time of harvest delayed, due to tuberous bulking. The differences in marketable tuberous root number per plant could also be attributed to varietal and harvest stage differences (Chattopadhyay A et al., 2005). The reduction in the marketable tuberous root number per plant at early harvest stages may be due to the impact of source sink activity of the plant early harvested tuberous roots were immature. The early harvest may leads to minimal partitioning of photo assimilates to the tuberous roots thereby reducing their marketable tuberous root number and increases unmarketable tuberous root numbers which were immature. More unmarketable tuberous root number per plant recorded at early harvest stages due to more number of immature tuberous roots, whereas at later harvest stages due to cracking and oversized tuberous roots (Markos D et al., 2016).

Influence of Harvest Stage and Genotype on Total Tuberous Root Number per Plant, Tuberous Root Length and Tuberous Root Diameter

According to total tuberous root number per plant increased till 120 DAP and declined at later harvesting dates. Among sweet potato genotypes, significant difference of total tuberous root number per plant was reported by several authors. A significant increase in tuberous root length was observed as time of harvest delayed. This shows that tuberous roots gained enough photo assimilates as time of harvest delayed. The highest tuberous root length (19.70 cm) was obtained at 120 DAP. The author reported that, tuberous root length was found to be maximum in “WBSP-4” variety (15.21 cm) followed by Kamala sundari (14.55 cm) and Tripti (14.50 cm) genotype (de Albuquerque JR et al., 2016). These differences were observed due to varietal differences reported that the tuberous root diameter increased up to 150 DAP. Varietal differences were also reported in tuberous root diameter. The observed differences could be attributed to varietal differences reported that harvest time had a significant effect on the weight of tuberous roots, with the maximum weight obtained at 150 DAP. The maximum tuberous roots weight per plant were obtained at 300 DAP, 1.57 kg for NP001 variety and 1.98 kg for Solomon variety. Late harvested plants have more time to deposit photo assimilates from vegetative parts to tuberous roots, which resulted in increased tuberous root size and weight (Etela I et al., 2011).

Effects of Harvest Stage and Genotype on Marketable and Unmarketable Tuberous Root Weight per Plant

Among evaluated genotype, most of them, produced the highest tuberous root weight per plant, as harvest of time delayed to 120 DAP. There was a significant increase in marketable tuberous root weight from 90 DAP to 150 DAP and then decreased among genotype. Marketable tuberous root weight per plant was increased with delays in harvest stage. This might be because plants have enough time to accumulate photo assimilates to tuberous roots from above ground parts as the time of harvesting is delayed (Ezell BD et al., 1952).

Influence of Harvest Stage and Genotype on Marketable, Unmarketable and Total Tuberous Root Weight per Hectare

Alcoy et al. early reported that the highest marketable tuberous root yield was obtained at 120 DAP with a mean yield of 35.49 t/ha, followed by those harvested at 105 DAP (25.30 t/ha) and 90 DAP (17.5 t/ha). De Albuquerque et al. also found highest marketable tuberous root yield (17.67 t/ha) at 150 DAP. Similarly, early maturity studies showed that the yield of three clones at 75 DAP, 90 DAP and 105 DAP were 13 t/ha, 23 t/ha and 33 t/ha, respectively. Marketable tuberous root yield of 12.77 t/ha was found when the tuberous roots were harvested at 150 DAP while it was 9.0 t/ha at 120 DAP. Shigwedha also reported that the percentage of marketable tuberous roots was lower at 90 DAP than marketable tuberous roots obtained at 150 DAP. The maximum weight obtained at 150 DAP (Gurmu F et al., 2015). In line with this, marketable tuberous roots were significantly smaller at 90 DAP than 120 DAP, 150 DAP and 180 DAP. The highest marketable tuberous root yield were reported at later harvesting. Marketable tuberous root yields were higher at 150 DAP and lower at 90 DAP. Tuberous root bulking continued under favorable conditions, to accumulate photo assimilates in the roots. The marked reduction in marketable tuberous root weights of plants harvested during growth attributed to the sub-optimal synthesis and partitioning of photo assimilates to the tuberous roots (Dong Wang J et al., 2015). At this stage the leaves were not mature enough to prepare photo assimilates to feed tuberous roots (strong sink at later growth stages). Alvaro et al. reported that unmarketable root yield was increased as harvesting dates delayed from 90 DAP to 180 DAP, this is due to sweet potato weevil damage to tuberous roots at prolonged harvest stages specially if droght is prolonged. Weevil damage and other root injuries are often associated with drought and significantly increased as harvesting was delayed. Acoording to the above author all the tuberous roots harvested at 180 DAP were classified as unmarketable. Total tuberous root yield increased as the harvest stages were delayed from 90 DAP to 150 DAP. The highest total tuberous root yield were reported at later harvest stage.

Recorded higher total tuberous root yield after 155 DAP harvests compared to 105 DAP and 130 DAP. Normally as harvesting date delayed total tuberous yield increased if weevil damage is controlled through different integrated pest controlling measures. As harvest stage delayed means of total tuberous weight per hectare was increased due to the optimal synthesis and partitioning of carbohydrates to the tuberous roots from vegetative parts at later harvest stages (Kathabwalika DM et al., 2013).

DISCUSSION

Effects of Harvest Stage and Genotype on Harvest Index and Tuber Dry Matter Content

Harvest Index (HI) is a measure of partitioning photo assimilates from above ground parts to tuberous roots. Harvest index increased as time of harvest stage delayed. Bhagsari and Ashley stated that harvest index ranged from 43% to 77% at final harvest 135 DAP and at 105 DAP, the harvest index ranged from 22% to 62%. The harvest index for sweet potato ranged from 1.2% to 56%. The harvest index was proportional to marketable and total fresh tuberous root yield and inversely proportional to total biomass. As harvest stages delayed the increase of harvest index were obtained due to more accumulate of photo assimilates to tuberous roots. Tuber dry matter accumulation increased as harvest stage delayed (Tian SJ et al., 1991). According to data on the dry matter content of eight clones for three seasons showed that dry matter increased significantly from 75 DAP to 90 DAP when the maximum dry matter occurs during this period and tends to deteriorate after that and at 105 DAP, the dry matter content in majority of the clones decreased. Dry matter content of about 27% could be obtained when the crop harvested either at 105 DAP or 120 DAP. Dry matter content increased with interval from planting to harvest up to 150 DAP but 180 DAP. Earlier report showed that, decreasing tuberous root dry matter content towards harvest was reported (Larbi A et al., 2007). A higher dry matter percentage was obtained at 150 DAP (41.6% and 23.4%) and this was higher than the dry matter recorded at 90 DAP, but not at 120 DAP (Monamodi EL et al., 2003). Also came to conclusion that there is a significant effect of harvest stage on the dry matter content of tuberous roots. This implies that when sweet potato is harvested at 150 DAP, it received maximum vegetative growth, as well as development of tuberous roots which aided maximum photosynthesis and hence the accumulation of dry matter in the tuberous roots were higher (Nath R et al., 2007). The average dry matter content in sweet potato is approximately 30%, but vary widely depending on cultivar, location, climate, day length, soil type, incidence of pests, diseases and cultivation practices (Bhattacharya NC et al., 1985).

CONCLUSION

In Ethiopia, sweet potato is widely grown in south, southwestern and eastern parts of the country by small scale farmers and with limited area coverage northern part of Ethiopia also produces this food security crop for human consumption and animal feed. However, the productivity of the crop remained low due to periodic drought, lack of planting materials during off season, lack of improved genotype, poor extension system, inappropriate harvest time and monocropping habit of the country. Authors worldwide have been conducted research to moderate the above problems and some of the findings have been published in different journals. However, there is no a complete reference source of these information. Therefore, this review summarized the major articles that have been published in different journals dealing with effects of harvest stage and genotypes on yield and yield components of sweet potato in elsewhere. It highlights the effects of different harvest stages on above ground fresh biomass yield, vine length, leaf number, marketable tuberous root number per plant, marketable tuberous root weight per plant, marketable tuberous root yield per hectare, tuberous root length, tuberous root diameter and tuberous root dry matter content. Based on reviewed information, almost all the above parameters increased to some extent as harvest stage delayed. This review article can be used as a reference resource for researchers, students, agricultural extension workers and smallholders globally working on sweet potato.

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