Performance of Indigenous Tomato Accessions

From Lake Victoria Crescent

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DEDICATION

This report is dedicated to my parents; late Sarah you loved education and Patrick Waako, my husband Abenaitwe Robert, Brother Francis, my sister Resty you have been a blessing to me. To my children Harison and Howard this is an inspiration to keep you going and developing your thirst for knowledge.

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May God bless you.

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees centigrade
AD	Ante domino
AVRDC	Asian Vegetable Research and Development Centre
CGIAR	Committee of Consultative Group on International Agricultural Research
FAO	Food Agricultural Organization,
GMOs	Genetically Modified Organisms
IPGR	International Plant Genetic Resource Institute
LVC	Lake Victoria crescent
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
NARO	National Agricultural Research Organization
RCBD	Randomized complete block design
SPSS:	Statistical Package for Social Scientists
UBOS	Uganda Bureau of Statistics
V_C	Vitamin C
PLL	Plant Leaf Length
PLW	Plant Leaf Width

ABSTRACT

A study to access the performance of indigenous tomato accessions from Lake Victoria crescent was conducted with objectives to evaluate the growth characteristics red and yellow indigenous tomato; to compare the yield of red and yellow indigenous tomato and the farmers' perception on the growing of indigenous tomato. An experiment was conducted to evaluate the growth characteristics of red and yellow indigenous tomatoes at the department of Agriculture Kyambogo University. Thirty accessions were evaluated in planting pots in a randomized complete block design (RCBD) replicated three times. The second experiment was to compare the yield of red and yellow indigenous tomato was also conducted at the department of Agriculture Kyambogo University. Ten accessions of five red and five yellow were used in the field experiment which was laid out in a random complete block design (RCBD).The plot size was 2m by 2m with the spacing of 1m between the rows and 0.5m between the plots in three replicates. A survey was carried out using questionnaire to assess farmers' perception on growing of indigenous tomatoes.

The results showed that there was significant difference between growth characteristics of red and yellow indigenous tomatoes on; number of fruits, number of brunches, PLL and PLW at($p<0.05$). On yield performance, results revealed that the yellow indigenous tomatoes perform better than red indigenous tomatoes at 5% LSD. On perception, farmers indicated that red indigenous tomatoes are grown more than yellow indigenous tomatoes are grown mainly for subsistence consumption and they are more resistant to pests and diseases among others. Data for growth characteristics was analyzed using analysis of variance (ANOVA). Yield performance between red and yellow indigenous tomatoes was analyzed using a T-test (15^{th} edition) and the farmers perception was analyzed using SPPS.

The study concluded that there was a significant difference in number of fruits, number of brunches, PLL, PLW and yield. Farmers mainly grow red indigenous tomatoes for subsistence purposes.

CHAPTER ONE

INTRODUCTON

1.1 Origin and importance of Indigenous tomatoes

The Indigenous tomato popularly known as Cherry tomato (*Solanum lycopersicum*) has origin traced back to the early Aztecs around 700 AD (Niel & Wessels, 2006). It originated in Latin America and has become one of the most widely grown vegetables with ability to survive in diverse environmental conditions. Tomato is believed to be native to the Americans and mainly of western, south and central regions of Mexico (Seminis, 2011), although it became pronounced in 16th century in Europe. Indigenous tomatoes are grown globally and by 2014, over 170.8million tones of indigenous tomatoes could be produced (FAO, 2014). The output of indigenous tomatoes has gradually reduced with introduction of exotic and improved varieties especially in China, Turkey, Spain and Netherlands.

The indigenous tomatoes were initially introduced and planted by travelers in Europe after discovery of the New Foundland and Americas. The British for example, admired the tomato for its beauty, but believed it was poisonous as its bright red color appeared similar to that of a wolf peach. In 1519, Cortez discovered tomatoes growing in momtezuma's gardens and brought seeds back to Europe where they were planted as ornamental curiosities. Traces of indigenous tomatoes in Africa can be associated with Ethiopia and Egypt (Berrueta *et al.*, 2012), and to date 14% of total vegetable production in African horticultural crops is tomatoes (Gok, 2015). With diversity in varieties and species, indigenous tomatoes are now grown with Uganda, Eretria, South Africa, Kenya, Malawi and Zambia, the leading continent's tomato producers.

The tomato (*Solanum lycopersicon*) is an herbaceous fruiting plant. It is an important source of Vitamin and cash crop for small and medium scale farmers. As an important source of minerals, vitamins and health acids, Similarly Tomato is an important source of antioxidants including, lycopene, phenolics, and vitamin C in human diet (Toor *et al.*, 2006).

According to FAO (1990), tomato is regarded as a top priority vegetable by scientists interviewed under the Technical Advisory Committee of Consultative Group on International Agricultural Research (CGIAR). There has been more emphasis on tomato production not only as source of vitamins, but also as a source of income and food security among East African Countries (Hirpa *et al.* 2010). Consequently, tomato is considered by the National Agricultural Research Organization (NARO) to be a top priority among other vegetables in Uganda (Valera, 1995; NARO, 1999).

Wener (2014) recounts that owing to their good taste, ability to ripen uniformly indigenous tomatoes are preferred for hotels and food houses. Additionally, Seminis (2011) notes that indigenous tomatoes also offer a good choice for tomato juice, easy to grow, requiring less care, costs and farm care.

1.2 Distribution and production of cherry tomato

Cherry tomato plants are still found in the countries between Ecuador and Chile as well as on the Galapagos Island (Molinar & Demoura, 2005). It is an edible garden plant, harmless and widely grown at household and for market gardening. It is a minor potential environmental weed in Australia and is seen as a sleeper weed. According to (FAO, 2003), tomato is now the most important vegetable in the tropics. It is annually planted on almost 4 million ha worldwide. By 2010, its global production was approximately 145.6 million tons of fresh fruit (Jensen *et al*.

2010) and this has since increased (FAO, 2016). Tomato grows best in fertile, well-drained soils, with pH 6 and ambient temperatures of about 25^0C. These conditions are common in East Africa and Uganda in particular.

East Africa's tomato farmers primarily produce Italian processing varieties (Rio Grande, Roma and Money Maker). These varieties are preferred because they are high yielding, disease resistant and have a longer shelf-life than other varieties. Kenya has two main production seasons: November–February and April–June with peak production in May. Tanzania's main production period is from August–December with peak production in October. Uganda has two production periods: the long period is from April-September with a short season from December–march. Kenya is the leading producer of tomatoes and is ranked 6th in Africa with a total production of 23.09 million tones (FAO, 2015). Uganda, Rwanda, Tanzania and Burundi follows. Growing of most indigenous tomatoes in East Africa has remained subsistence than being commercial.

Over 15.9 million farmers grow tomatoes in East Africa, although the percentage of farmers for indigenous tomatoes is small. In some eastern and southern Africa countries, tomato yields on smallholder farms do not exceed 20 t/ha. However, a smallholder commercial farmer is expected to get tomato yields of at least 100 t/ha (AVRDC, 1994). In Uganda, by 1990, most smallholder tomato producers are concentrated in the Lake Victoria basin region with about 150 to 500 hectares under tomato, and with an average annual production level of 10 t/ha Ministry of Agriculture Animal Industry and Fisheries,(MAAIF, 2015) and tomato is grown and consumed in every district of Uganda (Mukiibi, 2001).

1.3 Factors Limiting Tomato Yield

Low tomato yields are caused by a number of factors. These include lack of improved varieties, poor fruit setting due to heavy rains and excessively high temperatures, affecting pollination, more specifically fecundation plus pollen viability, pests and diseases (Villareal, 1979, Sonoda *et al.* 2009). In East and southern Africa, arthropods and fungal as well as bacterial diseases are considered to be the major constraints to tomato production. Viral diseases have been ranked as the third most important constraint among tomato diseases, basically because of absence of enough information on them (Varela, 1995). The yield and quality of fresh tomato are governed by both genetic factors and environmental conditions (Viskelis *et al.* 2008). In the case of Uganda, poor tomato yield is attributed to factors: namely, lack of improved varieties, occurrence of pests and diseases and lack of knowledge on sustainable agronomic practices (Ishihara *et al*. 2012). Pests and diseases such as blight (*Phytophthora infestans* and *Alternaria solani*), bacterial wilt (*Ralstonia solanacearum*), root nematodes (*Meloidogyne spp*.), African bollworm (*Helicoverpa armigera*), thrips (*Thrips tabaci*), whitefly (*Bemisia tabaci*) and aphids (*Myzus persicae*) are reported to infect tomato (Mwaule, 1995). Over 79.1% of the tomato farmers have limited training in tomato production, and as such their production is associated with challenges not only from diseases, pests and poor varieties, but also farm management. In addition the red tomatoes are vulnerable compared to yellow varieties, putting into consideration their manure in-take, moisture requirements, and soil requirements (Anon, 2005).

1.4 Problem Statement

Indigenous tomato is one of the tomato cultivars mostly found growing in the wild in Uganda. They have varied number of characteristics that could be measured to establish their performance like the exotic ones when properly managed in the field. In some villages especially in the Lake

Victoria Crescent regions, farmers and households grow indigenous tomatoes as part of their domestic crops. The core distinction between various varieties is that these accessions may exhibit differences in plant length, width, number of leaves, and other growth parameters. Studies to examine these parameters have been conducted extensively on exotic varieties with already set standards characterized by IPGR (International Plant Genetic Resource Institute) tomato descriptor but limited work had been carried out on indigenous tomatoes to examine the growth characteristics useful to determine their performance such as yield. Similarly the performance in yield between the yellow and red colour indigenous tomatoes had not been investigated in Uganda especially for tomatoes produced in the districts within the Lake Victoria Crescent. Given this little knowledge available about the growth characteristics and yield of the various types of indigenous tomatoes, this study was conducted with the following objectives.

1.5 General objective

The study examined the performance of indigenous tomato accessions from the Lake Victoria Crescent in Uganda.

1.6 Specific Objectives

The following objectives guided the study;

- **i.** To evaluate the growth characteristics of red and yellow indigenous tomato accessions from Lake Victoria Crescent.
- **ii.** To compare the yield of red and yellow indigenous tomato accessions from Lake Victoria Crescent.
- **iii.** To assess the farmers perception on the growing of indigenous tomatoes from Lake Victoria Crescent.

1.7 Hypotheses of the study

The following hypotheses were tested;

1. Indigenous tomato accessions from Lake Victoria Crescent have similar growth characteristics as well as the yield.

2. The farmers from the Lake Victoria Crescent perceive the production of indigenous tomatoes positively.

1.8 Significance of the study

The study findings can be used to guide policy makers like in the Ministry of Agriculture Animal Industry and Fisheries (MIAAF) to make clear guidelines on the growing and marketing of indigenous tomatoes. The study also provides literature on various aspects concerning the production and utilization of indigenous tomatoes in Uganda.

The findings will provide reliable information for researchers about the best morphology and that which are more prolific including the field management practices that can be carried out to increase tomato yield.

CHAPTER TWO

LITERATURE REVIEW

2.1 Growth characteristics of tomatoes

Generally, there are two growth types: indeterminate and determinate. The indeterminate tomato plants are usually pruned to keep a single stem and require trellising (Jones, 1999). They continue their growth and produce fruits on side shoots throughout the season (Lerner, 2001). On the other hand, the tomato cultivars that have a determinate growth are usually much small and bushier. They have a genetic makeup that has a set height (Lerner, 2001). Once it reaches this height, the growth stops and it produces flower clusters and sets fruits.

A tomato stem is about 4 cm in diameter at the base. The plant is covered with glandular and non-glandular trichomes, which are beneficial in plant defence against insects both through mechanical and chemical defenses (Kang *et al.* 2010). The leaves are compound with a larger terminal leaflet and up to 8 lateral leaflets which can be also compound. The flowers are day neutral and self-pollinated (Jones, 1999), however, it requires the flower to be vibrated to allow the pollen on the anthers to be released and fall on the stigma (Morse, 2009). The roots system can extent to 1.5m diameter and adventitious roots can develop on the stem, especially at the base (Picken *et al*., 1986).

According to studies (FAO, 2015; Elwagira & Algram, 2014; Abd-El-Kareem *et al.,* 2006) growth characteristics of tomatoes vary from one cultivar to another.

2.2 Tomato crop management

Tomato as a crop and a fruit requires care if it is to be of value to the farmer (Lebas & Ochoa, 2007). According to Molinar, Yang, Klonsky and De Moura (2005), production of tomatoes is associated with costs before the farmer reaps profits. These costs arise on-farm and off-farm. Well aware of perishability of tomatoes, farmers have to ensure proper farm management practices before, during, and after planting and harvesting tomatoes. These are tomato crop management practices (Molinar *et al*. 2005).

In Elwagira & Algram (2014), tomato farm management is seen to cover a number of activities including propagation, planting, fertilization, irrigation, weed control and pest and disease control at farm level. It also covers harvesting practices, storage and marketing practices. The farmer has to bear in mind that any defect in any of these activities has a far-reaching effect not only on quantity but also quality of produce (Morse, 2009). Additionally, the farmer is required to undertake tomato farm management practices such as training employees of what to do, how to check for signs and symptoms of infection, pruning, crop rotation, harvest maturity time, and how harvesting is done, grading, packing, storage and marketing (Morse, 2009; Kang *et al*. 2010).

2.2.1 Weed control in tomatoes

Several reasons are responsible for the low yields among which weeds have a big role that not only reduce yield, quality and value of the crops but also increase production and harvesting costs at the same time. Weeds reduce yields by competing for space, light, water and nutrients, weakening crop stand and reduce harvest efficiency (Abbasi *et al*. 2013). Some weeds can also increase other pest problems by serving as alternate hosts for insects, diseases, or nematodes. Although weed control has always been an important component of tomato production, its importance has increased with the introduction of the sweet potato whitefly and development of the associated irregular ripening problem. Increased incidence of several viral disorders of tomatoes also reinforces the need for good control of weeds which may act as alternate hosts.

Marana *et al*. (1986) estimated the critical period of weed competition to be 30-40 days after sowing; therefore, they recommended that weeds should be removed for 40-50 days after sowing. They further noted that the presence of weeds reduced fruit yield by 70% depending on stage and duration of competition. Shadbolt & Holm (1956) also concluded from their studies that the first four weeks were critical in many vegetable crops, during which time weeds should be removed. Govindra *et al*. (1986) found that weeds resulted in a 57% reduction in tomato yield when compared with weed free conditions. They further reported that one hand weeding in addition to herbicide application significantly increased yield.

Adigun (2000) reported that unrestricted weed growth throughout the crop life cycle resulted in 92 to 95% reduction in tomato fruit yield. Herbicides work best if soil moisture is adequate for plant growth. Pre-emergence herbicides will kill germinating seeds but not dry seeds. However, these materials should not be applied to wet soils because application equipment can cause soil compaction, particularly where power driven rotary tillers are used for soil incorporation. Post-emergence herbicides work best on plants that are not stressed for moisture.

Non stressed plants translocate the herbicide from where it is absorbed (mostly leaves) to the site of action (George *et al*. 2013; Shamim *et al*. 2013). Although herbicides can be effective in controlling weeds, they are also expensive and often beyond the budget of farmers as is the case in Pakistan. In addition, herbicide use requires particular equipment and expertise to be sure that proper rates are used and that human health and safety are protected. Mulching is a recent and important non-chemical weed control method. It is necessary to cover the soil surface with different materials to obtain high biological activity, retain soil moisture and to achieve a good control of weeds.

2.2.2 Irrigation

Irrigation is critical at the early flowering, fruit set and enlargement stages of tomato (Virginia Cooperative Extension, 2010). In field conditions, pollinators and the wind are sufficient to ensure pollination (Heuvelink, 2005). Optimal temperature conditions for pollination are between 13 and 24°C night and between 15.5 and 32°C day (Jones, 1999). It is a major step in the better management of water in tomato fields where out of the current three irrigation methods (furrow, sprinkling and drip irrigation), drip irrigation had the best water use efficiency.

Drip irrigation reduces water loss by having the water brought in slowly and directly to the root zone (Tan *et al*. 2009). Tomatoes also showed a 20% increase in yield when drip irrigated compared to furrow irrigation, and this was partly explained by better moisture regime at the root zone (Hebbar *et al.* 2004). Tu *et al*. (2004) in Southwestern Ontario also obtained a higher yield in drip irrigated tomatoes than tomatoes that only received rainwater. Drip irrigation also reduces the labour and management cost mainly by removing large metal pipes which make field work and machinery use more difficult. In arid and semi-arid regions, when comparing with furrow irrigation, drip irrigation was shown to have less production of nitrous oxides, especially N_2O, a greenhouse gas (Sanchez-Martin *et al.,* 2008).

2.2.3 Biotic and abiotic stresses of tomato

Though a range of factors contribute to the low yields, insect pest and diseases have to be among the most damaging (Ssekyewa, 2006). And the most important insect pest being aphids, thrips, African ball worm (Mwaule, 1998, Ssekyewa, 2006). Horticultural crops are susceptible to a wide range of disease and insect attacks (Baliyan, 2012). Tomato plants are susceptible to several pests and diseases including the large green caterpillar that consumes foliage and late blight, fungal disease that cause leaf spots and eventually rotting of the fruits. while varieties VF 6203 and Peto-C-8100 159 which are resistant to *Verticillium spp and Fusarium spp* are recommended for processing (Mwaule, 1995). Mwaule also reported that the Asian Vegetable Research and Development Centre (AVRDC) tomato lines MT 40, 41, 55, 56 and 57 are resistant to bacterial wilt (*Ralstonia solanacearum*). It is also reported that sustainable agronomic practices, such as plant spacing of 45cm x 90cm, mulching, staking and pruning lead to better quality and higher yields (Mwaule, 1995).

2.2.4 Staking

Tomatoes are usually staked and supported off the grounds which is an effort to minimize losses from rots when the fruit is in contact with the soil. It has also proven to increase yields and fruit quality (Saunyama & Knapp, 2003). Tomatoes shrive best in moderate climates, but can adapt to a wide range of climatic conditions. They do best on well drained, fertile soils.

2.2.5 Spacing

The effect of planting can be verified in terms of exposure to light, with narrow plant spacing, there is greater overlap and shading of leaves, reduced penetration of solar radiation to basal leaves and hence higher competition for light reducing photosynthetic efficiency of the plant. This competition promotes increased energy expenditure in process of cell growth and reduces translation of sugar for fruits (Mueller & Womser, 2009). Close spacing tend to promote growth of fungi in soil and on the plants, since air circulation which can reduce wet conditions is slowed by lack of space.

2.3 Tomato Domestication and Production

Tomato originated from South America, where it grows as a perennial (Heuvelink, 2005). The cultivated tomato, *(Solanum lycopersicum)* is the third most variable of all crop species and the most appreciated in terms of vegetable crops (Van der Hoeven *et al.*, 2002). Naika *et al.* (2005) also revealed that tomato growth is a function of seasons, and farmers have to ensure their planting activities fall within the season. Uganda has dry seasons (Jan to Feb. and June to Aug.) and wet seasons (Mar. to mid-June and mid-Aug. to Dec.) with dry and wet seasons alternating in a year (Mukiibi, 2001). Tomato cultivation is continuous throughout the year, with planting occurring at the beginning of each wet season (Tusiime, 2014). Tomatoes are seeded, transplants established and set in fields, and fruits mature within a period of 90-120 days after sowing seeds for transplants. In Uganda, tomato plantings are harvested over a time period of 3-4 weeks (Lebas & Ochoa, 2007; Kalibbala, 2011). Generally, Uganda grows different cultivars and each has its own characteristics. Studies including by Karungi *et.al.* 2012; Naika *et al.* 2005; and Mukiibi, 2001 show that propagation of tomatoes at times is associated with how tolerant or resistant they are to common diseases. Farmers adopt a number of methods of propagation, to ensure that proper farm management is provided.

Tomato (*Solanum lycoperscicon*) is one of the most widely grown vegetables in the world. Globally, Tomato production amounted to 170.8 million of tons by 2014 and this has steadily risen since then to date (Oishimaya, 2016). Dominant tomato producing countries in the world are China (52.6 metric million `tons), India (18.7m tonnes, USA (14.5 metric tonnes) and Turkey comes fourth with 11.9 million tons of tomato production. Egypt is the leading African country involved in tomato production, coming fifth after Turkey and India (FAO, 2015; Nabuzale, 2014).

2.3.1 Growth requirements

Universally, it is the second most paid vegetable after potato (FAO, 2005) and conclusively the most general garden crop. Tomato is a warm-season crop that is sensitive to frost. An average daily mean of 20° to 24°C is optimum for growth, yield and fruit quality. Fruit set and quality are poor at temperatures below 12°C and 35 °C. Hot, dry winds cause excessive flower drop while continuous moist, rainy weather conditions result in the occurrence and spread of foliar diseases. It was therefore recommended that tomatoes be grown in dry areas under irrigation (FAO, 2016). Although tomato requires a relatively cool, dry climate for high yield and better quality (Nicola *et al*. 2009), it is adapted to a wide range of climatic conditions from temperate to hot and humid tropical (Naika *et.al*. 2005).

2.3.2 Composition and uses

The tomato is composed of water, soluble and insoluble solids, citric and other acids, vitamins and minerals (Pedro & Ferreira, 2007). The tomato is grown for its fruits. Botanically, the fruit is a matrix that softens as the fruit matures and seeds are fully developed (Wafaa *et al.* 2015). Ripe tomatoes have a high content of antioxidant lycopene and carotine (Radzeuicius *et al.* 2009) which play possible role in prevention of certain cancers. It is consumed as a raw vegetable or being added to other food items; tomato may be processed into a variety of foods including paste, whole peeled tomatoes, diced products, and numerous forms of juice, sauces, and soups.

Olaniyi *et al.* (2010) reveals that tomatoes and tomato products have numerous health benefits and also contribute to a well-balanced diet. They are a key source of essential nutrients including vitamin A, C and E (Beecher, 1998), providing approximately 20 mg of vitamin C per 100 grams of edible product (Wilcox *et al.* 2003). One medium ripe tomato (145 grams), provide up to 40% of the Recommended Daily Allowance of vitamin C and 20% of vitamin A (Kelly & Boyhan, 2010). Taking a meal of tomatoes provides a person high opportunities of having well recognised metabolism, and good sight. Tomato can be consumed in sauces, soup, domestic meat or fish dishes, and fresh in salads. They can also be processed into purées, juices, and ketchup (Kelly & Boyhan, 2010). Modern technology and food processing have provided an opportunity for consumption of canned and dried tomato products (Naika *et al.*, 2005).

In Uganda, tomato (*Lycopersicum esculentum*) is among the important crops for small scale farmers and the most promising areas for horticultural development (Bosland & Votava, 2000; Nandelenga, 2010; Kyamanywa *et al.* 2013). Production of tomatoes ranges between 0.4ha-0.6 ha plot size and is concentrated in mountain areas of Mbale and Kabale districts and Lake Victoria crescent in Southern Uganda (Sonko *et al.* 2005; Tusiime, 2014). While tomato production in the country started as early as fruit gathering times, progressed to subsistence household farming, today, Uganda is one on the key exporters of tomatoes to a number of tomato processing countries including South Sudan, parts of Kenya and DRC.

There has been a net increase in the level of production of tomato paste in the last 5 years, from 616 tons to 940 tons per annum (Nabuzale, 2014). This production output is however uneven with the south western, victoria basin region and Central parts of the country taking a lions' share of the production levels. Recently, tomato production has been emphasized as a source of food security and income in Uganda (Ssekyewa, 2006). This robust increase has seen production or tomatoes wide spread in a number of districts including Kamuli, Kabale, Masaka, Kasese, Mbale, Kapchorwa, Mubende, Mpigi, Wakiso and Mbarara (Tusiime, 2014). However, a number of farmers still grown indigenous tomato accessions, with exception of a few large scale farmers who have a number of improved and hybrid varieties. Common growing indigenous tomatoes varieties growing include the Rio, money maker, Marglobe, Heinz 1370, and Roma (Kalibballa, 2011). However, there is a notable variance in tomato production and yield among various farmers and regions. This variance can be associated with a number of farming practices, cultivars grown, farmers' attitude and reasons for engaging in tomato production, and other agronomic supportive factors.

2.3.3Tomato production in Uganda

The Lake Victoria Crescent (LVC) is one of the leading tomato growing regions in Uganda. LVC covers a stretch of land entering inland by over 30-50kms from the shorelines of Lake Victoria. This region covers districts of Mpigi, Masaka, Rakai, Wakiso, Kampala, Buvuma, Kalangala, Buikwe, Jinja, and Mukono (UBOS, 2016). Tomato production especially indigenous tomato production is one of the leading sources of income, employment and dietary complement for households in the area. The LVC is part of the main Lake Victoria basin with over 31.2 ha. of the land under rain fed agriculture. Five systems of agriculture are undertaken in the area (FAO, 2009). The lake catchment thus provides for the livelihood of about one third of the combined populations of the three countries, and about the same proportion of the combined gross domestic product (Mailu, 2011), and among the many sources of livelihood is tomato production.

Tomato production in the LVC is largely subsistence in nature, and over 80% of the farmers still keep indigenous tomato accessions. Predominant accessions include Money Maker, Rio Grande, Marglobe, Heinz 1370, and Roma (Kalibballa, 2011). The Lake Victoria Crescent enjoys tropical and subtropical climates, temperatures of 25–30°C almost all throughout the year round and it is one of the areas with sufficient nutrients favourable for growth of various crops, including tomatoes. Despite these favourable factors, the area has predominantly remained a low profile in tomato output recognised as a major tomato production hub for the region, and the tomato yields is still low (FAO, 2012). A few farmers grow hybrid tomato accessions, and these are done for market gardening and commercial scale (Mailu, 2011). Thus, this study focused on examining the detail regarding the Performance of indigenous tomato accessions from Lake Victoria Crescent

2.4 Farmers' perceptions on the growing of indigenous tomatoes

The traces of tomatoes in Africa especially indigenous tomato production can be tracked from Egypt and although its growth have significantly changed. Production of indigenous tomatoes is associated with a number of perceptions especially with the modernization and adoption of modern technology (Seminis, 2011). Earlier studies (Tu *et al*. 2004; Shamim *et al*. 2013; Kang *et al.* 2010) show that there have been a number of perceptions regarding growing of indigenous tomatoes

In all countries, tomatoes are grown as market gardening and horticultural crop, considered as both a fruit, and vegetable. Apart from being a vegetable and fruit, different farmers and communities have varying opinions, perceptions, attitudes, and reasons for growing tomatoes. Nevertheless the production scope varies per country, accession grown and farm, and a number of factors account for this variation: in range of varieties, farming approaches, cultivars, among others (Aphane, Chadha & Oluoch, 2002).

The African tomato production has remained low with most communities growing tomatoes for subsistence purposes. With exception of some countries including Egypt, Nigeria, South Africa, over 67.9% of the current leading African tomato producers including Kenya, Uganda, Morocco, started the practice as a subsistence form of farming, focusing on obtaining cheap and nutritious household sauce (Nandelenga, 2010; Kyamanywa *et al.* 2011). Tomatoes is one of the leading cash crops for small scale farmers in many Sub-Saharan countries, being grown as a sole crop or under rain fed conditions as staked, unstaked or pruned plants (Gennari, 2015; Brown *et al.* 2005). While tomato production covers and does well in most parts of the East African region due to tropical/equatorial climate, production levels tend to vary with most output drawn from the Victoria basin and surrounding regions (Rubehaiyo *et al.* 2013).

Several times, out of diversity of various cultivars in place, as well as improvement in research and agronomic practices, the perceptions of growing indigenous tomato cultivars have changed. In the view of Berrueta (2012), farmers and more specifically indigenous tomato producers present both positive and negative attitudes towards tomato production by their varieties. Some of the farmers believe that being indigenous, they are easy to get, cheap, natural and this good for small-scale subsistence farmers (Tan *et al*. 2009).

Berrueta et al. (2012) adds that indigenous tomatoes apart from being tasty, a number of farmers and consumers have for long considered them as more healthy. They are preferred for maintenance of capillaries, bones and teeth and aids in the absorption of iron (Wales, 2015). Though indigenous tomatoes present the above benefits, their production is slowly declining and fading away because of production constraints and this can be a reason to account for the prevailing negative perceptions as well.

Van Eck *et al.*,(2006) also counts that farmers still grow indigenous tomato varieties because these tomatoes can be grown in a wide altitude range from the sub-tropical plains. Whether in the hills, plains, or valleys as long as there is tolerable temperatures, and the soils are better, the growth of indigenous tomatoes may not be constrained. Indigenous tomatoes are good when eaten raw and also when cooked. They give a good quality of processed tomato products compared to hybrid types. Studies (Wener, 2014; Seminis, 2011) agree in their arguments that indigenous tomatoes are still grown on small scale and moving to commercial scale, because they produce quality of juice that can be relevant for making first-class sauce ketchup and tomapes. It is extensively used in the canning industry. However, with the introduction of improved varieties, African tomato production is steadily shifting from subsistence vegetable to a commercial crop, with indigenous varieties being replaced with improved varieties (Berrueta *et al*. 2012).

Abolusoro *et al.* (2014) noted that indigenous tomatoes remain a major vegetable crop that has achieved tremendous popularity in the last century. There have been undoubted efforts to rank tomatoes among the highest source of food, sauce, income and rich in vitamins A and C in the world beginning with the highest nutritious value attached to indigenous varieties. FAO (2012) also show that indigenous tomatoes provide a lot of benefits to the farmer. Owing to their good taste, ability to ripen uniformly and being preferred for hotels and food houses. Indigenous tomatoes also offer a good choice when searching for tomatoes varieties with the juice. They are also considered as determinate or bush types and hence easy to grow and care for without a lot of costs and farm care.

Spence (2015) notes that while farmers complain of low yield of indigenous tomatoes, they still applaud them for being less costly, easy to manage and a number of these varieties are disease resistant, and can cope up with changes in soil and climatic challenges. Studies (Ssekyewa 2006, Shamim *et al*. 2013; Oruko & Ngun'gu (2011) revealed that a number of indigenous tomatoes had a lot of seeds, which were nutritious and are in their natural form. However, they do not give a good high yield like the hybrid tomatoes, a reason why farmers seem to be changing their attitude to growing better and improved tomato varieties.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Sample collection

Indigenous tomato seeds used in this study were collected from the districts of greater Masaka, Mpigi and Mukono in the Lake Victoria crescent during the 2014/15 crop seasons. Ten samples from were collected from each district making a total of 30 ripe tomato fruit samples. The tomato samples collected were brought to the Department of Agriculture, Kyambogo University where seeds were extracted and processed for subsequent experiments.

3.2 Experimental site

The experiments were conducted in the screen house at the Department of Agriculture, Kyambogo University. Kyambogo University is located 10 km east of Kampala city along Kampala-Jinja highway and lies on the grid 0 20’ 54.0’’N 32 37’ 49 0’’ E (Latitude; 0.348334; Longitude; 32.630275). The area receives a mean annual rainfall of 1100mm and temperatures ranging from 16^0c to $30\,^o$c. (https;//en.wikipedia.org/wiki/Kyambogo).

3.2.1 Experiment 1: Growth characteristics of indigenous tomatoes

The 30 indigenous tomato accessions were grown in buckets outside the screen house at the department of agriculture, replicated three times in a randomized complete block design (RCBD).

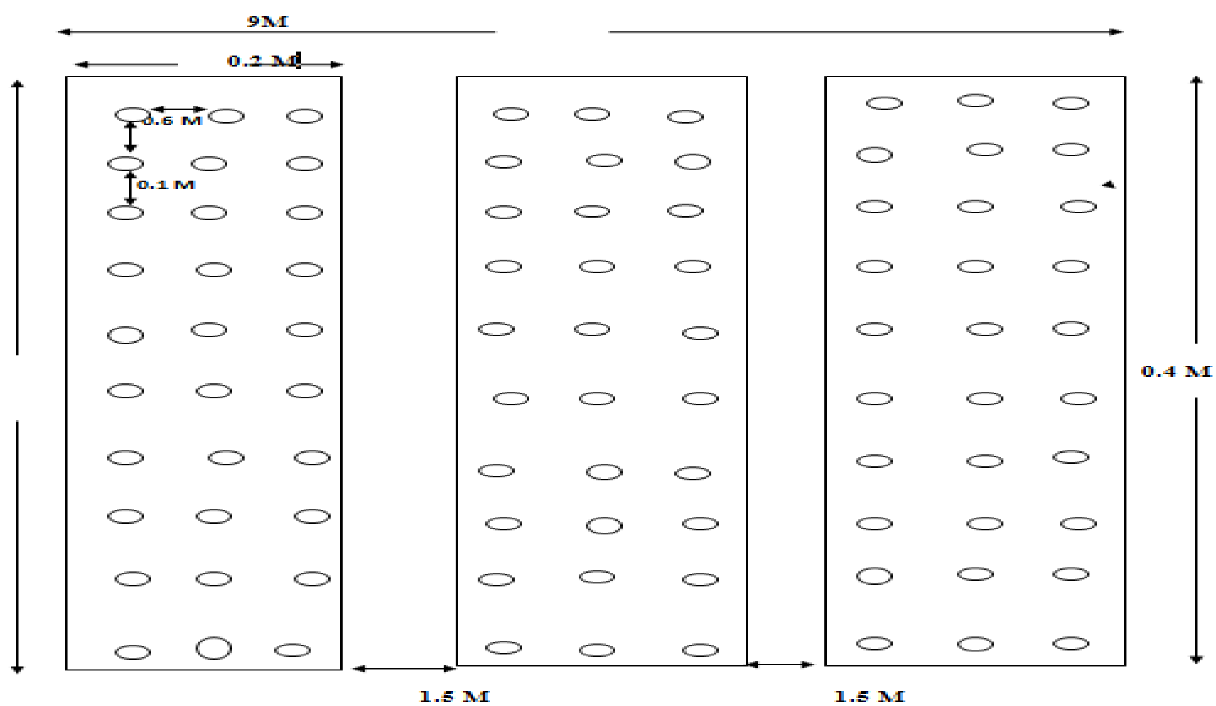
3.2.2 Seed preparation

Tomato fruits were obtained from the field and squeezed in cold water and kept for 3-5 days in order to allow proper extraction of the seeds. The seeds were spread on clean papers to allow proper drying for 3-4 days and packed separately in well labelled envelopes per accession.

3.2.3 Nursery bed preparation and management

Forest soil was mixed with chicken manure in the ratio of 3; 1 respectively. This was thoroughly mixed by turning until when a uniform mixture was obtained. This soil was loaded in the small sized disposable cups and filled to about three quarters of volume, and properly arranged inside the screen house ready to receive seeds. The soil in the cups was moistened and thereafter 20-25 seeds of each accession were sown in each cup. The seeds were then covered with a light layer of the dry soil and followed by watering. Operations required in the nursery such as watering weeding thinning were carried out periodically up to two weeks when the seedlings had attained a height of about 7-10cm and 3-4 leaves .The seedlings were then hardened off for 7 days by taking them out of the screen house in order to expose them to the field conditions, and thereafter were transplanted in the buckets in located in the field. The layout of the experiment was as shown below:

Figure 3.1 Layout of the experiment



3.2.4 Transplanting and management in the field

The buckets were loaded with mixed soil to about three quarters of their volume and two seedlings were planted per bucket and thinned to one plant per bucket at two weeks after transplanting. The weeds were controlled by hand pulling and this was carried out whenever need arose. Watering, pest and disease control were also carried out as well as pest and disease control using fungicides and pesticides. Staking was carried out using sisal strings tied at a height of about 1.5m above the buckets one month after transplanting. The usual management practices were carried out to ensure that an even stand of plants was maintained in the buckets up to the end of the experiment.

3.2.5 Data collection and analysis

Data was collected on growth and yield parameters. These included leaf length and width, plant height, number of branches and number of fruits at 51 and 81 days. Analysis of variance (ANOVA) was used using GenStat, and the means were separated using Least Significant Difference (LSD) at 5% probability for growth parameters.

3.2.6 Experiment 2: Yield comparison of red and yellow tomatoes

A total number of 10 accessions including 5 red and 5 yellow colored tomatoes were grown in the field at the department of agriculture in a randomized complete block design (RCBD) replicated 3 times. The field was divided into plots, each plot measuring 2m x 2 m. The seedlings were planted in rows at spacing of 60cm x 60cm making 3 rows for each plot giving a population of 9 plants per plot.

3.2.7 Nursery bed preparation

Preparation and raising seedlings in the nursery was done as in Experiment 1 above.

3.2.8 Transplanting and management in the field

In the field, each plot was prepared to fine tilth after which holes were dug in rows measuring 60 x 60 cm. Two seedlings were transplanted per hole at a depth of 5cm. Two weeks after transplanting, thinning was carried out leaving one plant per hole giving population of nine plants per plot. After thinning, chicken manure was applied using ring method. Mulching also was done immediately after transplanting as well as weeding.

3.2.9 Data collection and analysis

Data was collected on growth and yield parameters. The growth parameters considered were number of branches per plant, plant height, days to flowering, and days to fruiting. The Yield parameters were number of fruits per plant and fruit weight. Analysis was done using T-test to compare the yields.

3.3. Farmer perception on indigenous tomatoes

3.3.1. Area of study

The study was carried out in districts of greater Masaka, Mpigi and Mukono and it examined the perception of indigenous tomato farmers. The area (greater Masaka) was selected because it is one of the leading areas known for indigenous tomato growing in the country. Hence was a potential area with necessary information for the study.

3.3.2 Study Population

The study involved farmers around the Lake Victoria crescent growing indigenous tomatoes. A total population of 60 farmers from the Lake Victoria Crescent districts of the greater Masaka, Mpigi and Mukono districts. The districts were randomly selected basing on the fact that they are pioneer districts in the region and hence had many tomatoes growing residents. Snow ball sampling technique was used to raise the desired sample of 60 farmers. One farmer referred to the researcher to another tomatoes farmer after participating in the study. This method was not only convenient but also helpful to the researcher to get to the right target of those persons who are those particular people who fit in the study

3.3.3 Instruments for data collection

The data was collected using questionnaires from selected indigenous tomato farmers. The relevance of using questionnaires aim at getting specific information on a variety of topics. This was chosen because it permitted the collection of reliable and reasonable valid data, in relatively short period of time (Anderson, 1990; 209). The questionnaires were administered by the researcher with the help of research assistants. Each farmer was given a questionnaire, and where the respondent did not know English, the researcher translated to the Local language-Luganda.

3.3.4 Research Procedure

Using the letter of introduction obtained from Kyambogo University introducing the researcher to respondents and explaining the purpose of the research, the researcher proceeded to the field (Greater Masaka, Mpigi and Mukono Districts). After getting consent from the farmers, they were given questionnaires to answer. The research ethical values of confidentiality of the respondents, privacy and assurance about the information provided were also put into consideration in the course of conducting this study.

3.4 Data collection and analysis

3.4.1 Survey research Analysis

Survey studies were conducted in dominant tomato growing areas of greater Masaka, Mpigi and Mukono around the Lake Victoria Crescent. Questionnaires were used to collect information from sixty (60) farmers in the three (3) tomato growing zones. The questionnaires focused on farmers' background, tomato production characteristics, and production constraints of tomatoes as perceived by farmers. Questionnaires were self-administered to farmers.

After collecting all the necessary data, the data was coded, edited and analyzed to eliminate errors and ensure consistency. Data collected from the field classified into meaningful categories. Data was entered into a computer and analyzed with the use of statistical packages (SPSS). The study adopted and used a chi-square (x^2) to examine the findings obtained.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND INTERPRETATION OF THE RESULTS

4.1 Introduction

This chapter presents the findings of the study which were obtained from experimental and survey data. It includes the information about growth characteristics and the yield of red and yellow indigenous tomato accessions from Lake Victoria crescent, and farmers' perception on growing of indigenous tomatoes. The experiment results are presented below:

4.2 Growth characteristics of indigenous tomatoes

4.2.1. Fruiting days

The grand mean for days to fruiting of tomatoes from all the accessions (a, b and c) was 55.79. The lowest mean for fruiting dates was 37.6 whereas the highest was 58.33. Most means for fruiting date lie between 54.00 - 56.00. There was no significant difference in the days from planting to fruiting, detailed findings are presented in table 4.1

Table 4.1: Means for fruiting days

a)										
ACC	05	110	114	117	121	124	188	189	196	199
Means	54.33	59.00	57.00	58.33	55.00	57.67	55.67	56.33	37.67	55.00
b)										
ACC	201	217	220	222	223	231	232	233	237	240
Means	58.67	56.33	59.67	55.67	56.00	55.00	55.67	58.33	55.67	56.00
c)										
ACC	243	245	250	251	255	257	262	265	267	274
Means	56.00	56.33	55.67	54.67	55.00	59.00	55.33	56.00	55.00	57.67

a, b and c are randomized groups of experimental plots.

4.2.2 Number of Branches

The grand mean the total number of branches was 6.92 for all the accessions of the experiment. The lowest mean for the number of branches was 5.33 while the highest was 8.33, and most of the means lie between 6.00 -7.67. There was no significant difference in the number of branches at 81days of growth from the day of planting as shown in Table 4.2.

Table 4.2: Means for the number of branches at 81 days

a)										
ACC	05	110	114	117	121	124	188	189	196	199
Means	8.33	7.00	8.00	7.33	6.67	8.33	7.67	7.00	5.33	6.33
b)										
ACC	201	217	220	222	223	231	232	233	237	240
Means	6.33	7.00	7.33	7.00	6.33	8.33	6.00	5.00	6.33	7.67
c)										
ACC	243	245	250	251	255	257	262	265	267	274
Means	6.33	8.00	5.33	7.67	7.33	6.00	7.00	7.67	7.33	5.67

The highest number of branches recorded was (8) obtained from accession numbers 05 and 124 while the lowest recorded was five (5) branches from accession number 250. The results are not in line with Iqbal *et al*., (2011) and Davis *et al.*, (2003) who reported that number of branches varied in different cultivars due to their genetic makeup. There is a reason to believe that the 30 accessions are not of the same cultivar due the differences in fruit color, size and texture.

4.2.3 Fruiting characteristics

The highest mean for the number of fruits was 73.7 and the lowest 7.0. Most of the means lie between 47- 42, although the grand mean is 43.0 and Lsd is 28.35 as shown in Figure 4.1.

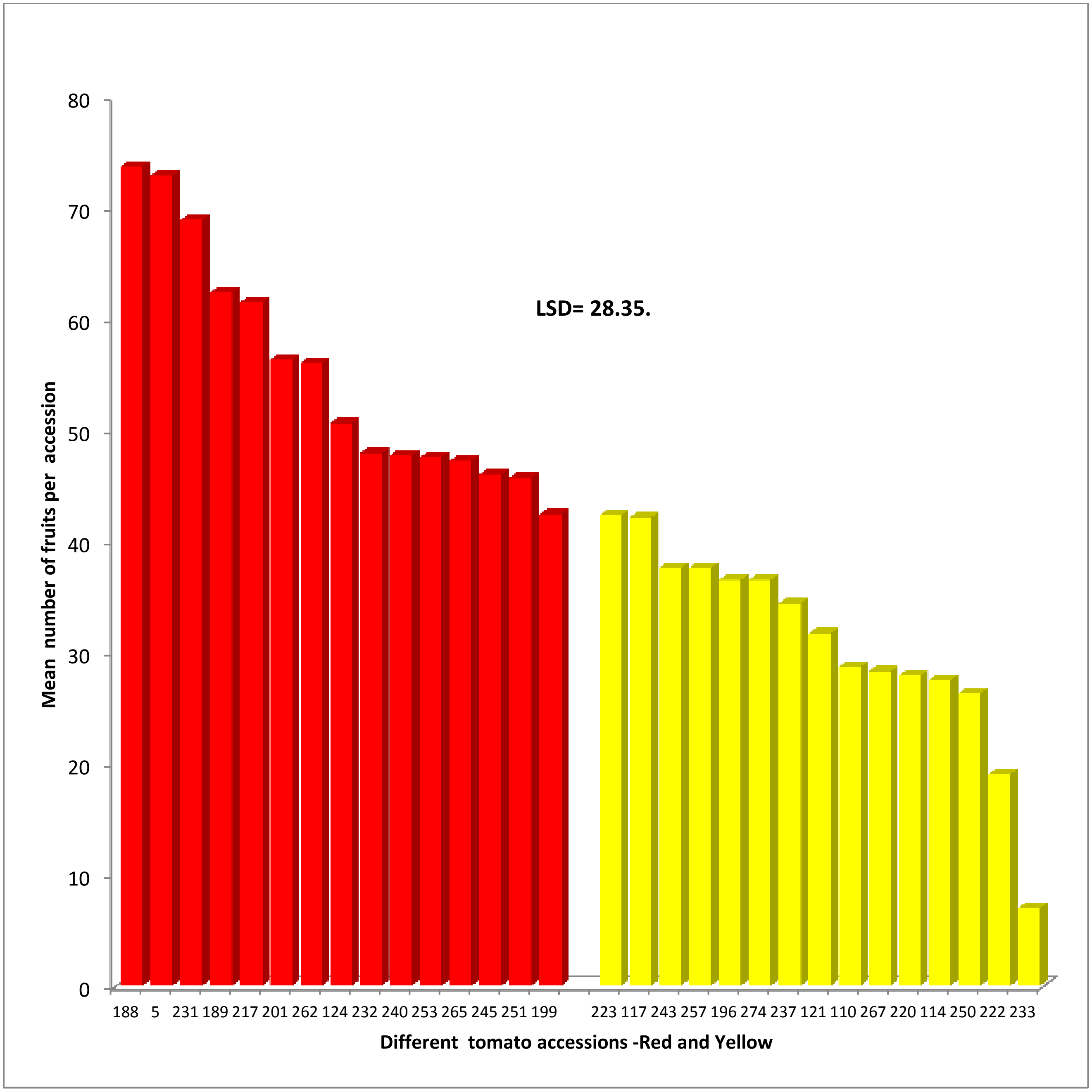


Figure 4.1: Mean number of fruits for tomatoes of different accessions

4.2.4 Plant height

The grand mean for the plant height for all the tomato accessions in the pots a, b and c of the experiment was 89.1, and most means were between 80.0- 79.0. The lowest mean was 70.0 and the highest being 117.0. There was no significant difference in the plant height for the different accessions at 81 days from the day of planting as shown in Table 4.3 below:

Table 4.3: Means for the plant heights at 81 days

(a)

ACC	05	110	114	117	121	124	188	189	196	199
Means	94.7	83.7	89.7	90.3	80.0	78.0	89.3	70.0	72.0	109.0
b)										
ACC	201	217	220	222	223	231	232	233	237	240
Means	10.07	91.3	97.7	97.0	94.3	92.3	82.0	90.0	87.0	89.0
c)										
ACC	243	245	250	251	255	257	262	265	267	274
Means	117.0	99.7	56.7	79.3	91.0	88.3	92.3	91.7	89.3	9.0

4.2.5 Plant Leaf Length at 81 days

Grand mean for plant leaf length (PLL) at 81 days was 7.433, LSD=1.2713. There was a significant difference in the PLL. The highest mean was 10.833 and lowest was 6.14. Most of the means lie between 7.0-7.913 and not significantly different at $p \leq 0.05$. The findings are presented in figure 4.2 below:

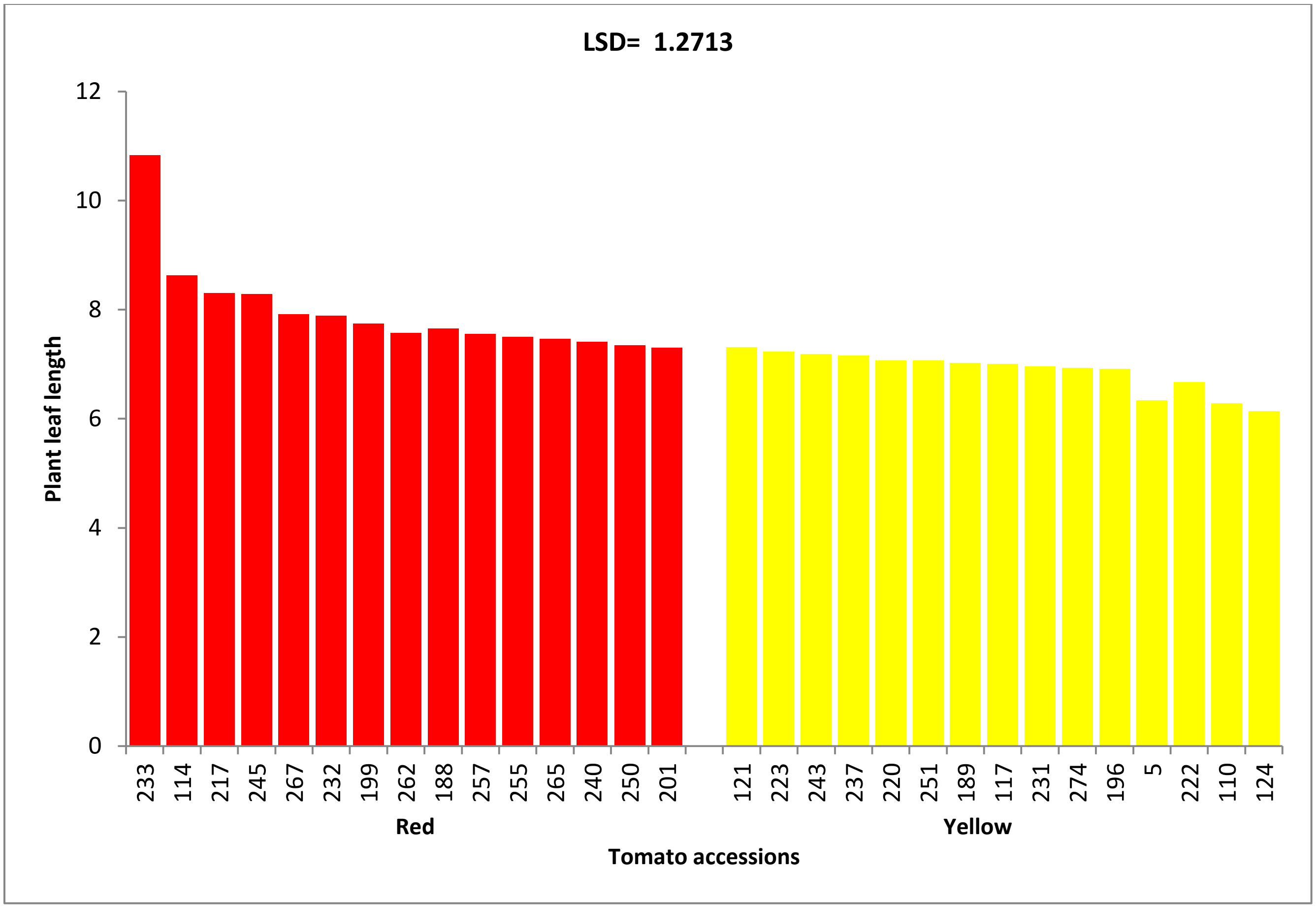


Figure 4.2: Means for the PLL at 81 days of growth from the time of sowing

4.2.6 Plant leaf width

The grand mean for plant width for indigenous tomatoes was 4.250, LSD=0.9186 There was a significant difference in the PLW, the highest mean was 5.913 and the lowest was 3.4. The grand mean obtained was 4.2. The means in the same row followed by the same letter are not significantly different at p ($\leq$0.05) as shown in Figure 4.3below:

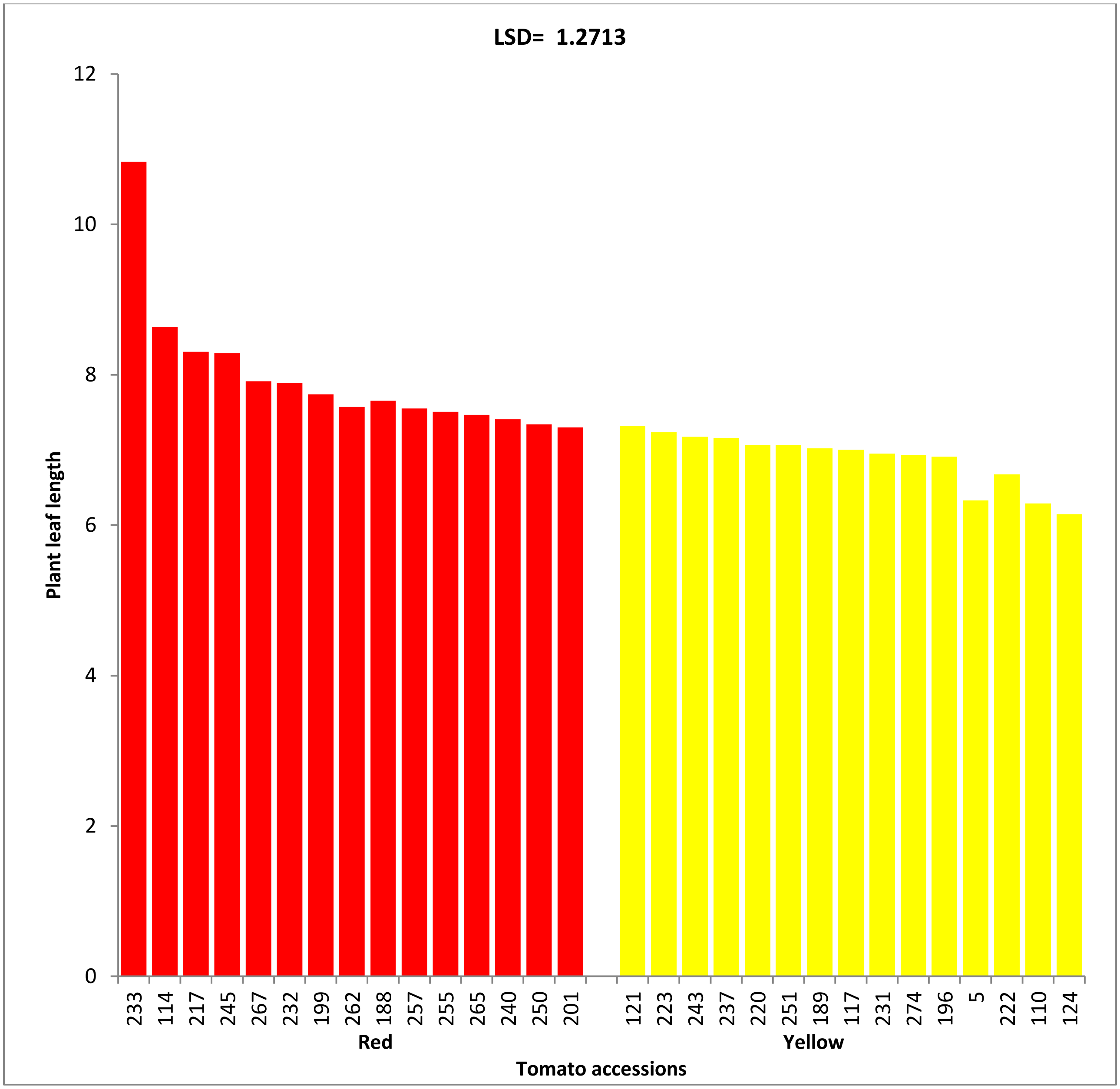


Figure 4.3*: Means for the Plant Leaf width at 81 days growth from the day of sowing*

Table 4.4: *Comparison of the height and branch characteristics of red and yellow indigenous tomato accessions from Lake Victoria crescent across different days.*

Accessions	**Mean plant height at 51 days**	**Mean plant height at 81 days**	**Mean number of branches at 51 days**	**Mean number of branches at 81 days**
237	36.00	87.0	5.00	6.33
262	43.00	92.3	5.33	7.00
240	36.50	89.0	6.00	7.67
257	40.67	88.3	4.33	6.00
189	47.50	70.0	6.33	7.00
232	44.33	82.0	4.00	6.00
222	42.50	97.0	4.67	7.00
231	45.33	92.3	5.00	8.33
217	43.67	91.3	5.67	7.00
245	37.00	99.7	7.00	8.00
199	47.00	109.0	5.67	6.33
220	36.10	97.7	4.00	7.33
188	41.97	89.3	7.00	7.67
233	49.00	90.0	4.00	5.00
114	37.33	89.7	5.67	8.00
255	52.17	91.0	5.67	7.33
110	39.00	83.7	5.67	7.00
250	41.50	56.7	5.99	5.33
251	39.33	79.3	6.33	7.67
124	38.17	78.0	6.67	8.33
267	39.30	89.3	6.00	7.33
117	42.00	90.3	4.67	7.33
274	39.47	91.0	5.00	5.67
5	42.27	94.7	7.33	8.33
223	44.83	94.3	4.67	6.33
201	33.47	100.7	5.00	6.33
243	47.00	117.0	4.33	6.33
265	41.03	91.7	6.00	7.67
121	39.00	80.0	6.33	6.67
196	48.67	72.0	4.33	5.33
e.s.e	**4.034**	**10.92**	**0.791**	**1.113**
s.e.d	**5.705**	**15.44**	**1.119**	**1.575**
L.s.d	**11.420**	**30.91**	**2.241**	**3.152**
CV%	**2.3**	**4.2**	**4.9**	**5.8**
F-pr	**0.245**	**0.386**	**0.115**	**0.855**

LSD (0.05) = Least Significant Difference at 5% level; E.S.E= Estimated Standard Error; S.E.D= Standard Error of Difference; F-pr = Fisher's Probability; CV%= Percentage Coefficient of Variations

The results show that the plant height showed a difference from 11.42 to 30.91 at LSD of 0.05 and a significant difference in the number of branches was also noted between 51 and 81 days of planting. This shows that the height and number of branches increased as the plant matured.

Table 4.5: *Comparison of leaf length and width characteristics of red and yellow indigenous tomato accessions from Lake Victoria crescent across different days*

Accessions	Leaf length at 51 days	Leaf length at 81 days	Leaf width at 51 days	Leaf width at 81 days
237	4.35	7.160	2.520	4.073
262	4.57	7.573	2.340	4.347
240	5.03	7.407	2.620	4.147
257	4.75	7.553	2.640	4.513
189	3.14	7.020	2.573	3.960
232	4.41	7.893	2.513	4.587
222	4.99	6.673	2.640	3.893
231	5.09	6.953	2.567	3.913
217	5.17	8.307	2.487	4.653
245	6.11	8.287	3.260	4.747
199	5.34	7.740	2.780	4.447
220	5.07	7.067	2.513	4.013
188	5.90	7.567	3.527	4.133
233	5.93	10.833	3.200	5.913
114	5.76	8.633	2.653	4.660
255	4.91	7.507	2.460	4.127
110	3.90	6.287	2.193	3.700
250	2.97	7.343	1.440	4.147
251	4.82	7.067	2.607	3.873
124	3.79	6.140	1.893	3.440
267	5.47	7.913	2.720	4.700
117	4.99	7.007	2.653	3.767
274	4.35	6.933	2.280	4.093
5	4.13	6.733	2.227	3.920
223	5.60	7.233	3.173	4.113
201	5.03	7.300	2.473	4.167
243	6.45	7.180	3.773	5.407
265	4.99	7.467	2.547	3.987
121	4.81	7.313	2.440	3.973
196	3.26	6.913	1.753	4.080
e.s.e	**0.701**	**0.4491**	**0.3847**	**0.3245**
s.e.d	**0.992**	**0.6351**	**0.5440**	**0.4589**
L.s.d	**1.985**	**1.2713**	**1.0890**	**0.9186**
CV%	**5.7**	**6.0**	**9.7**	**5.4**
F-pr	**0.103**	**<.001**	**0.086**	**0.003**

LSD (0.05) = Least Significant Difference at 5% level; E.S.E= Estimated Standard Error; S.E.D= Standard Error of Difference; F-pr = Fisher's Probability; CV%= Percentage Coefficient of Variations

The findings show that the plant leaf length and width increased with the plant's maturity/age, although there was no significance relationship between the leaf length and leaf width ($p < 0.05$), as shown in Table 4.6.

Table 4.6: *The average days to flowering, fruiting and ripening characteristics of red and yellow indigenous tomato accessions from Lake Victoria crescent*

Accessions	Days to flowering	Days to fruiting	Days to ripening
237	51.33	55.67	86.0
262	52.00	55.33	86.0
240	35.00	56.00	87.3
257	55.67	59.00	87.0
189	52.67	56.33	86.0
232	50.00	55.67	85.3
222	52.00	55.67	89.7
231	51.33	55.00	86.3
217	52.33	56.33	87.0
245	52.67	56.33	88.0
199	50.67	55.00	86.7
220	53.00	59.67	92.0
188	51.33	55.67	87.0
233	52.33	58.33	92.0
114	52.33	57.00	89.3
255	50.67	55.00	88.7
110	53.67	59.00	90.0
250	48.67	55.67	60.0
251	51.00	54.67	86.0
124	51.33	57.67	86.0
267	51.67	55.00	87.3
117	54.67	58.33	89.0
274	54.00	57.67	87.0
5	50.33	54.33	86.3
223	52.00	56.00	86.7
201	53.33	58.67	89.3
243	51.00	56.00	87.0
265	51.33	56.00	86.0
121	51.00	55.00	86.0
196	52.00	37.67	57.3
e.s.e	**3.480**	**3.679**	**7.84**
s.e.d	**4.921**	**5.203**	**11.09**
L.s.d	**9.851**	**10.416**	**22.19**
CV%	**1.3**	**1.7**	**1.3**
F-pr	**0.542**	**0.458**	**0.582**

LSD (0.05) = Least Significant Difference at 5% level; E.S.E= Estimated Standard Error; S.E.D= Standard Error of Difference; F-pr = Fisher’s Probability; CV%= Percentage Coefficient of Variations

4.3 Comparison of the yield of red and yellow indigenous tomato accessions from Lake Victoria crescent.

Table 4.7: *The average number of clusters per plant, number of fruits per cluster, number of fruits per accession and yield (g) characteristics of red and yellow indigenous tomato accessions from Lake Victoria crescent*

Accessions	**Number of cluster per plant**	**Average number of fruits per cluster**	**Number of fruits per accession**	**Average yield (kg)**
237	8.00	4.40	34.4	0.298
262	10.67	5.20	56.0	0.279
240	9.33	5.13	47.7	0.170
257	8.33	4.47	37.6	0.323
189	10.67	5.80	62.4	0.291
232	10.33	4.53	47.9	0.230
222	4.33	4.47	19.0	0.257
231	13.67	5.07	68.9	0.341
217	9.00	6.87	61.5	0.416
245	10.67	4.33	46.0	0.236
199	9.00	4.80	42.4	0.240
220	5.67	4.53	27.9	0.256
188	13.67	5.40	73.7	0.399
233	3.00	2.37	7.0	0.081
114	6.67	4.13	27.5	0.216
255	9.33	5.00	47.5	0.240
110	8.33	3.60	29.7	0.285
250	5.67	3.07	26.3	0.232.
251	8.33	5.47	45.7	0.196
124	11.33	4.73	50.6	0.347
267	8.00	3.53	28.3	0.338
117	8.33	4.67	42.1	0.258
274	7.67	4.80	36.5	0.283
5	12.67	5.73	72.9	0.321
223	6.67	6.27	42.3	0.231
201	9.00	6.20	56.3	0.154
243	8.67	4.47	37.6	0.321
265	10.33	4.53	47.2	0.284
121	8.00	3.87	31.7	0.251
196	7.67	3.13	36.5	0.251
e.s.e	**1.830**	**0.574**	**10.01**	**68.3**
s.e.d	**2.589**	**0.811**	**14.16**	**96.6**
L.s.d	**5.181**	**1.624**	**28.35**	**193.5**
CV%	**4.7**	**5.7**	**4.5**	**14.2**
F-pr	**0.032**	**<.001**	**0.002**	**0.446**

LSD (0.05) = Least Significant Difference at 5% level; E.S.E= Estimated Standard Error; S.E.D= Standard Error of Difference; F-pr = Fisher's Probability; CV%= Percentage Coefficient of Variations

Results of the study in Table 4.7 show that there was a significant relationship between number of cluster per plant and the number of fruits per cluster. There was significant relationship between accessions grown and the yield per accession over a given period of planting.

4.2. Comparison of the yield of red and yellow indigenous tomato accessions

The second objective was to compare the yield of red and yellow indigenous tomato accessions from Lake Victoria crescent. The yield was established basing on the weight of fruits kilograms for the two varieties. The findings were ascertained and are graphically presented in Figure 4.4.

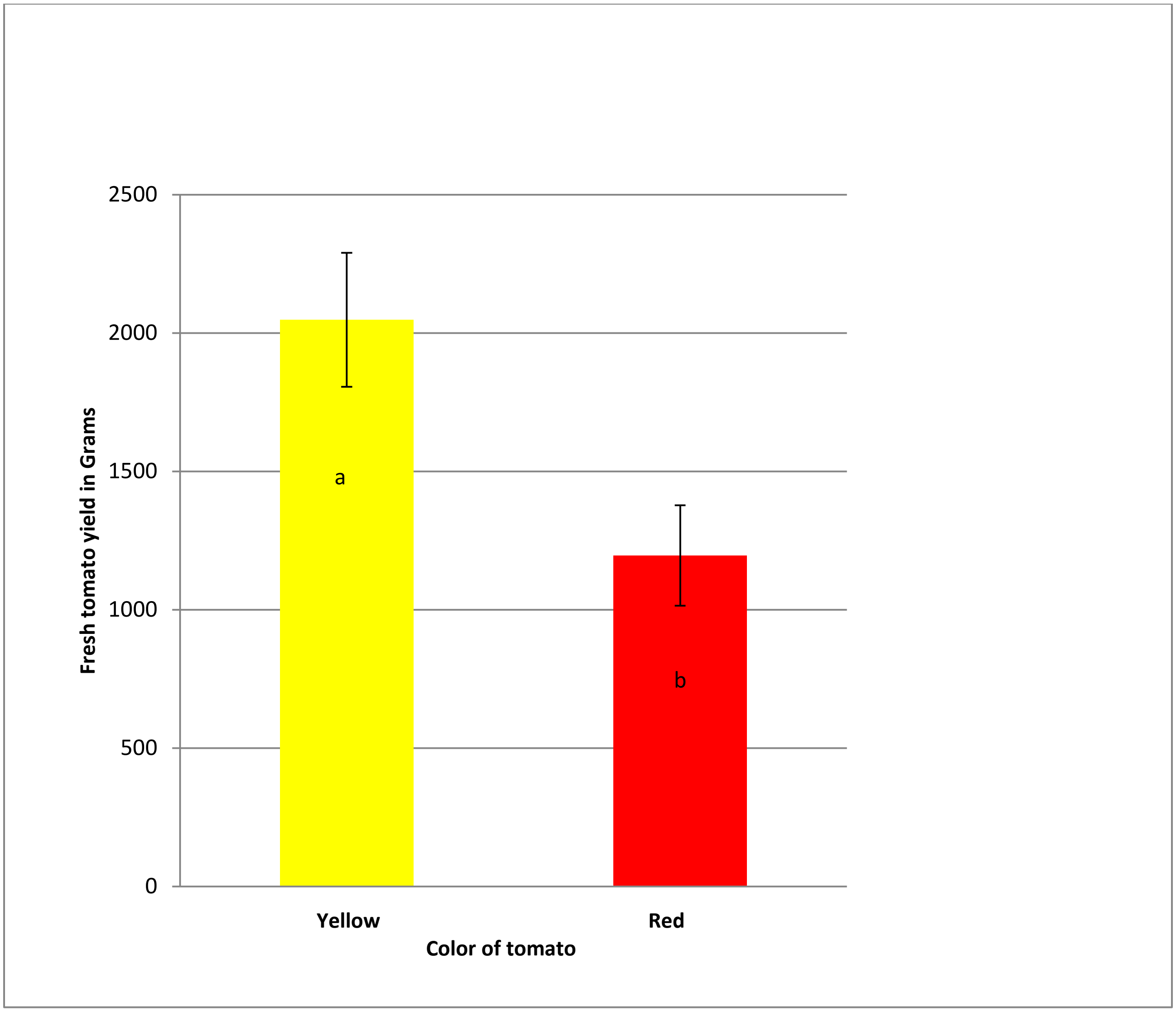


Figure 4.4 Mean yields in grams of Yellow and Red tomato varieties grown

Results from Figure 4.4 shows that yellow varieties had the highest mean yield (2048 grams in after the 81 days' harvest done from all the experimental crops, compared to the red, which had an average yield of 1,196 grams. More so, yellow's standard error (s.e) was 242.2 as compared to 181.9 for Red. The findings depict that growing yellow varieties is better in yield performance as compared to the red indigenous tomato varieties. Generally, the yield per plant and total yield per variety grown were statistically significant among the varieties of indigenous tomato accessions from Lake Victoria crescent.

4.3. Findings from the survey

Further findings were presented basing on the surveys conducted in the greater districts of the Lake Victoria Crescent. These findings are presented basing on the survey questionnaire. The results cover the background information and farmers' perceptions regarding the growing of indigenous tomatoes from Lake Victoria Crescent.

4.3.1 Background characteristics

Results revealed that six out of each ten (63.3%) were female and the remaining were male tomato farmers. Overall, tomatoes farming was being done by farmers of all ages though 31-40 years was the average age bracket (38.3%) in all selected regions. In the findings, nine out of ten (96.7%) were married, and most households (60%) had 1-5 members, a scenario which is observed even across the three study regions. Only 35% of the households had 6-10 members while 5% had 11 or more members. The findings show that growing of red and yellow tomatoes was an activity done by most of the married women, for purposes of feeding their families, and a few for sale. Details are provided in Table 4.8.

Table 4.8: Summary statistics based on background characteristics

Demographic variable	Sample N=60	Greater Masaka N=20	Greater Mpigi N=20	Greater Mukono N=20	Chi square
Age of the farmer (%)					5.860[NS]
20-30	18.3	5.0	30.0	20.0	
31-40	38.3	45.0	30.0	40.0	
41-50	18.3	20.0	15.0	20.0	
51-60	21.7	25.0	25.0	15.0	
Above 60	3.3	5.0	0.0	5.0	
Gender of the farmer (%)					1.005 [NS]
Male	36.7	45.0	35.0	30.0	
Female	63.3	55.0	65.0	70.0	
Marital status of the farmer (%)					4.138 [NS]
Single	3.3	0.0	10.0	0.0	
Married	96.7	100.0	90.0	100.0	
Household size (%)					4.024 [NS]
1-5 members	60.0	45.0	70.0	65.0	
6-10 members	35.0	45.0	30.0	30.0	
11 and above	5.0	10.0	0.0	5.0	
Education level of the farmer (%)					7.490 [NS]
No formal education	5.0	10.0	0.0	5.0	
Primary level	41.7	45.0	55.0	25.0	
Secondary	40.0	30.0	30.0	60.0	
Tertiary	13.3	15.0	15.0	10.0	

Socioeconomic characteristics of the farmer; Significance levels given as: **** $P< 0.01$, **$P < 0.05$* and ** $P < 0.10$*, [NS] Not Significant

4.3.2. Tomato production characteristics

Findings reveal that more than half of the respondents (58.3%) grow mainly two types (58.3%) of tomatoes and these are identified basing on their colour across all studied regions. Common type of indigenous tomatoes was red as noted by 86.7% of the respondents. The farmers in greater Masaka wholesomely grew the red type (100.0%), although 85% and three quarters (75%) of respondents in Greater Mpigi and Greater Mukono were identified growing the red type In general 83.3% of the farmers actually grow the red type while only 16.7% grow the yellow type. While majority (96.7%) grew tomatoes for home consumption, some few farmers were adopting the practice of growing indigenous tomatoes for sale (3.3%) especially in greater Mpigi. The purpose of growing tomatoes significantly correlates with the size of land used for tomato cultivation.

The overall sample results reveal that 98.3% of the respondents cultivate the tomatoes in less than ¼ ha. Only 1.7% cultivate in less than ½ ha. It is worth noting that all respondents in Greater Mpigi and Greater Masaka cultivate their tomatoes in less than ¼ ha. The proportion of farmers using more than ¼ ha under indigenous tomato farming is about 2 out of each ten farmers an indication that tomato production is predominantly a small-scale subsistence activity.

Regarding the source and ownership of tomato seeds, most farmers (91.7%) were found owning their own tomato seed. Only 6.7% obtain seed from fellow farmers' and1.7% purchase seed from seed dealers. These findings indicate significantly that farmers owned their seed, and developed seedlings on their own. For all the variable that describe the tomato production characteristics results of the chi square test reveal no statistical significance observed for the differences between the responses both for the overall sample and across the three study regions. The detail of the findings is presented in Table 4.10.

Table 4.9: Tomato production characteristics

Tomato production characteristics	Sample N=60	Greater Masaka N=20	Greater Mpigi N=20	Greater Mukono N=20	**Chi square**
Number of types of indigenous tomatoes ever seen (%)					7.997 NS
One	30.0	45.0	20.0	25.0	
Two	58.3	55.0	55.0	65.0	
Three	11.7	0.0	25.0	10.0	
Four and above					
Common type growing in area (%)					5.481 NS
Red	86.7	100.0	85.0	75.0	
Yellow	13.3	0.0	15.0	25.0	
Type grown by farmer (%)					3.840 NS
Red	83.3	90.0	90.0	70.0	
Yellow	16.7	10.0	10.0	30.0	
Purpose of growing tomatoes (%)					4.138 NS
Home consumption	96.7	100.0	90.0	100.0	
Sale	0.0	0.0	0.0	0.0	
Both home consumption and sale	3.3	0.0	10.0	0.0	
Size of tomato field (%)					2.034 NS
Less than ¼ ha	98.3	95.0	100.0	100.0	
Less than ½ ha	1.7	5.0	0.0	0.0	
Between ½ ha to 1 ha	0.0	0.0	0.0	0.0	
More than 1 ha	0.0	0.0	0.0	0.0	
Amount of fruit collected (%)					1.660 NS
1-2 kgs	56.7	50.0	65.0	55.0	
3-5 kgs	31.7	35.0	30.0	30.0	
Above 5 butasas	11.7	15.0	5.0	15.0	
Source of seed (%)					2.646 NS
Own saved seed	91.7	95.0	85.0	95.0	
From fellow farmers	6.7	5.0	10.0	5.0	
From market	0.0	0.0	0.0	0.0	
From seed dealers	1.7	0.0	5.0	0.0	

Tomato production characteristics of the farmer; Significance levels given as: *** $P < 0.01$, **$P < 0.05$ and * $P < 0.10$, NS Not Significant

4.3.3 Farmers' perception on the growing of indigenous tomatoes

The farmers' perceptions regarding the growing of indigenous tomatoes were also identified in relation to production constraints associated with indigenous tomatoes and their perceptions in regard to disease influx and management when growing indigenous tomatoes.

4.3.3.1. Production constraints associated with indigenous tomatoes

Findings in Table 4.10 below show that farmers' perception for the various tomato production constraints by region and based on weighted rank index. The study established that due to limited land (index 0.212), farmers had negative attitudes to indigenous tomatoes with the highest index of 0.212 for greater Masaka, 0.218 for Greater Mpigi, 0.209 for greater Mukono, and 0.213 for the overall sample.

Infertile soils and pests/diseases were ranked second and third constraints according to farmers' perception regarding hindrances to indigenous production activities in the LVCR. The ranking for all the constraints was similar both in position and the score index (Table 4.10). All in all, farmers' perceptions towards production of indigenous tomatoes were related with limited land as a large number of farmers revealed they cannot replace normal food items that are needed for every day meals by tomatoes. Thus, tomatoes are not a preferred crop by many farmers who cultivate a number of crops.

Moreover, output (yield) from tomatoes is not that much, fetches little earnings and income for the farmer. Other farmers' perceptions in regard to indigenous tomatoes production were their affinity to pests and diseases, lack of seed, drought, inadequate extension services, infertile soils, negative attitude about the type of tomato, limited market and competition with hybrid tomato. Farmers' perception on the severity of the production constraint (as ranked in table 4.10) is therefore a key determining factor on whether the farmer cultivates or does not cultivate indigenous tomatoes. The detail statistics are presented below.

Table 4.10: Farmers' perceptions to tomato production constraints based on a weighted rank index

Constraint[1]	Greater Masaka[2]				Greater Mpigi[2]				Greater Mukono[2]				Combined[2]			
	1	2	3	Rank[3]	1	2	3	Rank[3]	1	2	3	Rank[3]	1	2	3	Rank[3]
PD	12	3	5	0.132	19	0	1	0.092	15	2	3	0.155	46	5	9	0.113
LS	17	0	3	0.104	19	1	0	0.088	19	1	0	0.086	55	2	3	0.093
LL	2	3	15	0.212	3	2	15	0.218	4	1	15	0.209	9	6	45	0.213
D	20	0	0	0.080	17	0	3	0.109	19	0	1	0.090	56	0	4	0.093
IES	20	0	0	0.080	20	0	0	0.084	20	0	0	0.082	60	0	0	0.082
IS	10	1	9	0.156	10	2	8	0.159	9	0	11	0.172	29	3	28	0.162
NAT	20	0	0	0.080	20	0	0	0.084	20	0	0	0.082	60	0	0	0.082
LM	19	1	0	0.076	20	0	0	0.084	20	0	0	0.082	59	1	0	0.080
CHT	20	0	0	0.080	20	0	0	0.084	20	0	0	0.082	60	0	0	0.082

Notes: [1]PD = Pests and diseases, LS= Lack of seed, LL = Limited land, D= Drought, IES=Inadequate extension services, IS=Infertile soils, NAT=Negative attitude about the type of tomato, LM=Limited market, CHT=Competition with hybrid tomato; [2]1= Agree; 2 = Not sure; 3 = Disagree; [3]Ranking index = Sum of [3 for Agree+ 2 for not sure + 1 for Disagree] divided by [3 for Agree+ 2 for not sure + 1 for Disagree] for all production constraints

4.3.3.2. Farmers' perceptions to disease influx and management

Understanding the farmers' perceptions to indigenous tomatoes required examining their views regarding diseases affecting these tomatoes varieties and how they are managed. Results show that 66.7% of the respondents who were also indigenous tomato farmers mentioned that signs and symptoms of late blight that showed that their tomatoes were having the disease while 18.3% mentioned early blight. With exception of greater Mpigi, farmers (15%) in greater Masaka (20%) and greater Mukono (25%) were not facing any disease. This attracted a number of farmers to grow indigenous tomatoes, and indigenous tomatoes did not suffer bacterial wilt (0.0%).

Findings further revealed that eight out of ten (86.7%) of the farmers noted to have learnt the prevalence of the disease from fellow farmers, though some did not learn from any one especially in Mpigi. In all study regions, farmers of indigenous tomatoes revealed they did not get information from extension workers or media. Mostly farmers recognised the occurrence and presence of any of the above diseases at fruiting stage (58.3%). In all regions two out of ten (20.0%) farmers identified disease symptoms at seedling especially in Mukono and Mpigi, while others recognised it at flowering, shooting stages and about 13.3% did not pay attention to any stage. Moreover, 70% of these diseases were reported severe at fruiting stage of these indigenous tomatoes and the effect was observed on leaves (61.7%) and fruits for all regions. However, some farmers did not get any observable effect of the diseases in greater Mukono.

Regarding disease management, more than half of the respondents (61.7%) said they managed the occurrence of the disease in their community through use of plant extracts, although a number of farmers (26.7%) in all the regions did not have any disease management mechanism. A few farmers (1.7%) used pesticides (1.7%) and IPM (10%) especially in greater Mukono and Mpigi respectively.

A modern approach of using pesticides to manage indigenous diseases was less used (96.7%) especially none of the farmers in Mpigi had ever used pesticides. Moreover, only 5% of the farmers used it twice a week in Mukono and Mpigi regions. The findings were significant for the common tomato diseases at 0.05, disease severity at 0.10, and for the affected parts severity levels at 0.01. Nevertheless, other variables describing the farmers' perceptions to disease occurrence and management showed no statistical significance from the results of the chi square test. The detail of the findings is presented in Table 4.11.

Table 4.11: Summary statistics based on tomato diseases and its management

Diseases and management of tomato diseases	Sample N=60	Greater Masaka N=20	Greater Mpigi N=20	Greater Mukono N=20	Chi square
Source of knowledge of disease (%)					5.481 NS
From fellow farmers	86.7	75.0	100.0	85.0	
From extension staff	0.0	0.0	0.0	0.0	
Mass media	0.0	0.0	0.0	0.0	
None	13.3	25.0	0.0	15.0	
Stage of disease symptoms (%)					7.957 NS
Seedling	20.0	20.0	15.0	25.0	
Flowering	3.3	5.0	0.0	5.0	
Fruiting	58.3	50.0	80.0	45.0	
Shooting	5.0	5.0	5.0	5.0	
None	13.3	20.0	0.0	20.0	
Stage of disease severity (%)					12.652*
Seedling	8.3	20.0	0.0	5.0	
Flowering	6.7	5.0	10.0	5.0	
Fruiting	70.0	50.0	90.0	70.0	
Shooting	0.0	0.0	0.0	0.0	
None	15.0	25.0	0.0	20.0	
Part of plant most affected (%)					25.030***
Flowers	0.0	0.0	0.0	0.0	
Leaves	61.7	65.0	40.0	80.0	
Fruits	23.3	10.0	60.0	0.0	
Roots	0.0	0.0	0.0	0.0	
None	15.0	0.0	0.0	20.0	
Management of disease (%)					18.740**
Pesticides	1.7	0.0	0.0	5.0	
IPM	10.0	0.0	30.0	0.0	
Plant extracts	61.7	55.0	55.0	75.0	
None	26.7	45.0	15.0	20.0	
Frequency of use of pesticides (%)					1.034 NS
Once a week	0.0	0.0	0.0	0.0	
Twice a week	3.3	5.0	0.0	5.0	
Three times a week	0.0	0.0	0.0	0.0	
More than three times a week	0.0	0.0	0.0	0.0	
Not applicable	96.7	95.0	100.0	95.0	

Disease and management of tomato diseases; Significance levels given as: ****P< 0.01*, ***P < 0.05* and * *P < 0.10*, NS Not Significant

CHAPTER FIVE

DISCUSSION OF THE FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter covers the discussion of the findings that were established in regard to performance of indigenous tomato accessions from Lake Victoria Crescent. The discussion includes findings on growth and yield characteristics of indigenous tomato accessions and farmers' perception on the growing of indigenous tomatoes. It also presents the conclusions and recommendations reached by the study.

5.2 Growth characteristics of indigenous tomatoes

5.2.1 Fruiting dates

There was no significant difference in the fruiting dates for the tomatoes from the different accessions (Table 4.1). There were no significant growth rates due to the same planting dates and therefore the onset to flowering and fruiting was at the same time among different accessions. Additionally, these tomatoes may be of the same variety or genetic make-up despite the fact that they were picked from different places and therefore growing those under similar environment had no impact on the days to fruiting.

5.2.2 Number of branches

There was a significant difference in the number of branches at 81 days of growth from the time of planting (as shown in table 4.2). The highest number of branches recorded was obtained from accession numbers 05 and 124 while the lowest recorded was five (5) branches from accession number 250. The results differ with Iqbal *et al*., (2011) and Davis *et al.*, (2003) who reported that the number of branches varied in different cultivars due to their genetic makeup. There is a reason to believe that the 30 accessions are not of the same cultivar due the differences in fruit color, size and texture.

5.2.3 Number of fruits per accession

There was a significant difference ($p \leq 0.05$ appendix1) in the number of fruits per accession (also indicated in table 3a and b for the means). The highest and lowest number of fruits being seventy three (73) and seven (7) respectively (table 4.7). This could be due to the growing of these accessions in the same locality as well as the environment influences on the yield. This may also be due to their genetic composition as reported by Adelana (1975) who discovered that only 50% of the flowers produced developed into fruits, thus sink size was a limiting factor to fruit production in tomato. Similarly, the variation in the number of fruits could be due to poor fruit set may be as a result of high temperatures that are not conducive for good fruit set (Simon & Sobulo, Olaniyi *et al*., 1974).

Furthermore, practices like staking which was carried out indiscriminately in all the accessions could have impacted on the indeterminate and the determinate types and thus the variation in the number of fruits.

5.2.4 Plant height

There was no significant difference in the plant height at 81 days growth from the day of planting as indicated in table 4.4. This could have been attributed to by the staking that was provided to all plants during the growing period. Tomatoes are usually staked and supported off the ground, in an effort to minimize losses from rots when the fruit is in contact with the soil. This practice has also proven to be effective in reducing the increasing plant height and providing enough space, thereby increasing yields (Saunyama and Knapp, 2003). Additionally, plant height could have been influenced by the fact that all the accessions were staked. Staked tomatoes exhibit greater height as compared to the un staked. On the other hand, the tomato cultivars that have a determinate growth are usually much small and bushier. They have a genetic makeup that has a set height according to Lerner, (2001) who reported that once it reaches a given height, the growth stops and it produces flower clusters and sets fruits, yields and dies. This is not in accordance with Frank (2003) who recorded the highest plant height in un-staked treatments could be attributed to creeping nature of the tomato stem. Once a creeping stem is allowed to grow undisturbed, it has the tendency to grow faster and longer than the plant trained to grow against its natural course.

5.2.5 Plant leaf length and plant leaf width

There was a significant difference in the plant leaf length at 81days of growth among the accessions (as indicated in table 4.5 and 4.6). The highest plant leaf length was 10.83cm for accession number 233 whereas the lowest was 6.14 from accession number 124 and their mean value being 7.433 while the highest plant leaf width was 5.407cm from accession number 243 and the lowest was 3.440cm obtained from accession number 188 (table 4.5 and 4.6). The differences in leaf length and leaf width could be genetically driven since the accessions were all growing in the same environment.

According to Evans (1984), changes in leaf area depend on the relative rate of two processes, growth in leaf area and senescence. Change in shape and size of successive leaves on a plant are related to physiological changes associated with increasing age of the plant (Esau, 1965), interaction between the shoot apical meristem and the developing leaf primordial (Byrne *et al*., 2001), genetically regulated programmes of shoot maturation and a variety of environmental factors (Poethig, 1997). One of the leaf shape parameters is the length to width ratio. Verwijst and Wen (1996) found that in solanaceous plants, the length to width ratio changed with leaf size and differed between different types of shoots.

Sugiyama and Oozono (1999) showed that this ratio of individual leaves decreased with time and eventually became constant. Comparable results were found in tomatoes (Day *et al*., 2001). Consequently the ratio between leaf area and the product of length and width changes with plant age but the rate of this change may not considerably be the same (Marshall, 1968). This is similar with the results obtained from this experiment given the fact that these plants might have been growing at slightly varying rates.

5.3 Comparison in yield of the red and yellow indigenous tomato accessions

Findings of the study (Figure 4.7) and also in Table 4.7 show that while all the indigenous varieties presented a substantial yield after 81 days of experimental testing and growth, the yellow variety' yield was higher compared to red. This however was an average mark, given that in some regions/areas as noted in the survey had more of the red tomatoes doing better than the yellow. The study noted that the two varieties at the 95% confidence interval, exhibited difference in means: (231.8, 1473), which was significant. This finding relates closely to Niel and Wessels (2006) who in their study noted that the indigenous varieties tend to produce and give a farm yield basing on agronomic factors, but also the difference in the variety grown. This clearly depicts that under the same and normal conditions of growth, the yellow variety does best compared to the red indigenous variety.

A close look at the overall yield in the yellow and red indigenous varieties also shows that there was a significant difference in yield per plant in grams. More of the kilograms (2.048) were harvested from the yellow, compared to 1.196 kilograms of red tomatoes given the same conditions of propagation, care, management and environment. Therefore, improving on the growth of the yellow varieties is better as compared to investment in the red varieties, if the goal is to attain high farm output (yield).

5.4 Farmers perception on growing of indigenous tomatoes

5.4.1 Tomato farmers background

Tomato production is an indigenous activity of the people living in the Lake Victoria crescent. The Lake Victoria crescent (as in appendix II), is the areas served and having a shore line with the Lake Victoria on the Uganda side. In this study the three (3) major districts (greater Mukono, Masaka and Mpigi) were considered for the study. Tomato production in this area is mainly done on subsistence basis (Table 4.8) and by all households though dominantly undertaken by females (Table 4.8). The study noted that indigenous tomato growing is done on small-scale (1/4 ha) of land acreage. The practice of indigenous tomato production is not widely undertaken on commercial scale as it is for exotic breeds. This has made indigenous tomato production an activity dominantly substance. This finding agrees with FAO (2003) report which points out that tomato is now the most important vegetable in the tropics. From the findings, the age group of 31 – 40 years had the highest percentage of respondents probably due to the fact with that age range people are very energetic and with many responsibilities. This therefore encourages them to work very hard. On the contrary the age group of above 60 years may have respondents who are not very vibrant and with many responsibilities. A study by Tauer and Lordkipanidze (2000), indicates that farmers in age group 35– 44 are more productive by 7% than their counter parts of age 55–64. This is similar to the above findings that age group of 31–40 had the highest production percentage and age group above 60years had the lowest percentage. In a related study by Anyiro and Onyedikachi (2013), revealed that majority of the yam farmers are between the ages of 30 to 60 years which tallies with the above finding where majority of the indigenous tomato farmers are in the age group of 31 – 40 years.

A study by United Nations Development Programme (UNDP) revealed that women make up some 60 to 80% of agriculture labour force in Nigeria which agrees with reports by Oyugi *et al*, (2015) in Kenya who established that more female are involvement in production of orphaned crops. As stated other reports that women play more role in hoeing, weeding, harvesting as well as preservation and processing of crops and care for domestic animals (Mohammed and Abdulquadri 2012), which was in line with the observation made by Olayemi, *et al*, (2012) that women are known to be more involved in Agricultural activities than men in Sub – Saharan African countries.

In indigenous tomato production using labor provided from the house hold is one indicator why there were more married respondents so as to reduce on costs of hiring labor Anyiro and Onyedikachi (2013). This trend seem to agree with findings by Fabiyi *et al.,* (2007) where they observed over 50% of the married farmers engaged in production. This corresponds clearly with a report which revealed that married respondents were dominant than the male in cassava production (Nenna, 2016).

Overall, the growing of red and yellow tomatoes was an activity done by most married people in the households in lake victoria cresent region for subsistence needs. A fair literacy level was attained, this is quite relevant in taking up a farming enterprise like tomatoes since education reflect farmers' ability to obtain and evaluate information about an enterprise and therefore an indication of how the farmer would perceive the enterprise. This is in contrast with finding made by Saghir, (2015) and Rasheed (2004) which established high illiteracy levels of 77.5% and 66.7% among rural farmers, respectively. This corresponds with Anyiro and Onyedikachi, (2013), whose findings revealed that over 90% of the farmers were literate possessing diverse formal education levels ranging from primary to tertiary education.

5.4.2 Production characteristics

Most of the farmers were growing tomatoes for subsistence purpose. However, some farmers were growing the red and yellow indigenous tomatoes for sale especially in greater Mpigi. This was not a new aspect as it was also cited by MAAIF (2015) and tomato is grown and consumed in every district of Uganda.

The study also established that indigenous tomatoes are grown basing on local seeds produced by farmers themselves or get seeds from fellow farmers while a few purchased these seeds from seed dealers (Table 4.9). This still shows that production of indigenous tomatoes was considered a domestic activity, and some tomatoes grow naturally in the compounds and banana plantations.

5.4.3 Farmers' perception on production constraints and disease control of indigenous tomatoes

Growing and overall production of indigenous tomatoes is an activity that has attracted both positive and negative perceptions from farmers in Lake Victoria Crescent. Building on the view held in the FAO (2005) that tomatoes is the second most paid vegetable after potato, farmers still believe tomatoes is one of the most feasible vegetable and fruit each household should have. However, to a large number of farmers (Table 4.10), indigenous tomatoes were perceived to be associated with production constraints.

Results show that in all regions visited, land, infertile soils and instances of being infested with pests and diseases were noted production challenges which majority of the farmers perceived as constraining factors. Most farmers did not spare land for growing indigenous tomatoes, but used the compounds and homestead plantations, keeping the rest of the land for other crops. This perception stemmed from less prioritization of indigenous tomatoes, contrary to the Kyamanywa *et al* (2013) who noted that production of tomatoes is undertaken on land between 0.4-0.6 ha which determines production levels. Therefore, tomatoes production sets a basis for household income levels.

Moreover, it can also be deduced from the farmers' perception that production and growing of indigenous tomatoes was associated with pests and diseases, lack of seed, drought in some areas, as well as limited access to extension services which could be helpful to boost farmers' motives to grow the crop. Additionally, some farmers had negative attitude about the type of tomato, limited market and competition between indigenous breeds with hybrid tomato. These perceptions arise in a number of studies including Mailu (2011) who noted that market gardening and commercial scale in many communities and household. Another key perception farmers had was that the indigenous tomatoes were not prone to diseases like exotic breeds and were considered resistant to bacterial wilt in all regions. Nevertheless, they suffered from late and early bright especially in regions of greater Masaka and Mukono.

Access to information as well as seeds of indigenous tomatoes were from fellow farmers and most farmers in Mpigi hardly learnt from any one about growing indigenous tomatoes but did it on their own. The role of extension workers or media was insignificant, and this made farmers to believe that growing indigenous tomatoes was largely subsistence and less supported activity by government agencies and extension services. This finding agreed with Spence (2015) who notes that while farmers complain of low yield of indigenous tomatoes, they still applaud them for being less costly, easy to manage and a number of these varieties are disease resistant, and can cope with changes in soil and climatic challenges.

In the study findings, a number of farmers recognised that like any other tomatoes, indigenous tomatoes were susceptible to disease especially at fruiting stage with symptoms visible on flowering and shooting stages although at a limited extent. However, other farmers did not see any of the signs throughout the production activities. In most regions within the LVC, farmers did not get any observable effect of the diseases especially in greater Mukono regions.

The farmers in the Lake Victoria crescent also perceived that some diseases attack tomatoes but most of them did not use pesticides. A few farmers used pesticides twice a week (Table 4.10) although more of the farmers' perceived diseases and its effect less significant. These findings agree with Oruko & Ngun'gu (2011) who revealed that a number of indigenous tomatoes had a lot of seeds, which were nutritious and are in their natural form.

5.5 Conclusion

The study revealed that there were similarities and differences in the growth characteristics of indigenous tomatoes collected from the Lake Victoria crescent. For instance non-significant characteristics exhibited include dates to fruiting, plant height and leaf area index while other characteristics like number of brunches per plant and number of fruits per plant had a significant difference from the accessions collected.

In comparing the yield of red and yellow indigenous tomatoes from districts of greater Masaka, Mpigi and Mukono, yellow indigenous tomatoes produced more yield in terms of number of fruits per plant and the total yield in kilograms compared to the red indigenous tomatoes grown under same conditions.

Farmers from the area of study perceived the production of indigenous tomatoes differently for example, some were growing them while others were maintaining those growing on their own in the banana plantations and courtyard. The red tomatoes were more preferred to yellow basing on their response. Generally most of the farmers saw the need to manage diseases and they use traditional methods like ash and plant extracts to control diseases.

5.6 Recommendations

The farmers have to appreciate the differences in growth characteristics so as to properly grow the indigenous tomatoes where they can attain desirable growth conditions.

There is need to support farmers who are interested in growing indigenous tomatoes since it was found out that they are widely grown in the Lake Victoria Crescent region but on subsistence level. They can also be grown on a commercial basis to increase farmers' incomes and livelihood.

There is need to properly focus on growing indigenous tomatoes which yield highly and disease resistant to produce better tomato yields. This can be a means to strengthen the growing of indigenous tomatoes in the Lake Victoria crescent region.

There is need for training and sensitization of farmers on matters regarding growing and handling indigenous tomatoes as it is done for exotic/hybrid varieties. This can be done by local governments in relation with NARO, MAAIF, NAADS and other development agencies.

There is also need for strengthening partnership in extension service delivery through public private partnership regarding tomato growing (reaching out to the local farmer growing indigenous tomatoes). In the study, it was seen that there is need to boost farmers' motives to grow indigenous tomatoes.

There is need to enhance access to information as well as availing seeds of indigenous tomatoes to farmers so as to be able to grow them on commercial basis.

The study further recommends that farmers should focus on growing yellow indigenous tomatoes since it was statistically found viable in giving more yields compared to the red indigenous tomatoes.

5.7 Areas for further research

Some gaps were identified during the study and findings, and therefore are recommended for further research. These include:

- There also need to study the various diseases that affect indigenous tomatoes varieties grown in the Lake Victoria region.
- There is need to collect more accessions especially yellow tomatoes from the lake victoria crescent and other regions to be considered in doing more research work.
- More research should be carried out on how the different farming practices affect the indigenous tomato performance and yield.

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APPENDICES

Appendix 1: Map of Uganda showing Area of study