A STUDY OF THE EFFECT OF WATER STRESS ON YIELD, PHYSICO-CHEMICAL CHARACTERISTICS AND NUTRIENT UPTAKE OF *SOLANUM LYCOPERSICUM* L.

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Head of Department **Signature** **Date**

DEDICATION

This is dedicated to the Almighty God, the keeper of my dreams and lifter up of my head. The one who has given me the infinite opportunity to successfully carry out this research work, and also to my Gold and Jewel; Pastor and Mrs E.A. Akinrimisi to have laid the solid foundation for my education.

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ABSTRACT

This study investigated the osmotic adjustment and nutrient uptake of six varieties of tomato (*Solanum lycopersicum* L.) at different watering regimes and evaluated the relationship between water stress and marketable yield of the tomato varieties. This was with a view to determining the role of water in crop growth and production.

The six varieties of *Solanum lycopersicum* used for the study were: Chico III, Ibadan local, Ibarapa, Ife-1, Rio Grande and Roma-VFwere the tomato varieties collected from the National Horticultural Research Institute (NIHORT), Ibadan, Oyo State, Nigeria.The tomato seed varieties were sown in bowls of 54 cm x 8 cm dimension and the seedlings were transplanted after 21 days of establishment into 54 experimental pots (20 cm x 21 cm) at the rate of three seedlings per pot. The seedlings were raised in a screenhouse under normal environmental conditions. The experimental layout was quantified with three levels of watering regimes (W_1, W_3 and W_5). A 6 x 3 factorial experiment laid out in a completelyrandomised design (CRD) was used; with watering regimes and varieties as the factors. Samplings were carried out after three weeks of transplanting. Data were recorded for growth, yield and yield components. The parameters studied for osmotic adjustment were relative water content (%) and proline ($\mu molg^{-1}$). Sodium, potassium, magnesium, calcium and manganese contents were analysed after digestion using Perkin Elmer Analyst Model – 400 Atomic Absorption Spectrophotometer. The proximate composition and the physico-chemical properties of the tomato varieties were carried out using standard procedures. Data were subjected to analysis of variance (ANOVA) while the means were separated using least significant difference (LSD) post-hoc at $p \geq 0.05$ level of probability.

Tomato plants subjected to water stress were reduced significantly ($p \geq 0.05$) in their shoot height, number of leaves and plant biomass compared to those that were watered everyday. Accumulation of proline enhanced water stress tolerance in tomato varieties of Ibadan local and Ibarapa, by improving the osmotic adjustment of the varieties, while the high relative water content in the Chico III and Roma-VF varieties made them more drought tolerant. The highest uptake of sodium, magnesium, calcium and manganese were enhanced by drought condition in Ife-1, Ibarapa and Roma-VF varieties, while,the highest uptake of potassium was influenced by watering everyday. Better fruit yield was obtained with three days watering regime. However, 35 % and 104 % reduction in yield respectively occurred with watering everyday and watering every five days. Tomato plants watered every five days had the best accumulated levels of proteins, carbohydrate and dry matter, while the plants watered every three days had the best moisture, fat and ash contents. A considerable range of variation was recorded among the tomato varieties and the drought tolerance of the varieties were in the order: Ife-1 = Chico III > Ibadan local = Roma-VF > Rio Grande > Ibarapa.

The study concluded that the accumulation of proline could not be used as the sole determinant of osmotic adjustment in water stressed plant but also potassium and magnesium ions uptake.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Stress in Plant

Stress in plants can be defined as any external factor that negatively influences plant growth, productivity, reproductive capacity or survival (Rhodes and Nadolska-Orczyk, 2001). This includes a wide range of factors which can be broadly divided into two main categories: abiotic or environmental stress factors, and biotic or biological stress factors. Stress is also defined according to Grime (1979) as the external constraints which limit the dry matter production of vegetation. Stress potentially is responsible for the abnormalities often discovered in plants which brought about favourable and unfavourable conditions. These stresses include abiotic or environmental stress factors such as salt and ion stress, heat stress, radiation stress, flooding, drought, low and high temperature and heavy metal toxicity. Stress may also be biotic or biological stress such as diseases and competition stress.

Organisms need to adapt themselves to changes in fluctuating environmental conditions. The plants, since they are not able to escape from adverse environmental conditions, have to rely entirely on their developmental plasticity to survive (Krouk *et al.,* 2011). These adaptations include the responses to temperature fluctuations, water and nutrients imbalance, UV radiation, pathogens, and insects, among other biotic and abiotic stresses. Plant growth regulators (phytohormones), compounds derived from plant biosynthetic pathways, mediate these responses by acting either at the site of synthesis or following their transport, elsewhere in the plant. Collectively, plant hormones regulate every aspect of plant growth, development and the responses of plants to biotic and abiotic stresses (Peleg and Blumwald, 2011).

A key adaptive mechanism in many plants grown under abiotic stresses, including salinity, water deficit and extreme temperatures, is accumulation of certain organic compounds of low molecular mass, generally referred to as compatible osmolytes (Hare *et al.,* 1998; Sakamoto and Murata, 2002). Under stress, different plant species may accumulate a variety of osmolytes such as sugars and sugar alcohols (polyols), proline, tertiary and quaternary ammonium compounds, and tertiary sulphonium compounds (Sairam and Tyagi, 2004).

1.2 Tomato (Solanum lycopersicum)

In 1753, the tomato was placed in the genus Solanum by Linnaeus as *Solanum lycopersicum* L. (derivation, 'lyco', wolf, plus 'persicum', peach, i.e., "wolf-peach"). However, in 1768, Philip Miller placed it in its own genus, and he named it *Lycopersicon esculentum* (Slow food Upstate, 2014). This name came into wide use, but was in breach of the plant naming rules (Slow food Upstate, 2014). Technically the combination *Lycopersicon lycopersicum* (L.) H. Karst, would be correct, but this name (published in 1881) has hardly ever been used. Therefore it was decided to conserve the well-known *Lycopersicon esculentum,* making this the correct name for the tomato when it is placed in the genus *Lycopersicon.* However, genetic evidence (e.g.Peralta and Spooner, 2001; Foolad, 2007) has now shown that Linnaeus was correct in the placement of the tomato in the genus *Solanum*, making the Linnaean name correct; if *Lycopersicon* is excluded from *Solanum*, *Solanum* is left as a paraphyletic taxon. Despite this, it is likely that the exact taxonomic placement of the tomato will be controversial for some time to come, with both names found in the literature.

Botanically speaking a tomato is the ovary, together with its seeds, of a flowering plant, i.e. a fruit. However, from a culinary perspective the tomato is typically served as a meal, or part of a main course of a meal, meaning that it would be considered a vegetable (a culinary term which has no botanical meaning), (Slow food Upstate, 2014).

The tomato (*Solanum lycopersicum*) is a short-lived perennial plant, grown as an annual plant, in the Solanaceae or nightshade family(Slow Food® Upstate, 2014;Solanaceae Source), typically growing to 1-3 m tall, with a weakly woody stem that usually scrambles over other plants. The fruit is an edible, brightly coloured (usually red, from the pigment lycopene) berry, 1-2 cm diameter in wild plants, commonly much larger in cultivated forms. Though it is botanically a berry, a subset of fruit, the tomato is nutritionally categorized as a vegetable (Enza Zaden – Teeltnieuws, 2009;Tomaat September, 2010).

The Tomato is native to South America but growing in temperate climates worldwide. The tomato begins its colourful and varied history upon the coastal highlands of western South America, where it was being enjoyed by the native peoples for a long time. Evidence supports the theory that from Peru it foundits way to Central America where it was domesticated as a little yellow fruit, called *'xitomatl'*, meaning "plump thing with a navel", and later called *'tomatl'*by other Mesoamerican peoples(Tomato History, 2013). Maya and other peoples in the region used the fruit in their cooking, and it was being cultivated in southern Mexico, and probably in other areas, by the 16th Century.

1.3 Modern Day Uses and Nutritional Values

The tomato's medicinal properties had already been endorsed in Continental Europe in the 16th Century and their consumption was believed to benefit the heart among other things, as it contains lycopene, one of the most powerful natural antioxidants which, especially when cooked, has been found to help prevent prostate, lung, stomach, pancreatic, colorectal, oesophageal, oral, breast and cervical cancers (Slow Food® Upstate, 2014).

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