GROWTH, YIELD AND NUTRITIONAL QUALITY OF LONG CAYENNE PEPPER (*Capsicum frutescens* L.) AS INFLUENCED BY ORGANIC FERTILISERS IN IBADAN AND OGBOMOSO, NIGERIA

BY

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Matric. No.: 44862

A Thesis in the Department of Agronomy

Submitted to the Faculty of Agriculture in partial fulfilment of

the requirements for the degree of

DOCTOR OF PHILOSOPHY

of the

UNIVERSITY OF IBADAN

August, 2019.

ABSTRACT

Long Cayenne Pepper (LCP) is rich in capsaicin, vitamins and antioxidants but its fruit yield and quality is reduced by low soil fertility. Organic Fertilisers (OFs) are environmentally friendly and could be used to improve soil fertility, enhance yield and crop quality. However, information on response of LCP to OFs is scanty. Therefore, effects of different OFs on growth, yield and nutritional quality of LCP in Ibadan and Ogbomoso were investigated.

Eight Organic fertilisers (Tithonia Compost-TC, Poultry Manure without Shavings-PM-S, Poultry Manure with Shavings-PM+S, Commercial Organic Fertiliser-COF, Brewery Waste-BW, Cow dung, Oil Palm Bunch Ash-OPBA and Cocoa Pod Husk-CPH) at the rate of 130 kg N/ha were each mixed with 5 kg soil from Ibadan and Ogbomoso in pots arranged in a completely randomised design with three replicates. Two cultivars of LCP (NHV-1A and NHV-1F) were transplanted at two seedlings/pot. Pots without OF served as control. Data were collected on Plant Height-PH (cm) and Number of Leaves (NL). On the field, three of the OFs (TC, SOF and PM-S) at the rate of 130 kg N/ha were evaluated on Pepper Fruit Yield-PFY (t/ha) in Ibadan and Ogbomoso. In another experiment, effects of TC at 0 (control), 45 (T1), 90 (T2) and 135 kg N/ha (T3) were evaluated on PFY in Ibadan and Ogbomoso. Vitamin C (VC) and Crude Protein (CP) contents of fruits were determined using standard procedures. Residual effects were evaluated. Field experiments were laid in a randomised complete block design with three replicates. Data were analysed using ANOVA at $\alpha_{0.05}$.

Cultivar, OFs, location and their interaction effects were significant for PH and NL. The PH ranged from 50.2±3.2 (control, NHV-1F) to 78.3±5.2 (TC, NHV-1A) and 56.9±3.3 (control, NHV-1F) to 85.1±5.3 (TC, NHV-1A), while NL ranged from 125.4±13.6 (control, NHV-1F) to 219.9±16.6 (TC, NHV-1A) and 139.8±14.0 (control, NHV-1F) to 230.0±17.1 (TC, NHV-1A) in Ibadan and Ogbomoso, respectively. The PH (84.3±5.4) and NL (234.3±17.0) under TC were highest, but similar to 79.9±5.2 and 227.3±16 (COF) and 71.3±3.2 and 221.7±12.4 (PM-S), respectively. Control treatment had the least PH (50.2±4.0) and NL (125±12.2). The PFY differed significantly among OFs and cultivars. The PFY ranged from 6.4±0.2 (COF, NHV-1F) to 7.5±0.2 (TC, NHV-1A) and 10.3±0.5

(COF, NHV-1F) to 12.6±0.5 (TC, NHV-1A) in Ibadan and Ogbomoso, respectively. Across cultivars and locations, PFY was in the order 8.3±0.3 (TC) >7.3±0.3 (COF) >6.6±0.3 (PM-S) >5.3±0.3 (control). The PFY, VC and CP were significantly different among TC rates. Across locations, PFY under T2 (39.9±2.6) and T3 (43.5±3.7) were similar but significantly higher than T1 (30.5±3.3) and control (25.2±2.0). Across cultivars and TC rates, PFY in Ogbomoso (44.1±2.8) was significantly higher than in Ibadan (25.4±2.1). The VC and CP ranged from 68.4 (control) to 90.2% (T2) and 3.8 (control) to 6.3% (T3), respectively. In the residual, PFY, VC and CP ranged from 23.7±2.1 (control) to 33.2±5.0 (T3), 56.2 (control) to 82.0% (T2) and 3.0 (control) to 5.2% (T2), respectively.

Application of 90 kg N/ha Tithonia compost improved the growth, yield, vitamin C and crude protein contents of long cayenne pepper in Ibadan and Ogbomoso, Nigeria.

Keywords: Long cayenne pepper, Tithonia compost, Pepper fruit yield, Organic fertilisers Vitamin C content

Word count: 498

ACKNOWLEDGEMENTS

To God be the glory and adoration, with Him all things are possible. My sincere gratitude goes to my supervisor, Professor J. A. Fagbayide for his invaluable encouragement, guidance and support at every stage of my project. My unalloyed appreciation goes to my supervisory committee: Professor H. Tijani-Eniola, Professor R. O Awodoyin, and Professor E. A Akinride for their useful advice and suggestions at the beginning and during the course of the work that resulted to this thesis.

The Executive Director, Dr A. A. Olaniyan, Drs E. O. Ajayi and D. J. Ogunniyan deserve my sincere appreciation for their physical, financial and intellectual contributions to the success of this work, My friends and colleagues in the Institute: Drs. S. O. S. Akinyemi, H. A. Akintoye, L. O. Olajide-Taiwo and A. A. Makinde, Olagorite Adetula, Oyeboade Adebayo, Olawumi Odeleye, Oluwafunmilayo Idowu, Olutola Oyedele and Mrs. Folasade Tairu also assisted tremendously in one way or the other for successful completion of this project. Staff of Vegetable Programme namely: Mrs. Oladayo Idowu-Agida, Mrs. Oladunni Akinpelu, Mrs. Wuraola Ajijola, Mr. Abiola. Oladigbolu, Dr Abiola. Oke, Mrs Nike Olaniyan, Mrs Funmilayo Adeyemo. Dr. Sadiat Babalola, Dr Oluyemisi Adebisi-Adelani, Mr Ademoyegun Femi, Mrs. Ronke Adesegun, Mrs. Mercy Olaniyi contributed immensely to field, laboratory and office work that led to the success of this study. I appreciate my pastor-friends, Pastor Abiodun Adeleke of Christ Deliverance Ministry (CDM) Ile aanu, Pastor Adegunwa, Pastor Kunle Adesanya and others which are too numerous to mention here for their prayers night and day. Your labour in His vineyard shall greatly be rewarded.

I shall forever remain grateful unto my parents, late Pa. Samuel Akinfasoye Akintokunbo and my aged mother, Mrs. Esther Olabimpe Akinfasoye for sponsoring my education despite the fact that they were not privileged to attend formal school.

My thanks also go to my siblings and their children that were always looking forward to the completion of the project, Mr. D. O, Akinfasoye, Mr. C. A. Akinfasoye, Mrs. Alice Olakinye, Mrs. Felicia D’almeida, Mr. J. Akinwale, Akinfasoye and the baby of the house Mrs. Dunni Akinbobola. To “My choice”, Mrs. Yetunde Akinfasoye, my children, Ayomide, OreOluwa, Akinyemi, Akinwumi, and Akinbolade for their patience and persistence while I was conducting this study. God bless all of you.

DEDICATION

This thesis is dedicated to my parents, Mama Esther Olabimpe Akinfasoye and Late Pa Samuel Akinfasoye Akintokunbo who were not opportune to attend formal school but ensured that their children have sound education.

CERTIFICATION

I certify that this work was carried out by Mr. Joel Akindele AKINFASOYE, in the Department of Agronomy, University of Ibadan.

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CHAPTER 1

INTRODUCTION

Capsicum frutescens L (Pepper) is a very important fruit vegetable that is commercially grown in the tropics. South America and Central America are presumed to be sources of the crop and was domesticated first in Mexico and later transferred to Europe through the Spanish explorers alongside with Portuguese traders. The genus *Capsicum* is made up of 22 wild, with five domesticated species. Pepper production and its consumption have consistently increased annually worldwide dating back to the 20 century because of its importance as vegetable, spice and industrial raw materials (Salter, 1985; Wien, 1997).

The five domesticated capsicum pepper species are *Capsicum annuum, Capsicum frutescens, Capsicum chinense., Capsicum baccatum, and Capsicum pubescens* (Bosland and Votava, 2000). This pepper species can be categorised to many cultivar classes depending on several factors including number of fruits per plant, shape of the fruit, colour exhibited by the fruit, pungency, flavour, intended use and the size of plant. Most commercially cultivated varieties all over the world are grouped under *C. annuum* (Smith *et al*., 1987; Bosland, 1992).

Pepper is usually cultivated as annual vegetable crop all over the world, but it grows and yields better in the tropical region of the world. Pepper crop of various species are cultivated in the different agro-ecology of Nigeria. It forms a major integral part of our daily diet and a vital component of stew and soup consumed by all and sundry in Nigeria. Pepper fruits are consumed fresh, processed or dried (Alegbejo *et al*., 1999; Gruben and El-Tahir, 2004). Daily intake of different cultivars of pepper by Nigerians on average is estimated to be 15 g, this is higher than onion, tomatoes, egusi melon and some other notable vegetables (Grubben and El-Tahir, 2004). Pepper thrives better when cultivated on well-drained soil with loose soil structure. It is mostly cultivated as annual vegetable crop, although some pepper landraces do grow as perennials. The majority of perennial belongs to the group of the Chilies. Pepper height can grow up to 30 to 100 cm in height depending on the variety, environmental conditions and seasonal influence. Soil moisture content coupled with warm atmospheric conditions show significant effects on the different developmental stages of pepper. (Grubben and El-Tahir , 2004, Idowu-Agida *et al*., 2012).

Pepper production requires high level and readily available soil mineral nutrients in the growing medium for optimum growth and yield. The primary nutrients considered essential for optimum growth and yield of pepper species includes nitrogen, phosphorus and potassium (Grubben and El-Tahir, 2004). All these nutrients listed are inherently low in tropical soils as a result of low organic matter content, especially in Nigeria. However this can be improved through some agricultural practices such as bush fallowing, shifting cultivation, crop rotation and application of organic based fertilisers or mineral fertilisers. Inorganic fertilisers are costly especially to the low resource farmers, not easily accessible and often unavailable at critical time when it is most needed. Also the negative environmental effect limits the use of more fertilizers. Moreover, the application of mineral inorganic fertilisers could not replenish soil micro nutrient that often become depleted by growing crops consequently causing reduction in the crop productivity and yield (Sikora and Szmide 2001).

The nutrients content in various organic fertilisers are released gradually unlike inorganic fertilisers; make nutrients available in every developmental levels of pepper. Majority of farmers who cultivate pepper across the world use inorganic fertilisers. Moreover, some of the inorganic fertilisers applied are absorbed by plants while the left over dissolved into the environment (surface water, atmosphere and ground water) as pollutants, affecting the ecosystem. The flora and faunas are destroyed by the pollutants. The tremendous daily increase in animal production and increase in urban population will surely continue to increase the production and relative availability of plant and animal wastes;thus the sources of obtaining the ingredients for continuous organic fertiliser production is certain (Adediran et *al.*,2003). Raw materials for organic fertiliser production are obtained from processing and curing of decomposed plant and animal materials. Organic wastes that exist in

Nigeria varied from domestic waste such as (kitchen wastes and urban refuse dumps), industrial waste (brewery wastes and food industries), to farm left overs (plant and animal residues) (Adediran *et al.* 2003). Moreover, the availability of these wastes are in million tonnes annually, usually constitute serious disposal challenges in the urban environment and their regular management contributes huge economic losses for the nation (Adediran *et al.* 2003).

. The Organic fertilisers that are collected from different sources and location, or prepared from different organic waste materials usually vary greatly in nutrient composition. Therefore, organic fertilisers from composts and other types can be quite variable from one batch to another (Moyin-Jesu, 2008). These forms of fertilisers have been reported to improve soil structure, enhance long-term productivity as well as plant biodiversity and provide essential nutrients to plant, leading to better quality of plant and fruits, especially of *Capsicum annuum* (Enwall *et al.*, 2005; Alabi, 2006).

Awareness in Nigeria today on the use of these organic materials in the management of soil fertility is on the increase. However, the information required for proper use and in adequate quantity of different organic fertiliser types is still needed (Ojeniyi, 2000). The need for the use of renewable resource form of energy to reduce cost implication of fertiliser input to agricultural crops has rekindled the awareness on the use of organic fertilisers all over the world. The improvement of environmental sanitation and public health could also be part of the reasons for advocacy for the increased use of various organic fertiliser types (Seifritz, 1992; Maritus and Vlele, 2001).

Despite the numerous uses and the advantages derivable from pepper production in Nigeria, the yields on farmer's field remained very low. The major challenges to the poor performance of pepper include poor soil fertility, weeds infestation, the intensity of cropping, pests and diseases,. Among these, the low soil fertility status constitutes higher constraints to pepper production. The soil fertility status could be improved through the application of mineral or organic fertilisers, but inorganic fertilisers are very expensive, scarce, and not readily available, more rapidly depleted and result to increase in soil acidification and environmental degradation. Organic fertiliser of various sources such as compost, animal wastes, city wastes, domestic wastes, industrial wastes, etc. releases nutrients gradually, slowly and consistently for longer time when compared with mineral fertiliser. This made organic fertiliser capable of supplying nutrients throughout the growth periods of pepper. Using organic fertiliser for optimum physiological and yield requirement of pepper is not a technique that can be compromised for sustainable pepper production, because organic based fertiliser is known to enhance the physical structure, chemical properties and biological composition of the soil. Therefore, it is necessary to look for organic fertiliser materials that are sustainable and environmentally friendly for the improvement of the growth, fruit yield and nutritional qualities of pepper.

The main objective of this study was to determine the effectiveness of some readily available organic fertiliser materials as nutrient sources for pepper production in Nigeria.

The specific objectives of the study were to:

i. determine the growth of two cultivars long cayenne pepper in relation to the applied organic fertilisers.
ii. determine the effects of the selected organic fertilisers on the yield of two cultivars of long cayenne pepper.
iii. determine the organic fertiliser rate that will optimise the nutritional quality of two cultivars of long cayenne pepper.
iv. evaluate the residual effect of organic fertiliser on the growth and yield of long cayenne pepper.

CHAPTER 2

LITERATURE REVIEW

2.1 Origin and distribution of pepper

The cradle of pepper, *Capsicum* species is from Bolivia across South to Mexico in the far of South America. As far back as 7500 BC, it had been part of human diet (Mac Neish, 1964). In Spain and Portugal, explorers were the first group of travelers that distribute pepper all over the entire world. Pepper arrived at Spain as early as 1493, got to England around 1548 thereafter to Central part of Europe in 1585. Pepper cultivation in Europe spreads to Asia (Purseglove *et al.*, 1981). Historically, the dynamics of pepper particularly the pungent type of pepper is linked with the traveller, Columbus who was given appreciation for introducing pepper crop to various part of Europe, and subsequently find its way to the land of Africa and Asia (Heiser, 1976). Columbus on his trip came across a crop that has a fruit that its pungency resemble that of *Piper nigrum* L, (black pepper). Columbus gave its name as red pepper simply due to the fact the matured fruit, from the plant were of red colouration. Pepper crop physiological characteristics were different from *Piper negrum*, but not yet unidentified crop which was later grouped to be *Capsicum*. Presently, pepper crop is been cultivated in different countries worldwide including Spain, China, Israel, Malaysia, Pakistan, India,, Sri Lanka, Ghana, Nigeria, Uganda, Mali and Ethiopia (Adetula and Olakojo 2006).

2.2 World Pepper Production

Nigeria as a country, is recognised as one of the leading *Capsicum frutescens* producers in tropical Africa producing about 50% of the entre African production (Adetula and Olakojo, 2006). World pepper production as at 2001 was estimated to be 21.3 million tonnes, emanated from the land area of about 1.6 million ha (mean fruit yield of 13.4 tonnes per hectare). Despite this, fruit yield of pepper on farmers field in Nigeria under sole cropping was estimated at 8.0 tonnes per hectare (Grubben and El-Tahir, 2004). In the country, the total land area available for the production of pepper was 77,000 hectares yielding the total output of about 695,000 tonnes (Ado, 1988; Erinle, 1989). The landed area for pepper production covers an area the country that increased tremendously from 82,000 to 85,000 hectares from 2003 - 2006 pepper production years (Adetula and Olakojo, 2006). Pepper production has drastically reduced few years back. Various means could still be used for potential increase in its production in Nigeria. (FAO, 2007). There is extensive area of land that is suitable for pepper production all over Nigeria, (Grubben and El-Tahir, 2004). Also the ecology of these agricultural land areas has great potential value for higher pepper production.

Pepper dry fruit yield at subsistence farm holdings is estimated at about 4 tonnes per hectare. In government owned farms, the mean yield is about 13 tonnes per hectare of pepper fruit (Grubben and El-Tahir, 2004).. However, fresh sweet or green pepper yield stands at 15 tonnes per hectare. In experimental field the pepper fruit yield varies from 25 to 30 tonnes per hectare. The ultimate yield of pepper can be influenced by varieties and likewise performances of varieties are affected by a number of factors. This indicates that long cayenne pepper requires intensive care and management at all stages of growth and development for higher productivity per unit land area. Differences in pepper yield may occur due to non- adaptability of existing varieties to prevailing climatic situation and lack of adequate moisture during the dry seasons, this may consequently result in huge flower dropping and hence low productivity. Research efforts are therefore needed to combat such production challenges.

2.3 Taxonomy and morphology of pepper

Long cayenne pepper belongs to Solanaceae family, genus *Capsicum* with the species name as *frutescence* L. The domesticated species include *Capsicum frutescens, Capsicum chinens., Capsicum annuum,. Capsicum baccatum, and Capsicum pubescens.* Chili pepper could be characterized by its slim small fruit size in comparism with the other pepper varieties. This group of pepper is the most pungent among the *Capsicum.* They are consumed in small quantity. They are of various size, fruit texture, colour, and shape.

Capsicum species are commercially classified according to the quantity of *capsaicin* ($C_{18}H_{27}NO_3$) content available in the fruit which is usually an indicator of "pungency". *Capsicum* species group are mostly diploid, with 24 number of chromosome (2n=24, seldom with 2n=26) (Lippert *et al.* 1966; Berke *et al.,* 2000). However, some research findings have indicated that the number of chromosome is also a probable means of identifying cultivars. The lower the chromosome number the less the pungency which could be as low as n=13. This attribute may be a promising technique of classifying the non-pungent and pungent pepper varieties. Pepper varieties could also vary from mild to very hot in the degree of hotness, (Tong and Bosland, 2003; Idowu-Agida *et al.*, 2012).

The leaf and stem may vary. The flower peduncle may range from single to several flowers per node. The calyx may ranges between conical, flat, slim, to truncate calyx, to green coloured to spine-like protrusions. The corolla colour among species is highly variable. Seed colour is creamy, except for *C. pubescens* that are black seeded. Most *pepper* species have one flower per node that protruded from the leaf and the stem of the first branch angle with consequent flowers emerging from every subsequent node, the physiologically active growing point of pepper crop is shifted to the fruit. Seed set influence growth and yield development and consequent development of the fruit. Usually, emerging fruit developed to mature green level within 35-50 days of the pollinated flower (Tong and Bosland, 2003).

Pepper can be classified as annual and biennial shrubs. The morphological characteristics of the wild and the cultivated species are very distinctive. Virtually all the wild varieties of pepper have berry-like, small, red fruits colour which are of small sizes that usually attract birds. Naturally grown pepper fruits are usually perennial; this indicated that in case the fruits escaped animals' consumption when ripe, it drops off the plant, however most of the seeds within the capsule could still be at peak of their viability. Cultivated species shows various forms of colorations; leaves, flowers, fruits and seeds (Pickersgill, 1971; Eshbaugh, 1976). Some earliest research taxonomists have compared different *Capsicum* species, and classify hot pepper basically into two major categories: The first, identified with small, red coloured fruits followed by the second group identified by large size fruits. This category of grouping created an effective distinction between the uncultivated and the cultivated type of pepper.

2.4 Importance of pepper

Pepper is cultivated for its numerous qualities. The fresh fruits can be consumed raw or in various processed forms. It could be oven dried and milled into powder for further use or prepared fresh for table sours vegetables and for spices or for industrial raw materials or condiments (Geleta, 1998; Streambank, 2009). *Capsicum* Pepper has been identified as a good and rich means of obtaining vitamin C, A and vitamin E. The fruit consist of more vitamin C than most other vegetable crops that are rich in vitamins (Poulos, 1993). Among the *Capsicum* species, chili pepper has been identified to be the richest capsaicin source, that can widely be used as industrial additives (Dorantes *et* al., 2000; Kurital *et al.,* 2002). Chili pepper alongside sweet or bell peppers, as eggplant coupled with tomato consist of high content of Vitamins A and vitamin C and also known rich of vitamin B_2, potassium, and calcium with phosphorus (Bosland and Votava, 2000). Pepper has lots of medicinal uses (Alicon, 1984; Thakur, 199).

Bosland and Votava, (2000). Pungent chilis with Anti-mugger aerosols were active ingredient used to replace tear gas and mace in many departments of police in United States of America. The spray resulted into enemy gasping and running for fresh air helplessly for survival at least half an hour (Bosland and Votava, 2000).

2.5 Environmental conditions for pepper production

Pepper thrives well under different environmental conditions, so also the prevailing environmental temperature is very important for pepper physiological development and yield (Grubben and El-Tahir, 2004). Pepper thrive well under irrigation or rain-fed in those areas with the rainfall ranging between 600-2000 mm and temperature range of between 18-30 ^{o}C (Erinle, 1989; Grubben and El-Tahir, 2004). Like most related solanacious crop plants, pepper performs well in a well-drained loamy soil that is rich in organic composition (Lemma and Edward, 1994). Good soil with its acidity varying from 6.5 to 7.5 is desirable, and the land should have a good tilth? of low gradient level (0.01 to 0.03 % slope) this is to enhance good drainage and prevent root related diseases that might be caused by water stagnation. Adequate, regular and timely water provision and supply as at the time needed is essential. Water stress could cause the introduction of flowers abortion and fruit drop, particularly when it occur during flowering period, and this will reduces the number and weight of fruit yield (Matta and Cotter, 1994; Haigh *et al.,* 1996).

Irrespective of the recent level of technological inventions and scientific advancements, climatic condition is still the major key variable factor in pepper production. The time, seedling age and season of transplanting of pepper usually affect the days to flower emergence, 50% flowering, fruit maturity, fruits/plant and fruit weight/plant (Idowu-Agida *et al.,* 2012). Climatic condition also acts as major resource and challenges in pepper growth and yield. The weather resource values need to be at optimum level because the hazards caused by weather need to be managed. Thorough understanding of the association between pepper growth and yield and other environmental factors is critical for the development of good crop management systems that will entrench consistent quantity and quality production achievement. Moreover, the findings of better improved crop production technique that will constantly enhance and ensure continuous productivity of pepper will demand a thorough mastering of the period and continual changes of the prevailing conditions and the level which wherein the conditions can affect pepper physiological growth performance and yield.

2.6 Agronomy of pepper

Pepper performs well in a well-drained soil conditions with loose soil structure for easy water and air percolation for proper growth (Centre for new crops and plants products, 2002). Pepper cultivation could be carried out throughout the year, as long as the environmental conditions are favourable. Seeds germination and emergence is best at 25 to 30 °C. Flowering can be delayed if the prevailing temperature during the day reduces to as low as 25 °C. Flower abortion increases when the night temperature increases higher (from 32 °C and above). The quantity of Pollen available for pollination is drastically reduced when environmental temperature increases beyond 30 °C and falls below 15 °C. Cool night's temperature down to 15 °C enhance fruit setting. Capsicum performs well where the height start from sea level even to as high as about 200 m. Irrigation is very essential especially in the dry season. If rain fed is required, an annual rainfall of 600 mm minimum is required. Pepper grows on almost every soil where it is planted, but yield better when established on well-drained loamy or sandy soils that are high in lime content, the soil should be of pH range between 5.5 – 6.8 and with the tendency to retain water capacity.

Pepper can be established on the field either through direct seeding or by transplanting methods, depending on soil type and the prevailing environmental situation of an area. These two cultivation techniques are with their unique merits and demerits (Carter, 1994). Moreover the cost of seed, especially the hybrid and the size of pepper seed necessitated the adoption of transplanting. Transplanting when done as at when due is been used for precision of plant population and accurate spacing (Bosland and Votava, 2000). Research has proved that in many instances, transplanted pepper usually tends to have shorter height and more nodes and root growth is lower than direct seeded pepper planting. Research findings of some scientists in the United States of America reported that transplanted pepper started flowering for as early as 16 days than direct seeded pepper plant, and usually those that were planted through direct planting yielded low if it is cultivated when atmospheric condition is not favourable (Schultheis, 1988). Leskovar and Cantliffe (1993) in an experiment also concluded that when pepper is transplanted it gives significantly earlier and higher fruit yields than directly sown pepper plants.

For pepper nursery establishment, seeds are sown in shallow trays loaded with the combinations of virgin land soil, sharp sand from river bed and animal waste mixed together in the combination of two, one and one measurement respectively (NIHORT, 2006; Idowu-Agida *et al*., 2012). Transplanting is done when seedlings are six weeks old or when seedlings have eight to ten leaves (NIHORT, 2006). It is better to transplant pepper when the atmosphere is clement. This should be either early in the morning or in the evening, and when there is cloudy weather. There is need for light watering after transplanting to reduce mortality. Inter- and intra- row spacing for optimum performance is 50cm x 50cm (Grubben and El-Tahir, 2004; NIHORT, 2006). First weeding should be done at two weeks after transplanting, while subsequent weeding should be done as at when due. Pepper fruit may be harvested at any size desired, but usually at the ripe stage (Bosland and Votava, 2000).

2.7 Influence of organic fertiliser on physiological and reproductive characters of pepper

Various research works on organic fertiliser had been reported with reference to bell pepper growth and yield. Abu-Zahra (2012) reported that application of organic fertiliser does enhance the growth of pepper but mineral fertiliser had higher physiological growth, however reproductive characters were exhibited earlier in organic fertiliser. Adhikari *et al* (2016) used different manure sources, vermin-compost and NPK. The result showed that poultry manure enhanced early flowering. When poultry manure is applied to pepper crop, some nutrient elements that are essential for photosynthetic activities are released into the soil for the enhancement of plant development. Moreover, high quantity of poultry manure has been found out to increase the quantity of leaves, leaf area enlargement stem size increase and increase in the number of plant branches ((Malgorzata *et al* 2010) . Fruit maturity and early ripening was observed in another experiment with organic fertiliser using bell pepper as test crop (Arancon *et al* 2004). Compost made from farm waste, used in the production of bell pepper enhanced yield of bell pepper than animal wastes (Adhikari *et al* (2016).

Malgorzata *et al* (2010) used bio-fertiliser made from worm cast to produce bell pepper and compare with mineral fertiliser, result obtained indicated that plant crown diameter, number of pepper plant branches, quantity of leaves and tallness were noticeably better when compared with plot where mineral fertiliser was applied. Moreover, chlorophyll content of bell pepper with bio fertiliser was 32% higher than that of mineral fertiliser. Organic fertilisers have been reported to improve pollination in bell pepper with the attendant of more fruits production than when mineral fertilisers were applied (Stephen *et al* 2003).

2.8 Nutritional composition of pepper

The different chemical constituent of matured *Capsicum spp f*ru*it* has been analysed especially some vital known component, with respect to chemicals like the vitamin (C, E), β-caroten and carotenoid pigments (Palevitch and Craker, 1996). Freshly harvested sweet peppers of various colours consist of high and a sure way means of obtaining ascorbic acid and the composition ranges from 76 to 243 mg 100 g^{-1} from the weight of newly harvested fruit (Howard *et al*., 2000). Red matured peppers of different varieties or cultivars contain the highest quantity of β-carotene and β-cryptoxanthin and pro-vitamin A (Mi´nguez-Mosquera and Hornero-Me´ndez, 1994; Materska and Perucka, 2005). Many research works on peppers focused mostly on the flavonoid aglycones (quercetin and luteolin) derived after hydrolysis (Howard *et al.,* 2000; Lee *et al*., 1995). Peppers also contain various phenolic compounds, flavonoids and carotenoids (Amakura *et al*., 2002; Materska and Perucka, 2005). Materska *et al*. (2003) discovered two flavonoids in chilli pepper pericarp or fruit coat and some other flavonoids were found in fruits of pepper. Howard *et al*. (2000) conducted research on pepper fruit maturation and its effect on the nutrient increase and antioxidants concentration in different varieties of pepper which include (*Capsicum annuum, C. Chinense* and *C. frutescens*). It was discovered that as the maturity level of pepper fruit increases, the compounds of antioxidant concentration also increase consistently.

Carotenoids are colorants which are very important in most fruit vegetables, they usually provided red and orange colours. These various compounds are mainly antioxidants and they are known for the reduction of harmful oxidation reactions in human body. Therefore, the consumption of different varieties of pepper can help in prevention of various diseases which are associated with some free radical oxidation (Hollman and Katan, 1999; Harborne and Williams, 2000)

2.9 Nutrient requirement and management of pepper

Nutrient relative availability in the root zone of the soil is assumed to play a leading role and the most critical factors in pepper growth and yield, among which nitrogen play a leading role as very important element for proper plant establishment, growth and development (Uddin and Khalequzzaman, 2003) Sentence not properly constructed. Relative availability of Nitrogen fertiliser improves dry matter accumulation, fruit development and nutrient absorption and water intake ability of pepper (Hole *et al*., 2005). Organic fertilisers use in various research globally has shown that its response to various crops have significant effect especially on vegetable cultivation, for more than one reasons. In the first instance, the reason to improve vegetable production and its yield requires regular application of nutrients into the soil for sustainability. Secondly, various experimental results reported on the application of inorganic fertilisers conducted in several countries have proved and identified that application of mineral fertilisers to pepper alone will not optimise the expected yield. (Singh and Jain, 2004). Heavy dosage of organic fertiliser application to pepper crop improves the growth, development and maximized the yield of pepper tremendously. Literature reported that continuous application of organic fertilisers will enhance consistent quality production of solanacious crop that include leafy and fruit vegetables like tomato, pepper and eggplant (Gezerel and Donmez, 1988). Such, fertilisers could enhance the production to 92 tonnes per hectare in tomato when compared to the optimum of 42 tonnes per hectare when mineral commercial fertilisers were used (Gezerel and Donmez, 1988).

The solanaceous group of vegetable generally takes up large amounts of nutrient from the soil. The ultimate herbage and fruit yield in crop production is dependent on the amount of nutrients uptake. This also is affected by numerous factors such as gene composition and environmental conditions (Shukla and Naik, 1993). Late maturing varieties will demand for higher amount of nutrients compare to early maturing varieties, this is because late maturing crop will produce higher dry matter and fruit.

Research has proven that nitrogen among other soil nutrient is mostly needed by crop plant especially for the vegetative development in the cultivation of vegetables. Nevertheless, most soils in all parts of Nigeria are low in nitrogen concentration, Nitrogen is usually added to the soil through synthetic or industrial manufactured nitrogen fertiliser and the use of this inorganic source has increased steadily over many years. However, one major disadvantage of this is the pollution of groundwater after crop harvest that results from its application. Agboola and Sobulo (1981) and Mapfumo *et al.* (2005) indicated that the cost implication of synthetic fertiliser too high and its relative unavailability makes it incapable to sustain African farmers in their quest for higher productivity. Studies on the use of different fertilisers in Nigeria had proven that organic fertiliser do not easily washed away to the water bodies as does in inorganic fertilisers (Sridhar and Adeoye, 2003). Consequently, the advocacy for the use of organic based fertiliser has been increased to boost the regular and steady crop productivity in Nigeria since it is also cheaper and may not likely cause the pollution of the groundwater as compared to chemical fertilisers (Zhu *et al.*, 2005). In order to stem down the use of inorganic fertiliser, organic fertiliser fortified with mineral fertilisers (otherwise known as organo-mineral fertiliser) has been introduced as an alternative to improve soil nutrient for optimum yield in many crops (Sridhar and Adeoye, 2003).

The amount of nutrients to be applied to a particular crop by farmer will depends on the initial available soil nutrient, the genetic makeup of the crop and the climate of the growing environment, the geographical location of the farm and plant growth conditions. Pepper needs a continuous supply of nutrients throughout their life span because pepper vegetative and reproductive stages overlap. It will be very essential for scientist to develop a good and appropriate technique for nutrient management. The methods that will ensure adequate nutrient supply as at when required by crop plant in quantities appropriate to meet crop requirement that will result into regular nutrient use efficiency. This method must be environmentally friendly and sustainable at different location for vegetable crop production most especially for pepper production
(Sridhar and Adeoye, 2003).

2.10 Integrated soil nutrient management for pepper

The major rules that guides the use of nutrient use efficiency is its consistent maintenance, it's continuous and consistence availability for crop optimum productivity for a long period of time. Regular production of cultivated crop is attainable with the use of different skillful science application for maximum achievable crop performance in term of crop growth, crop yield and its quality, such that agro-ecological adaptability will be enhanced. Organic manure has been in use by farmers for many years in fresh vegetable production; recently there has been the combination of both mineral fertilisers with inorganic fertilisers, to supply the crop with the crop nutrient requirement. Subbiah *et al.* (1985) combined farmyard manure with mineral fertiliser in eggplant and tomato production, higher yield of both vegetable crops was recorded. With the applications of 100 kgN ha^{-1}, portion of (50%) urea and the application of half dosage of similar equivalent of avian droppings (50%), enhanced tremendous yield increase of 45.8 t/ ha higher when compared with mineral fertiliser when the same level of nitrogen urea alone was applied (37.8 t/ ha). When poultry manure and mineral fertiliser were combined the application enhanced more nutrient absorption and consequent higher yield (Jose *et al.*, 1988).

Jablonska (1990) conducted a research with the use of the combination of rye straw and mineral nitrogen fertiliser, the result showed more yields in the production of tomato, garden egg and bell pepper more than inorganic nitrogen fertiliser or farmyard manure. Herencia *et al.* (2007) conducted an experiment where it was revealed that compost added to crop enhanced soil fertility improvement and higher crop yield and higher nutrient constituent especially in the consumable part of such crops when compared with only inorganic mineral nutrient applied. Akinfasoye *et al.* (2013) found out that when organic fertiliser from different sources is applied to pepper, it enhanced the growth and yield of pepper differently; it also indicated that organic fertiliser of different types from various types contains various levels of nutrient composition. Thus organic fertiliser is suitable for pepper production in Nigeria.

2.11 Organic fertilisers and their uses

Fertilisers of organic origin are made from carbon compounds or from decomposed plant and animal. These remains enhance crop development, productivity and improved the nutrient composition of farm produce higher than those crops where mineral fertilisers were applied (which are rich sources of soil nutrients, which can well improve the growth and quality of agricultural produce) Check the font size The quantity of organic matter available in a given soil is a factor that determines the suitability of the soil for crop productivity. The more the quantities of organic matter present in the soil the richer the soil. It controls the biological, physical, and chemical activities operating the dynamics of the interface for optimal performance (Ghimire *et al* 2013).. A good criterion for soil health, nutrient and property determination could be soil organic matter composition (Adeola *et al* 2011). Presently, less emphasis is still placed on the importance of organic matter to vegetable crop production. The ability of the present agricultural technique to sustain the current world population is a major challenge of the populace. Therefore, the understanding by farmer the relationship organic matter in the soil will help in sustaining the soil productivity for a long period of time.

Although, the growth and yield performance of crops cultivated using organic method and conventional (inorganic) method may be closely similar in the short run, but in the long term, the subsequent organic production will surely out yield conventional production systems (Euras, 2009). A means of conserving soil nutrient, especially the organic matter content is the application of organic materials. This in turn helps to reduce the excessive waste discharge by human populace. Application of organic fertiliser of any form into cultivated agricultural farm land has been proved to beneficially transform or change the macro and microbial, structural and chemical composition available in the soil. Composted organic materials applied into cropping soils have shown tremendous improvement of soil properties among which are cation exchange capacity (CEC), water holding capacity and low bulk density. Other improved soil properties include soil microbial activities, porosity etc. (Maarten et al 2005).

The non-sustainability of cultivable Nigerian soil is attributable to very low organic matter on the thin surface of the soil. Sufficient quantity of organic matter in the soil significantly enhances crop productivity (Alabi, 2006). Continuous application of organic manure and regular maintenance of organic matter in the soil is crucial for improved crop fruit yield and fruit quality. The use organic fertiliser to improve crop yield is an important channel of meeting the economic potential, progress and improving the environmental quality. The relative abundance of organic matter build up in the soil increases the biomass, biological diversities culminated together to increase the levels of organic fertiliser. With good agricultural practices and proper soil management there is bound to be improvement in the soil structure, texture and nutrient recycling, capacity buffering with the attendance of diseases control within the production practices.

The relationship between the nutrient content of the soil and the organic matter status present within a given soil environment is closely related. Increase in organic matter present in the soil positively translates to increase in the nutrient content of the soil. Continuous application of organic fertiliser to a given farm land with continuous cultivation compared to continuous application of inorganic fertiliser at same rate, showed that organically treated soil produced higher and more quality crop than inorganic fertiliser. (Alabi, 2006). Moral *et al (*2005) carried out an experiment where they made use of dog waste and human wastes to correct the deficiency of iron observed in guinea corn crop plant in calcareous type of soil. The result showed tremendous improvement in available iron with attendant increase in dry matter, with enhanced uptake of iron, copper, manganese and zinc. Application of compost to soil has shown a beneficial effect in increasing water infiltration rate, soil structure and soil acidity (Stamatoados *et al.*,1999). At the time of application of compost to soil, it will initially increase the soil acidity but in the long run the acidity will continue to decline hence increase in soil pH over time. However when inorganic fertiliser is used there is continued increase in soil acidity (Bulluck *et al.,* 2002).

Research finding has shown that application of organic fertiliser to crop on the field tremendously increase the microbial activities in the soil. Biomass accumulation is also enhanced when organic fertiliser is applied to field crop (Drinkwater *et al.*, 1995). When organic manure is applied to crops, it helps crop plant to absorb other nutrient elements in the soil environment and this will improves crop resistance to disease infestation from the soil. It is evident that organic fertilisers applied help plant in a substantial way in combatting some soil borne diseases. The most affected soil pathogens are the fungal diseases; these include damping off diseases caused by *Rhizotium, Pythium* and *Fusarium*. (Lampkin,1990). The crucial technique employed by organic manure when applied to soil is the hindrance of soil microbes against one another, these will aid in the production of toxins and antibodies, struggling for food and energy for survival, and/or parasitism (Lampkin, 1990). ???????

2.12 Characteristics of organic fertilisers

The elemental nitrogen that is needed by crop plant and the quantity of organic fertiliser that will supply the quantity needed for the soil to supply are always at variance for consistent availability of organic matter in the soil medial. The quantity of composted materials that will supply the amount of nutrient that will be needed by plant must be known. This will provide the pool where the nutrient demand by soil and crop will be adequately supplied. (Nasef *et al* 2004)

Composting therefore is the method by which different component of decomposed waste materials are converted to substances that are relatively humus in nature for crop use. The product formed (compost) is used for soil amelioration for crop growth and development otherwise known as organic fertiliser (Akanbi 2002). Composting process helps to transform the chemical, biological and physical components of wastes materials by reducing its phytotoxins (Akanbi 2002). The conversion of organic waste to composting is one of the surest ways of getting rid of the problem of waste disposal and at the same time increase the quantity of organic fertiliser that can be used to improve crop production and environmental preservation (Stentiford, 1987). The ready to use product obtained from the decomposed waste is said to be stable when the effect of C and N is minimal on soil dynamics (Reddy *et al*., 1980). Well composted organic materials should be assessable and tolerated by crop plant with no hindrance to crop growth and development as fresh manure will do. Therefore the composted materials meant for crop use will release nutrient slowly for a long period of time making nitrogen available consistently for crop growth and development.

The source of organic materials used for composting will determine the available nutrient in the compost product. While organic fertiliser contains different compounds of carbon which varies in decomposition rate, the disintegration of biological process will depend on the carbon content of the materials from the sample. Studies have shown that carbon dioxide to carbon ratio increases at the beginning of composting but the rate will depend on the type of organic materials used for composting (Titiloye *et al*., 1985; Ajwa and Tabataba, 1994). Khalid and Shafei (2005) conducted an experiment on the rate of mineralization of organic fertiliser. The result showed that the higher the quantity of animal dung, the higher the nitrogen content of the formed compost. Research works have also reported that variation in the climatic situation of the environment has a lot to do with the degradation process of any organic product in the soil. Furthermore decomposition rate has been reported to be influenced by some factors. Among the factors that affects decomposition are; temperature, air percolation, specific substance used, soil acidity, water content of the material, soil porosity, cultivation technique textural class of the soil and nutrient status of the soil have been proofed to play critical role in the rate of decomposing of organic materials applied to a given soil (Clark and Gilmour, 1983). Organic materials used in composting consist of nitrogen that is in organic form. Principally, they are made of protein that associated together as peptide linkages. The quantity of mineralized organic materials into elemental nitrogen for crop absorption after compost application to the soil is a factor of the environmental condition and this may range from low percentage to hundred per cent. Palada, *et al.*, (2004) carried out a research on organic matter mineralisation and concluded that mineralization of a given organic manure ranges from 5% to 10%. However, Farhad *et al.*, (2009) reported that the rate of mineralization of organic nitrogen in poultry manure in the first year is about 66%. Sikora *et al* (2001) corroborated the report, confirming that there is fast rate of nutrient release from poultry manure, approximated at 35% to 50%. Organic nitrogen can mineralize in the soil within 14 days after its application. Griffin *et al.* (2000) in another experiment concluded that mineralisation rate of organic nitrogen varied within a cropping period depends on the source of organic manure: poultry dropings, 60%; pig dropings, 50%; cow dung, 25% and lactating cow, 35%. The nitrogen requirement of a crop in a given soil environment traditionally has been the bases for organic manure application. Therefore the mineralization rate should be the bases for Organic fertiliser application in any cropping soil (Sikora *et al*, 2001).

Research finding has shown that 100 kg nitrogen per hectare of cow dung is contained in 20,000 kg per hectare of the manure. Compost is one of the major sources of nitrogen fertiliser in different quantity. Therefore, a deep knowledge of the underlining factors controlling nutrient release of organic compost will ensure relative availability of nutrient for cultivated crops, especially horticultural crop (Sikora and Szmide, 2001).

One of the most efficient and economically viable manure for crop use is the poultry droppings. This is attributable to its high inorganic nitrogen, high pH value and low organic carbon, therefore its low C:N ratio when compared with other types of manure (Bitzer and Sims, 1988). On the field, to increase soil nutrient status based on crop nitrogen demand, organic substance of low C:N ratio like poultry droppings, grinded grain seeds, or green manure are preferred materials for composting. Thus, it has been recommended that the best C:N ratio required for fully cured compost should be about 15:1 (Ajwa and Tabataba, 1994). In another perspective when higher organic carbon is required, then organic manure with higher C:N ratio like twigs or bark based compost that are more woody or cow and horse dung may be a preferred option.

2.13 Availability of organic fertilisers

Organic wastes are by-products of organic materials of plant and animal origins. Such organic wastes include urban, market, household or kitchen, and field wastes (straw of maize, rice, sorghum, millet etc.). Organic fertilisers are of various types and of various nutrient compositions depending on the materials that form them. Adetiloye *et al.* (1985) reported that there were thousands and one different organic wastes in our environment, which could be organic in form of industrial (brewery waste), urban (refuse dumps), kitchen wastes (food remnants, such as yam, cassava, plantain/banana pills etc.) to farm wastes. The availability of these materials is in million of tonnes yearly in Nigeria. These waste materials are transformed by decomposition to form organic fertiliser. Adediran *et al.,* (2003) in an experiment confirmed that continuous increase in animal production, industrial expansion of food processing factories, and increase in urbanization will continue to ensure the relative abundance of organic waste in the society with an attendant increase in the types of organic fertiliser production. Similarly, rapid increase in poultry farm establishment will subsequently increase poultry manure production thereby increasing organic fertiliser availability for crop production purposes.

Organic manures are of various types, thus the environment where one lives will dictate the type of organic waste that is available. Titiloye *et al.* (1985) investigated twenty-one organic waste materials collected from different locations within five states in South-Western part of Nigeria. Collected samples were subjected to laboratory analysis for nutrient composition, and the result obtained showed that the nutrients varied from one waste product to the other. Also organic fertiliser from different location varied in nutrient composition at one location to the other, this may be due to differences in the materials from which they are made. However, all were capable of increasing soil fertility. Gaskell (1999) used seven different organic nitrogen fertiliser types comparing them with green manure alongside with cover crops used for soil improvement and management. Consequent result concluded that organic manure from different sources or types enhanced crop yield when applied under similar environmental condition, with the same quantity of application. Delate *et al*. (2003*)* narrowed organic manure types to three for pepper production and Ghosh *et al.,* (2004) compared poultry manure, cattle manure and phosphorus compost for pepper production. They concluded that poultry manure enhanced higher yield than other types. The source of the poultry manure used may also influence the nutrient composition differently. Similarly, the type of food/feed given to animals producing the waste may also influence the nutrient content of such organic fertiliser produced.

The demand for organic horticultural products is rapidly increasing perhaps because of its health security. On a daily basis, organically produced horticultural crops command premium price in the market (Maarten *et al.,* 2005). Continuous availability of organic wastes is therefore of great importance to organic fertiliser production. This will reduce or overcome the problem caused by disposals (Fagbayide, 2005, Moral *et al.*, 2005).   Research has also proved that application of organic fertilisers to crop can lead to higher quality of produce; similarly the product will have better taste, longer shelf life and more attractiveness to consumers. The consequent of such attraction is higher premium for farmers (Heaton, 2001).

CHAPTER 3

3.0 MATERIALS AND METHODS

3.1 Description of experimental sites

This study was conducted at two Ibadan and Ogbomoso. The Ibadan location was National Horticultural Research Institute (NIHORT), Idi-Ishin, Jericho, Ibadan (7° 33´ N; and 3° 56´ E 168 m above sea level) and at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Ogbomoso (8° 10´ N; 4° 10´ E; 275 m above sea level) between 2008 and 2011. Ibadan site, lies within savannah: forest transition ecology of Nigeria. The rainfall period and its distribution have its peak twice a year, with its first in the month of June and the second in the month of September. The annual rainfall ranges from 1250 mm to 1500 mm, which is distributed within eight months with effect from (March to October) and while in August there is a short period of dry spell. The period of November to March is regarded as dry season. The temperature of the location ranged from 27^{o}C to 33^{o}C with relative humidity of about 75%. Mean temperatures, Relative Humidity (RH), rainfall distribution during the period of the experiments are presented in Table 3.1. The soil of Ibadan experimental site falls into three major associations viz: Iwo, Egbeda and Okemesi (Smyth and Montogomery, 1962). They are termed Alfisols under the World Great Soil Groups. Mixed cropping, and occasional sole cropping of vegetables are practiced in homestead and Fadama in Ibadan area. Major crops grown include maize, cassava, yam and vegetables such as pepper, tomato, okra, amaranths, *Corchorus olitorious*, *Celosia argentia* and *Telfairia occidentalis*. Prominent weed species of the experimental site include *Chromolaena odorata, Panicum maximum, Tithonia diversifolia, Sida acuta, Cynodon dactylon.* Location of the site used for the experiment has been under cropping of various vegetable of different types for more than 15 years.

The Ogbomoso site is located in the Southern Guinea Savanna zone of South western Nigeria. Soil of this site is Olorunda series (Smyth and Montgomery, 1962).

Table 3.1: Mean monthly temperature, relative humidity and rainfall of Ibadan at 2009 to 2011.

Month	2009				2010				2011			
	Max Temp °C	Min Temp °C	RH (%)	Rain-fall (mm)	Max. Temp °C	Min. Temp °C	RH (%)	Rain-fall (mm)	Max Temp °C	Min. Temp °C	RH (%)	Rain-fall (mm)
Jan	33.6	22.1	87	328	35.3	23.2	89	75	33.8	20.2	80	0
Feb	34.6	24.2	88	79	35.9	24.1	86	273	34.1	23.7	88	265
Mar	34.4	24.1	89	208	34.9	24.7	87	111	34.4	24.8	89	64
Apr	33.1	23.4	89	237	34.3	24.7	86	204	33.4	24.3	86	150
May	31.5	23.0	88	150	31.9	23.7	88	106	32.7	23.6	88	302
Jun	30.8	23.0	88	141	31.1	23.9	88	82	30.7	23.5	89	159
Jul	29.5	23.0	91	98	29.1	22.7	89	138	28.4	22.7	92	148
Aug	28.2	22.6	90	28	28.6	22.7	90	181	28.7	23.5	91	148
Sep	29.9	22.4	90	215	29.9	22.7	89	123	30.1	23.3	92	153
Oct	30.2	24.8	89	136	31.3	23.2	88	100	30.8	22.4	90	236
Nov	32.1	22.1	87	113	33.3	23.8	88	0	30.9	21.4	85	0
Dec	34.5	23.1	89	0	34.1	22.1	85	0	31.2	20.5	79	0
Total				1733				1393				1625
Mean	31.9	23.2	89		32.5	23.5	88		31.6	22.8	87	

Source: Nigerian meteorological station, Old Airport Samanda, Ibadan, Oyo State.

The annual total rainfall ranged from minimum of 1250 mm to a maximum of 1500 mm and is distributed across eight months (March to October) with dry spell in August. The rainfall distribution and pattern determines the nature of crops grown in the area. Maximum and minimum temperatures, relative humidity and rainfall pattern of the site during the study are presented in Tables 3.1 and 3.2.

Mixed cropping is the major cropping pattern in the area. Most prominent food crops include maize, cassava, sorghum, cocoyam and vegetables like pepper, amaranths, okra, tomatoes, *Corchorus olitorius, Celosia argentea and Telfairia occidentalis*. The site had been previously cropped to maize, cassava and vegetables for some years before establishment of the experiments. Prominent weeds at the site were *Euphorbia heterophylla, Amaranthus spinosus, Boeharvia sp, Commelina sp*., *Imperata cylindrica* and *Tithonia diversifolia.*

3.2 Soil sampling and analysis

Pre-cropping soil sample was randomly taken at the depth of 0-15 cm for the analysis of its physical and chemical properties at Ibadan and Ogbomoso. At each sampling site, 20 core samples were taken using soil auger. These were bulked to form a composite sample. The samples from the experimental sites were dried under room temperature, crushed, sieved with 0.5 mm and 2.0 mm mesh to determine the particles size, pH (H_2O), Total nitrogen (N), percentage organic carbon (% C), available phosphorus (P), iron (Fe), copper (Cu), zinc (Zn), exchangeable cations (EC) and exchangeable acidity. The particle size analysis was determined using the method of Bouyoucous (1951), total nitrogen was determined by Kjeldahl method (Bremmer, 1965), Available P and percentage C were obtained using Bray-P1 technique and hydrochlonic acid digestion, respectively (IITA, 1982). Soil samples were extracted with ammonium acetate (pH 7.0) to determine exchangeable bases and cations using flame photometer and atomic absorption spectrophotometer.

Table 3.2: Mean monthly temperature, relative humidity and rainfall of Ogbomoso experimental field.

Month	2009				2010				2011			
	Max Temp °C	Min Temp °C	Rain-fall (mm)	RH (%)	Max Temp °C	Min Temp °C	Rain-fall (mm)	R H (%)	Max Temp °C	Min Temp °C	Rain-fall (mm)	RH (%)
Jan	34.3	21.4	11	62	35.1	22.6	0	73	34.0	19.6	0	51
Feb	35.5	23.1	106	77	36.7	22.8	41	73	34.2	22.6	126	75
Mar	35.5	23.6	145	76	34.9	23.1	439	76	33.7	23.2	103	81
Apr	32.3	22.5	116	83	34.2	23.6	103	81	33.3	22.9	72	80
May	31.3	22.4	145	84	31.2	22.8	157	85	33.0	22.9	51	81
Jun	30.0	22.0	113	86	30.7	22.6	167	87	30.4	21.2	112	88
Jul	28.3	21.2	117	92	28.5	21.3	77	91	27.9	21.2	88	92
Aug	28.3	21.1	105	92	28.2	21.5	88	94	27.3	21.0	159	95
Sep	28.2	21.1	70	93	29.2	21.5	117	89	29.0	21.5	117	92
Oct	29.8	21.8	91	88	30.3	21.5	109	88	30.1	21.4	126	88
Nov	32.2	20.5	21	71	31.8	21.8	145	83	32.6	22.1	6	83
Dec	34.8	21.4	0	73	33.5	20.7	0	70	34.2	18.9	0	51
Total			1040				1443				960	
Mean	31.7	21.8		81	32.0	22.2		83	31.6	21.5		80

Source: Nigerian Metrological Station, International Airport, Ilorin. Kwara state.

3.3 Planting materials

The two long cayenne pepper cultivars (NHV-1A and NHV-1F) used in the study were high yielding and early maturing cultivars developed in NIHORT. They adapt to various agro-ecologies in Nigeria and are relatively tolerant to viral, bacteria and fungi infections and nematode infestation. The cultivars are annual, erect and can grow up to 1.0 m. They have considerable branches with simple and dark green alternately arranged leaves. The flowers are white and solitary. Their fruits are long, pendulous and are ox-blood in colour with either smooth or rough surface when ripe.

The leaves of NHV-1A are larger and its fruits are smoother, glossier, and bigger in size but tapper to the base than those of NHV-1F. Fruits of NHV-1A are ox-blood when fully ripe and its calyx is dome shaped or flat at the point of attachment to the fruit. Fruits of NHV-1F are slimmer, longer, more wrinkled and more elongated than those of NHV-1A (Plate 3.1).

Seeds of the two accessions used for the study were obtained from NIHORT, Ibadan in 2008

3.4 Nursery establishment

Ten nursery trays were filled with sterilized and sieved, well mixed component of organic manure, rich virgin soil and gutter sand devoid of pebbles in a proportion of half top soil, one quarter manure and one quarter gutter sand. (NIHORT,1986). The trays were arranged in the nursery where vegetable seedlings are usually raised for various experiment in NIHORT. Seeds of the two cultivars were sown in separate trays and watered once daily for the first 14 days, and once in two days thereafter till the time of transplanting at six weeks after sowing (WAS).

3.5 Composting of organic materials

Tithonia compost (TC) was prepared in NIHORT with Tithonia as the plant component mixed with poultry manure. The materials were arranged in layers of ratio 3:1 (Tithonia: poultry manure) based on dry weight (Akanbi, 2002; Adediran *et al*., 2003).

Poultry pure manure was collected from battery cage pen at Institute of Agricultural Research and Training (IAR&T), Research Farm, Moor Plantation, Ibadan in Ido Local Government Area of Oyo State.

(i) Cultivar NHV – 1A

(ii) Cultivar NHV – 1F

Plate 3.1: Fruits of the two long cayenne pepper cultivars used for the study

3.6 Procedures for composting

Each of the organic materials used in the preparation of tithonia based compost were cured and filled into a 1.5 m wide × 1.5 m long and × 1.0 m wooden box (Akanbi, 2002). Non-biodegradable materials were sorted out of the materials. At the time of pilling up the materials, the wall of the container used was lined with black polythene sheet to conserve heat and prevent water loss as well as volatilization of some of the compost nutrients. Water was applied to the materials at the beginning of composting. The compost was turned at fortnight. The cured compost was evacuated, air dried, shredded and bagged in polythene sacks.

3.7 Collection and preparation of other organic fertilisers

Samples of materials weighing 50 kg each of organic fertilizers were collected at identified locations in Oyo, Osun and Ondo States.

(a). Poultry manure plus shavings (PM+S) (poultry manure droppings from deep-litter system) was collected from ZARTECH farms poultry unit at Gbekuba Area, Apata, Ibadan.

(b). Pacesetter Organic Fertiliser (POF) is a product of Oyo State organic fertiliser plant located at Bodija cow market, Ibadan, Ibadan North Local Government Area, Oyo State. Market wastes (remnants of vegetables and food stuffs) and animal dung were the major components of this organic material.

(c), Commercial Organic Fertiliser (COF) was collected from Ondo State organic fertiliser factory at Igbatoro Estate, Akure, Ondo State. It was produced from the combination of industrial, city and market wastes.

(d). Ayeye Organic Fertiliser (AOF) was obtained from Ayeye fertiliser factory located at Ayeye area, Ibadan, Ibadan North East Local Government Area, Oyo state. The major raw material was urban wastes.

(e). Brewery Waste (BW) was collected from the Nigerian Breweries factory, Alakia, Ibadan, Ibadan North West Local Government Area, Oyo State.

(f). Cow Dung (CD) was collected from Akinyele cow market situated at Akinyele Local Government Area, Oyo State.

(g). Oil Palm Bunch Ash (OPBA) was collected at Ajagba village in Iwo Local Government Area, Osun state.

(h). Cocoa Pod Husk (CPH). Dried cacao pods were obtained at Cocoa Research Institute of Nigeria (CRIN), Idi-Ayunre, Oluyole Local Government Area, Oyo state.

3.8 Preparation of organic fertilisers for chemical analysis

The samples were dried under room temperature by spreading under shade to reduce their moisture content (MC) to 12% before analysis. The samples' Desired Moisture Content (DMC) was monitored by weighing the sample before and during drying. The following formula was applied:

Samples were prepared when the DMC of 12% was obtained and subjected to chemical analysis using standard methods in the laboratory according to the procedures of IITA (1982). Samples weighing 250 g per organic material type were dried in the oven at 60 °C to constant weight. The products were finely powdered and working samples were subsequently drawn for analyses of various nutrients.

$$\text{Weight of sample (kg) at DMC \%} = \frac{(100\text{-Initial MC \%}) \times \text{Initial sample weight}}{(100 - \text{DMC \%})}$$

3.9 Determination of Potassium (K), Phosphorus (P), Calcium (Ca), Magnesium (Mg), Zinc (Zn), Sodium (Na) and Copper (Cu) in the organic materials

Organic material of 0.5 g finely ground sample of each material was weighed in porcelain crucible. The samples were ignited in a muffle furnace for about seven hours at 450 °C. The ignited samples were cooled and about 5 ml 1 N HNO_3 solution was added and the samples were subjected to complete dryness using hot plate. Obtained samples were subjected to higher temperature after evaporation, and heated at 400 °C for 15 minutes. The samples were cooled again and 10 ml 1 N HCl was added. The component was then filtered into a 50 ml flask. The crucible and the filter paper were washed with additional 10 ml portion of 0.1 N HCl three times and made up to volume with 0.1 N HCl solutions. The filtered materials were stored for determination of K, P and Fe in a photo colorimeter; and Ca, Mg, Zn, Na and Cu using atomic absorption spectrometry.

3.10 Determination of total nitrogen (N) in the organic materials.

Samples were prepared, dried and digested using micro-Kjeldhal method. Total N in Kjeldhal digest was determined colorimetrically using a Technicon autoanalyzer according to IITA (1982).

3.11 EXPERIMENT I

3.11.1 Growth attribute of NHV-1A and NHV-1F long cayenne pepper as influenced by organic fertilizers in the screenhouse

Top soil (low in N and P) was collected from NIHORT vegetable experimental field and Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm. 180kg of soil was collected from each location. The soil was filled into each pot after sieving with 2 mm mesh sieve. The pot was 50 cm in height and 50 cm in diameter. Five (5) kilogramme of the composite soil was filled into each black poly pot.

Each of the 8 different organic fertilisers were added to the soil at the rate of 130 kg N/ha. Four pots representing a replicate. The content was watered twice a week for two weeks to aid mineralization process before seedlings were transplanted.

Pepper seedlings of 6 weeks old of NHV-1A and NHV-1F was transplanted at 2 seedlings per pot. The seedlings were transplanted in the evening, to avoid shock. The treatments were arranged randomly in the screenhouse at NIHORT Ibadan. Weeding was done as at when due.

Growth parameters measured were; plant height (cm), number of leaves and branches per plant, Leaf area per plant, and mean plant dry matter (g). The data were taken at 10 weeks after transplanting when it was observed that the optimum physiological stage of the pepper has been attained.

3.11.2 Growth and fruit yield of NHV-1A and NHV-1F long cayenne pepper as influenced by organic fertilisers on the field.

Objective

To investigate the performance of different organic fertilisers on the growth and fruit yield of field grown long cayenne pepper.

Treatments and experimental design

A randomized complete block design experiment made up of two cultivars of long cayenne pepper (NHV-1A and NHV-1F) and 8 organic fertilisers was conducted at Ibadan and Ogbomoso. There was a plot with no organic fertiliser as the control. From each organic fertilizer type, equivalent quantity of 130 kg N ha^{-1} was added to soil once at one week before transplanting (Grubben and El-Tahir, 2004). Quantity of the organic fertiliser applied per plot (tonnes) based on N content were as follows: TC = 8.43, PM-S = 8.70, PM+S = 9.63, POF = 11.31, COF = 3.48, AOF = 38.78, BW = 17.40, CD = 27.14, OPBA = 17.86 and CPH = 17.40). The respective quantity applied was equivalent to the 130 kg N ha^{-1} recommendation for pepper production (Grubben and El-Tahir, 2004).

Each experimental plot measuring 3 m × 2 m (6 m^2) was separated from the other by 1 m gap. Pepper seedlings were transplanted into experimental plot when they were six week old at one seedling per stand in June 2008. Each plot contained five rows of seven plants at a spacing of 0.5 m × 0.5 m representing 35 plants per plot. Missing stands were supplied a week after transplanting. The field layout is shown in Appendix 2. The field was weeded first at two Weeks after Transplanting (WAT) and subsequent weeding at three weeks interval. A total number of five plants per plot in each replicate were randomly selected, excluding the border rows, for growth and yield data collection. Harvesting of ripe fruits started at 12 WAT, continued twice weekly.

3.11.3 Collection of data and analysis

Plant height data was collected using ruler. Number of leaves and branches per plant were obtained using visual counting. Leaf area was determined by grouping leaves on tagged plants into three categories, small, medium and large through visual observation. Five pepper leaves from each group were measured by determining the length from lamina base to the apex. The breath was determined across the widest part of each leaf. The mean was calculated and the result integrated, using linear regression equation estimator model Y = 0.60 × L × B (where Y = leaf area, L = leaf length from apex to base and B = leaf breath at the widest part) (Salau *et al.,* 2008). The parameters on growth and yield were obtained from the five randomly picked plants per plot. The data collected were statistically analysed using ANOVA and least significant difference (LSD) at $p < 0.05$ was applied to compare the means.

3.12 EXPERIMENT II

Growth and yield of field grown NHV-1A and NHV-1F long cayenne pepper as influenced by organic fertilizer in Ibadan and Ogbomosho.

Treatments and experimental design

The experiment was a 2 × 4 factorial arrangement fixed into randomized complete block design (RCBD) and repeated in three places. The treatments involved two cultivars of long cayenne pepper (NHV-1A and NHV-1F) as the main plot while three types of organic fertilizers (PM-S, COF and TC) selected from experiment I and the control comprised the sub plot treatments. The plot size was 3 m × 2 m (6 m^2) with 1 plot gaps between. The optimum nitrogen requirement of pepper (130 kg N/ha) was applied one week before transplanting based on its N content. Each plot contained 5 rows of seven plants spaced at 0.5 m × 0.5 m giving rise to 35 plants per plot corresponding to 40,000 plants per hectare. The quantities of organic fertilizer applied were 8.43 t/ha TC, 8.70 t/ha PM-S and 3.48 t/ha COF. One week before seedlings were transplanted, treatments were applied by uniformly working them into the soil with light hoeing. Six-weeks old seedlings were transplanted to the experimental plots at one seedling per stand using a distance of 0.5 m × 0.5 m. This gave a population of 35 plants per plot and 40,000 stands per ha. Missing stands were supplied a week after transplanting. Weeding was done to eliminate competition between crops and weed.

Collection of data

Data collection commenced at 6 WAT and was carried out every two weeks till harvest. The parameters measured included plant height measured with metre rule from the ground till the position of the last leaf, functional leaves on the plant and lateral shoots on each stand, observed with visual count, and size of the stem taken where the height is at 5 cm from soil level with digital venial calliper. The breadth was determined across the widest part of each leaf. The mean was calculated and the result integrated, using linear regression equation estimator model $Y = 0.60 \times L \times B$ (where Y = leaf area, L = leaf length from apex to base and B = leaf breath at the widest part) (Salau *et al.,* 2008). Data on days to first flowering, days to 50% flowering, days to first fruit harvest, mean fruit weight (g), fruit girth (cm), fruit length (cm), number of fruits per plant, fruit weight per plant (g), number of seeds per fruit, 1000 seeds weight (g) and fruit yield (t/ha) were recorded on the five tagged plants per plot.

Analysis of data

Data recorded were put to Analysis of variance (ANOVA) and means of the main effect and their interactions were compared using LSD at $p<0.05$.

3.13 EXPERIMENT III

Effect of rates of tithonia based compost on growth, fruit yield and nutritional qualities of long cayenne pepper

Treatment and experimental design

The experiment was a 2 × 4 factorial arrangement in RCBD comprising of two pepper cultivars (NHV-1A and NHV-1F) as the main plot while the sub-plot involved four levels of Tithonia compost (0, 45, 90, 135 kg N/ha contained in 0, 2.81, 5.6, 8.43 t/ ha respectively) of the compost material. The total area of land used for the experiment was 15 m × 6 m (90 m^2) The plots were 1 m apart, but blocks were separated 2 m apart. Each block consisted of eight plots and each unit plot was 3 × 2 m (6 m^2) in dimension. Vigorous and healthy seedlings of the crop were transplanted at one plant per stand using a distance of 0.5 m × 0.5 m which was equivalent to 40,000 plants per hectare. Missing stands were replaced one week after transplanting. Tithonia based compost fertilizer were applied to each plot one week before pepper seedlings were transplanted. The established experiment was replicated three times. Missing stands were supplied at one week after transplanting. Weed control was achieved through regular weeding with hoes. Harvesting of ripe fruits was carried out twice a week.

Data collection and analysis

A total of five plants were randomly selected among the core pepper plants within the plot. Height of plant was measured with metre rule, number of leaves and branches by visual counting on the main stem per plant and stem diameter measured with digital vernier caliper. Leaf area was determined as in Experiment II. Records of number of days it take before the first flower came up, number of days it took for 50 % flower to emerge, days to first fruit harvest, mean fruit weight (g), fruit diameter (cm), (at the point of calyx attachment), fruit length (cm), number of fruits per plant, fruit weight per plant (g), number of seeds per fruit, 1000 seed weight (g) and fruit yield (t/ha) were taken. Harvesting of ripe fruits was carried out twice a week as described in Experiment II. Data collected were subjected to ANOVA and means were compared with LSD at $p < 0.05$.

Determination of nutritional qualities of long cayenne pepper

Dry matter and ash content:

Samples of 100 g homogenized pepper fruit was dried, first at 70 °C for 3 hours and later at 105 °C to a constant weight to quantify the dry matter (AOAC, 1990). The dried pepper fruit residue was burnt in a muffle furnace at 525 °C for 16 hours and the residue was weighed to determine the ash content (AOAC, 1990). pH, titratable acidity, and soluble solids: Pepper juice was extracted from a 10 g sample with an Ultra-Turrax (T25, IKA-Labortechnik), followed by centrifugation at 4 °C. The supernatant was recovered for pH, titratable acidity, and soluble solids measurements. The pH was measured at 20°C. Titratable acidity was determined by titration with 0.1 N NaOH until pH 8.1 was reached and reported as g citric acid/100 g fresh weight. Soluble solids content was determined at 20 °C with a refractometer and reported as ºBrix.

Protein content: The protein content (g protein/100 g fresh weight) was quantified using the Folin–Lowry method (Lowry *et al*., 1951) and bovine serum albumin (BSA) as standard.

Total nitrogen: This was determined by the Kjeldahl method (AOAC, 2000) using an autoanalyzer (Alpken RFA-300, OI Analytical, College Station, TX). Protein content was calculated based on the product of Kjeldahl nitrogen 6.25 value obtained.

Fibre**:** It was determined by grinding the dried samples to pass a 1.0 mm screen, and extracting with ether to remove excess fat. Samples were then digested in dilute tetra-oxo-sulphate (vi) acid, filtered, digested in dilute sodium hydroxide (Fisher Scientific, Pittsburg, PA), and filtered again. The residue was washed, dried, weighed, ignited, and reweighed. Fibre was calculated from the loss on ignition of the residue (AOAC, 2000).

Carbohydrate**:** The carbohydrate was obtained by removing protein, fat, moisture, and ash from 100 and expressed as a percentage.

Moisture content determination**:** Direct drying method was used to obtain moisture value of the material used. Homogeneous material (10 g) was oven dried at 105 ºC overnight till the sample was of constant weight. Moisture lost was the difference between initial weight and constant weight (Tee *et al*., 1996). Samples were analysed in three replicates while the results obtained were recorded as g/100 g FW of sample.

Lipid content determination**:** Lipid content was obtained through semi-continuous solvent extraction technique. 10 g sample was obtained using 180 ml petroleum ether in a Soxhlet apparatus within 10 hours. Petroleum ether was removed by evaporation and the residue of lipid was weighed (Tee *et al*., 1996). Samples were analysed in three replicates, the result obtained expressed as g/ 100g FW of sample.

Mineral content extraction**:** Sample was ashed and the ash content left was cooled and weighed. Ash was diluted to obtain minerals content this was later prepared by dissolving the ash product in 100 ml 1 N hydrochloric acid. To obtain Ca, K, Na, Fe, Cu and Zn, the ash obtained was subjected to atomic absorption spectroscopy (Tee *et al*., 1996). Samples collected were subjected to analysed in three replicates. The results obtained are expressed as g/100 g FW of materials for ash content, and mg/100 g FW of sample for each mineral element.

3.14 EXPERIMENT IV

Evaluation of the residual effects of the tithonia based compost applied on the vegetative growth and fruit yield of long cayenne pepper

Treatments and experimental design

This experiments were conducted in Ibadan and Ogbomoso to investigate the residual effect of the applied tithonia based organic fertilisers on pepper performance. The experimental design, plot layout and spacing used in the experiment were maintained. Plots were manually cleared and planting was done on the flat with minimum soil disturbance. Weed free plots were achieved by hoeing. The debris was allowed to rot on the plot, subsequently, hoeing was introduced to ensure that there was no weed interference during the experimental period. Seedlings of the two pepper cultivars were transplanted at 6weeks of age.

Data collection and analysis

Observations were made from five selected plants per plot for plant development and yield of fruit, observation on plant height measured with meter rule, available leaves on each plant and prominent pepper plant branches on the major stem per plant were accessed with visual count, stem girth were determined with the aid of digital venier caliper. Leaf area was also determined following the procedure in experiment II. Data collected were subjected to ANOVA and means were compared with LSD at $p<0.05$.

CHAPTER 4

RESULTS

4.1 Characteristics of the Soils of the Experimental Fields

The chemical and physical properties of soil in the experimental locations are presented in Table 4.1. The mean soil pH, organic carbon, total nitrogen, the macro and micro nutrient in both locations were below the minimum requirement for plant grow and yield. The mean sand and silt contents in both stations were as presented in Table 4.1, but the clay content of Ogbomoso soil was slightly higher (16.33g/kg) than that of Ibadan (11.67 g/kg) (Table 4.1).

4.2 Nutrient composition of organic fertilisers evaluated

Among the organic fertiliser types evaluated, the top three in terms of nitrogen content were Tithonia compost (TC), Commercial organic fertiliser (COF), and Poultry manure minus Chavings (PM-S). The phosphorus content was similar but highest in Oil Palm Bunch Ash (OPBA) and Cocoa Pod Husks (CPH). While the Pacesetter Organic Fertiliser (POF) had the highest potassium (K) content (Table 4.2). The overall macronutrient content of the ten organic fertiliser types was in the order COF > OPBA ≥ CPH > AOF > TC > POF > PM-S ≥ CD > BW > PM+S.

4.3 Evaluation of vegetative parameters of NHV-1A and NHV-1F on the organic fertiliser in the Screenhouse

Plant height; In the screenhouse, plant height of NHV-1A (72.7 cm and 78.9 cm) was significantly taller than NHV-1F (67.4 cm 74.0 cm) on Ibadan and Ogbomoso soil respectively. Among the Organic Fertilisers (OFs); TC (78.3 cm, 85.1 cm), COF (78.4 cm, 85.3 cm) and PM-S (76.9 cm, 84.0 cm) were significantly better than other OFs at both locations. However all the OFs produced significantly taller plants than the control (Table 4.3).

Number of branches; Cultivar NHV-1A (10.5 and 14.0) produced more branches than NHV-1F (8.2 and 11.5) on Ibadan and Ogbomoso soils respectively. Both cultivars had

Table 4.1: Chemical and physical soil properties of the experimental fields

	Year 1		Year 2		Year3	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
pH (H_20)	5.9	5.5	5.8	5.8	5.1	5.7
Organic carbon (g kg^{-1})	4.4	3.8	3.8	3.2	3.4	4.4
Total N (g kg^{-1})	0.3	0.3	0.3	0.3	0.1	0.3
Available P (mg kg^{-1})	7.9	4.2	3.8	6.0	3.6	5.3
Fe (mg kg^{-1})	10.6	11.8	11.9	11.4	9.8	12.0
Cu (mg kg^{-1})	2.6	2.0	3.2	2.7	2.9	3.4
Zn (mg kg^{-1})	2.8	2.2	2.1	2.0	2.0	3.1
Ex. K (cmol kg^{-1})	0.2	0.3	0.3	0.3	0.4	0.3
Ex. Na (cmol kg^{-1})	0.3	0.3	0.3	0.3	0.2	0.3
Ex. Ca (cmol kg^{-1})	2.8	3.2	3.1	3.4	3.3	3.4
Ex. Mg (cmol kg^{-1})	0.6	0.6	0.6	0.7	0.6	0.8
Ex. acidity (cmol kg^{-1})	0.3	0.4	0.3	0.3	0.3	0.3
ECEC (cmol kg^{-1})	4.7	5.0	5.2	5.2	4.8	4.7
Base saturation (g kg^{-1})	930	924	950	940	920	936
Sand (g kg^{-1})	878	864	868	860	865	868
Silt (g kg^{-1})	110	122	120	120	124	117
Clay (g kg^{-1})	12	14	12	15	11	15
Textural class	Sandy loam		Sandy loam		Sandy loam	

Table 4.2: Nutrient constituents of different organic fertiliser types used for the study

Organic fertiliser	g/ kg							mg/ kg	
	N	P	K	Ca	Mg	Na	Fe	Zn	Cu
TC	16.1	10.4	29.3	21.5	6.0	8.6	6.7	129.0	29.5
PM-S	15.3	37.6	10.6	20.9	2.9	6.1	14.6	180.5	38.5
PM+S	14.1	22.9	20.9	9.5	4.1	4.7	10.5	120.5	36.5
POF	12.0	45.0	38.0	25.8	5.2	4.6	6.2	118.0	34.0
COF	36.0	50.0	30.3	45.6	3.0	2.1	11.4	116.0	30.4
AOF	3.5	37.8	26.1	22.0	8.0	5.6	8.5	110.0	25.4
BW	7.8	76.0	7.9	1.3	3.1	5.7	7.8	140.0	22.5
CD	5.0	28.0	24.0	18.5	6.4	8.4	10.9	126.0	28.6
OPBA	7.6	110.2	15.3	24.1	9.1	4.8	12.4	110.0	16.8
CPH	7.8	95.1	11.1	21.7	8.4	5.4	8.6	134.2	42.4

TC = Tithonia compost, PM-S = poultry manure without shavings, PM+S = poultry manure with shavings, POF = Pacesetter organic fertiliser, COF = commercial organic fertiliser, AOF = Ayeye organic fertiliser, BW = Brewery waste, CD = Cow dung, OPBA = Oil palm bunch ash, CPH = Cocoa pod husk, NF = No organic fertiliser.

more branches in Ogbomoso than Ibadan soils. Number of branches among the OFs ranged from 8.7 to 13.3 and 12.1 to 15.0 at Ibadan and Ogbomoso soil respectively. All the OFs tested produced significantly more branches than the control (Table 4.3).

Number of leaves; Cultivar NHV-1A (181.7 and 193.1) produced more leaves than NHV-1F (168.1 and 184.1) in Ibadan and Ogbomoso soils, respectively. Tithonia based compost (219 and 230) in Ibadan and Ogbomoso produced higher number of leaves per plant that is significantly higher than other OFs. However all OFs significantly enhanced leaf production than the control.

Leaf area; The cultivars, NHV-1A (1356.4 cm^2 and 1382.6 cm^2) were significantly better than NHV-1F (1296.0 cm^2 and 1301.0 cm^2) in Ibadan and Ogbomoso respectively. Leaf area among the OFs tested was significantly better than the control. Table 4.3

4.4 Effects of organic fertilisers on vegetative parameters of field grown NHV-1A and NHV-1F long cayenne pepper cultivars

All the organic fertilisers applied improved the growth of NHV-1A and NHV-1F pepper cultivars. However, the OFs induced variations in all the growth parameters considered (Table 4.4). The TC and COF highly increased plant height at Ibadan (80.89 cm and 87.01 cm) and Ogbomoso (81.39 cm and 87.54 cm), respectively. However, their effects were not significantly different from those of PM+S, PM-S, CPH and CD. Number of branches was highest (17.84) when plants were treated with PM-S and this was similar to those of TC and BW. The TC, COF and BW produced pepper plants having highest number of functional leaves and had similar value with PM-S. Applied TC, COF and PM-S had significant effects on leaf area and plant dry matter (Table 4.4).

Plant height

Pepper plants fertilised with TC, COF, PM+S, PM-S and CPH showed greater performance when compared with the other applied OFs (Table 4.4). All OFs applied produced taller plants were significantly higher compared to the control (NF). NHV-1A and NHV-1F responded positively to the applied organic fertilisers at both locations in similar ways, although pepper grows taller at Ogbomoso than at Ibadan location. The plant height was in the order of COF > TC > CPH > PM-S > PM+S > CD > POF > BW > AOF > OPBA > NF (Table 4.4).

Number of branches

Significant variation existed on number of branches in the response of pepper to the applied OFs within and across locations. Pepper produced more branches in Ogbomoso soil than Ibadan soils (Table 4.4). All the organic fertiliser types at both locations showed greater performance when compared with the control. The top five at Ibadan location included PM-S (14.43), TC (13.25), BW (12.00), CD (11.50) and COF (10.50). Similar result was also obtained from Ogbomoso with PM-S (17.84), TC (16.69), BW (15.59) CD (15.17) and SOF (13.90), being the best five.

Number of leaves

Significant differences existed among the applied organic fertilisers at the two locations. Nevertheless, all the organic fertiliser types produced significantly better pepper plant than the control (Table 4.4). The top five OFs at Ibadan were TC (226.28), BW (215.06), COF (214.91), PM-S (207.11) and CD (182.04), while at Ogbomoso the best five were TC (237.88), SOF (226.51), BW (226.49), PM-S (218.60) and CD (193.64)

Leaf area

At Ibadan and Ogbomoso locations the mean leaf areas values of long cayenne pepper were similar. All the OFs applied produced leaf area that were significantly better than the control. Significant variations also existed among the applied organic fertilisers. The leaf areas were: PM-S (1815) > COF (1645.13) > TC (1587.44 cm^2) in the order of superiority (Table 4.4).

Plant dry matter

In Ibadan COF produced the highest DM of 54.28 g but this was not significantly different from PM-S of 54.17 g while both were significantly higher than TC (46.28g). Pacesetter Organic Fertiliser produced 59.06 g DM, which was similar to PM-S (58.95 g) but TC was significantly lower than COF and PM-S. Ogbomoso location produced higher dry matter contents with each of the organic fertiliser type than that of Ibadan location (Table 4.4).

Table 4.3: Influence of applied organic fertilisers on the vegetative growth of NHV-1A and NHV-1F long cayenne pepper in the screenhouse

Treatment	Plant height (cm)		No. of branches/plant		No. of leaves/plant		Leaf area/plant (cm^2)	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar								
NHV-1A	72.7a	78.9a	10.5a	14.0a	181.7a	193.1a	1356.4a	1382.6a
NHV-1F	67.4b	74.6b	8.2b	11.5b	168.1b	184.3b	1296.0b	1301.7b
Organic fertiliser								
TC	78.3a	85.1a	11.9b	15.0b	219.9a	230.8a	1550.1c	1576.5c
SOF	78.4a	85.3a	9.7d	14.2b	207.4b	222.5b	1607.8b	1630.7b
PM-S	76.9a	84.0a	8.5e	11.6c	162.8f	177.4e	872.7j	889.7j
PM+S	76.5a	83.6a	8.3e	16.5a	200.9c	214.1c	1791.2a	1808.8a
CPH	77.5a	84.3a	8.3e	11.5c	161.3f	176.5e	1291.6f	1304.7e
CD	70.0b	76.3b	10.2cd	13.8b	175.3d	189.1d	1235.9g	1251.3g
BW	68.4b	74.3b	10.7c	13.8b	208.7b	222.0b	1249.7g	1268.1f
OPBA	60.5d	67.6d	8.7e	12.1c	167.4e	180.5e	1193.3h	1200.8h
NF	50.2e	56.9e	4.6f	7.9d	125.4g	139.8f	1139.5i	1155.1i

TC= Tithonia compost, PM-S= poultry manure without shavings, PM+S= poultry manure with shavings, COF= commercial organic fertiliser, BW= Brewery waste, CD= Cow dung, OPBA= Oil palm bunch ash, CPH= Cacao pod husk, NF= No fertiliser.
Mean with the same alphabet are not significantly different from each other using DMRT.

Table 4.4: Influence of applied organic fertilisers on the vegetative growth of NHV-1A and NHV-1F long cayenne pepper in Ibadan and Ogbomoso experimental fields.

Treatment	Plant height (cm)		No. of branches/plant		No. of leaves/plant		Leaf area/plant (cm^2)		Dry matter (g)	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar										
NHV-1A	72.73a	78.90a	10.53a	14.00a	181.69a	193.12a	1356.42a	1382.64a	38.06a	42.88a
NHV-1F	67.42b	74.61b	8.18b	11.46b	168.06b	184.27b	1296.03b	1301.70b	32.04b	33.87b
Organic fertiliser										
TC	78.32a	85.12a	11.9b	15.02b	219.89a	230.88a	1550.13c	1576.46c	43.84b	46.93b
COF	78.39a	85.26a	9.65d	14.16b	207.35b	222.51b	1607.81b	1630.76b	50.34a	55.11a
PM+S	76.50a	83.62a	8.52e	11.64c	162.82f	177.35e	872.74j	889.66j	28.29f	31.40e
PM-S	76.92a	84.01a	13.25a	16.54a	200.89c	214.05c	1791.19a	1808.84a	51.06a	53.34a
CPH	77.51a	84.29a	8.31e	11.48c	161.28f	176.52e	1291.63f	1304.65e	30.06ef	32.49e
CD	70.05b	76.27b	10.23cd	13.80b	175.32d	189.07d	1235.85g	1251.31g	33.01de	36.22d
POF	68.96b	75.45b	8.63e	11.77c	127.50g	141.73f	1335.96d	1343.09d	32.23de	35.90d
BW	68.41b	74.31b	10.65c	13.82b	208.67b	222.01b	1249.67g	1268.06f	34.56d	37.85cd
AOF	65.07c	71.39c	8.42e	11.80c	167.05e	181.16e	1320.70e	1335.06d	37.79c	40.90c
OPBA	60.48d	67.62d	8.74e	12.10c	167.39e	180.52e	1193.32h	1200.88h	28.79f	32.46e
NF	50.21e	56.94e	4.59f	7.93d	125.44g	139.83f	1139.46i	1155.09i	15.56g	19.50f

TC = Tithonia compost, PM-S = poultry manure without shavings, PM+S = poultry manure with shavings, POF = Pacesetter organic fertiliser, COF = commercial organic fertiliser, AOF = Ayeye organic fertiliser, BW = Brewery waste, CD = Cow dung, OPBA = Oil palm bunch ash, CPH = Cacao pod husk, NF = No fertiliser.

Mean with similar letter along column are not significantly different from each other using DMRT.

4.5 Effects of organic fertilisers on fruit yield and yield attributes of two cultivars of long cayenne pepper in Ibadan and Ogbomoso

Friut Length: Organic fertiliser types significantly influenced the fruit length of pepper at both locations. All organic fertilisers applied enhanced the pepper fruit yield than where organic fertiliser was not applied. The best three organic fertiliser types at both locations in terms of fruit length were TC = COF = PM-S.

Fruit diameter: At both locations, fruit diameter was significantly higher with the applied organic fertilisers than the control. Fruit diameter at Ogbomoso was relatively higher than that of Ibadan. At Ogbomoso, the best three organic fertiliser types in terms of fruit diameter are COF (4.23 cm) ≥ TC (3.88 cm) > BW (3.34 cm) (Table 4.5).

Number of marketable fruits: There are significant variations among the organic fertilisers applied in relation to number of marketable pepper fruit yield. However, this parameter was lowest in the pepper plant that received no fertiliser. The three most promising organic fertilisers in terms of number of marketable pepper fruit at Ibadan location included TC (438.46) > PM+S (276.52), > PM-S (249.19). Similarly at Ogbomoso the best three organic fertiliser types were TC (444.25) > PM+S (289.78) > PM-S (258.04) (Table 4.5)

Seed weight/ fruit: This followed similar pattern as in number of marketable fruit across the locations. The top three included COF (1.97g, 2.61g) > TC (1.41g, 2.05g) = PM-S (1.41g, 2.09g) at Ibadan and Ogbomoso locations respectively (Table 4.5).

Number of seeds/ fruit: Organic fertiliser types significantly influenced the quantity of seeds in each fruit both in Ibadan and Ogbomoso experimental locations. The top three at Ibadan included BW (101.47) = CD (96.82) > TC (83.43) whereas at Ogbomoso they were BW (107.18) ≥ CD (103.22) > TC (91.64) (Table 4.5).

Fruit yield per t/ ha: Total fruit yield was highest under TC (26.00, 31.00), PM-S (27.00, 30.00), COF (24.00, 29.50) and PM+S (23.00 29.00) at Ibadan and Ogbomoso respectively. Fruit yield at Ogbomoso was consistently higher than that of Ibadan when plants were treated with the same OFs. Overall, the organic fertiliser types positively enhanced pepper fruit yield than the plots where no fertiliser was applied across the locations. (Fig 4.1).

Table 4.5: Effect of organic fertilisers on the yield parameters of NHV-1A and NHV-1F cultivar of long cayenne pepper in Ibadan and Ogbmoso experimental fields

Treatment	Fruit length (cm)		Fruit diameter (cm)		Number of marketable fruits		Seed weight/ fruit (g)		No of Seed/fruit	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar										
NHV-1A	9.09a	12.51a	2.42a	3.67a	202.51a	208.92a	1.52a	2.10a	75.41a	85.03a
NHV-1F	5.34b	8.17b	1.74b	2.80b	165.57b	182.97b	1.18b	1.79b	67.01b	72.50b
Organic fertiliser										
TC	10.922a	14.55a	2.80b	3.88b	438.46a	444.25a	1.41b	2.05b	83.43c	91.64c
COF	10.44a	13.37b	3.23a	4.23a	112.46h	123.27g	1.97a	2.61a	56.95g	66.38fg
PM+S	6.41bc	9.59cd	1.73def	2.73f	276.52b	289.78b	1.02e	1.71c	77.47d	85.66d
PM-S	10.41a	13.17b	2.06cd	3.12cd	249.19c	258.04c	1.41b	2.09b	69.81e	76.76e
CPH	6.26bcd	9.39cde	2.17c	3.20cd	123.52f	138.45f	2.00a	2.60a	56.86g	64.00g
CD	6.44b	9.59cd	1.64ef	2.88def	155.35e	169.34e	1.21c	1.70c	96.82b	103.22b
POF	6.20bcd	9.09cde	1.46f	2.79ef	219.13d	230.75d	1.05de	1.67c	48.61h	57.30h
BW	5.39cde	8.75def	1.91cde	3.34c	119.64g	133.27f	1.19cd	1.74c	101.47a	107.18a
AOF	7.168b	10.10c	1.82cdef	3.03cdef	123.03f	134.53f	1.45b	1.97b	76.58d	82.17d
OPBA	5.33de	8.39ef	1.96cde	3.10cde	110.35h	123.37g	1.03e	1.63c	60.68f	68.50f
NF	4.36e	7.75f	2.14c	3.30c	96.80i	110.34h	1.12cde	1.65c	54.67g	63.59g

TC = Tithonia compost, PM-S = poultry manure without shavings, PM+S = poultry manure with shavings, POF = Pacesetter organic fertiliser, COF = commercial organic fertiliser, AOF = Ayeye organic fertiliser, BW = Brewery waste, CD = Cow dung, OPBA = Oil palm bunch ash, CPH = Cacao pod husk, NF = No organic fertiliser

Means with similar letter along column are not significantly different using DMRT.

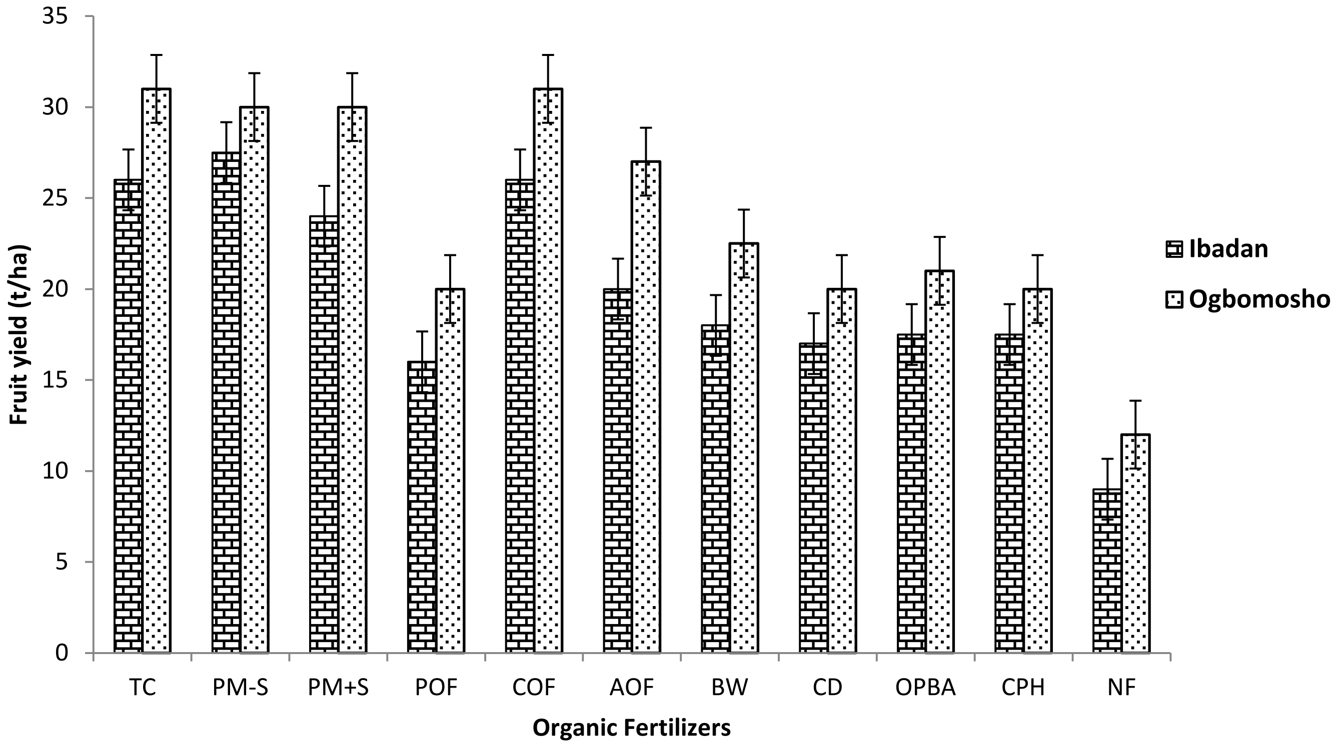

Figure 4.1: Effects of organic fertilizer types on fruit yield of long cayenne peppers at Ibadan and Ogbomoso.

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TC = Tithonia compost, PM-S = poultry manure without shavings, PM+S = poultry manure with shavings, POF = Pacesetter organic fertiliser, COF = commercial organic fertiliser, AOF = Ayeye organic fertiliser, BW = Brewery waste, CD = Cow dung, OPBA = Oil palm bunch ash, CPH = Cocoa pod husk, NF = No fertiliser

4.5 Effects of the three selected organic fertiliser types on the growth of two cultivars of long cayenne pepper

4.5.1: Plant height

Organic fertiliser types did not affect height of pepper in Ibadan, but significantly affected the height of pepper grown in Ogbomoso (Figure 4.2). The tallest plants were obtained with the application of TC, at 6, 8, and 10 WAT followed by COF while the least was recorded under control in Ogbomoso (Figure 4.2). At 8 WAT the response of cultivars to OFs on plant height was significant in Ibadan and in Ogbomoso (Figure 4.3). However cultivars did not have significant effect on plant height at Ibadan and Ogbomoso. The interaction of cultivars and organic fertiliser types indicated that NHV-1A planted with TC performed significantly better than COF and PM-S throughout the crop growth stages (Figure 4.3)

4.5.2 Number of leaves per plant

Significant differences existed on number of leaves/plant due to applied organic fertiliser types only on Ogbomoso grown pepper at 6, 8 and 10 WAT (Figure 4.4). Highest number of leaves was obtained under the application of TC. This was followed by COF and PM-S, while the least number of leaves was obtained under no fertiliser application. At 6 WAT in Ogbomoso NHV-1A was significantly better with the application of TC. At 8 and 10 WAT, TC and COF were similar but better than PM-S in Ogbomoso. However, the least number of leaves was recorded in the no fertiliser application at 6, 8 and 10 WAT at Ogbomoso (Figure 4.5). Cultivar NHV-1F did not show significant effects at Ibadan and Ogbomoso.

4.5.3 Leaf area: Significant difference was observed on leaf area of the cultivars only at 8WAT in Ibadan whereas at Ogbomoso significant differences were observed both at 8 and 10 WAT (Table 4.6). Effect of fertiliser types was significant at both locations with TC having higher leaf area than others. Response of cultivars to application of different fertiliser types on leaf area were significant at 8 and 10 WAT in Ibadan and only 6 WAT at Ogbomoso (Fig 4.6). Cultivar NHV-1A consistently produced higher leaf area than NHV-1F with TC. Effect of cultivars by tithonia compost was significant only at 6 WAT in Ogbomoso (Fig 4.6).

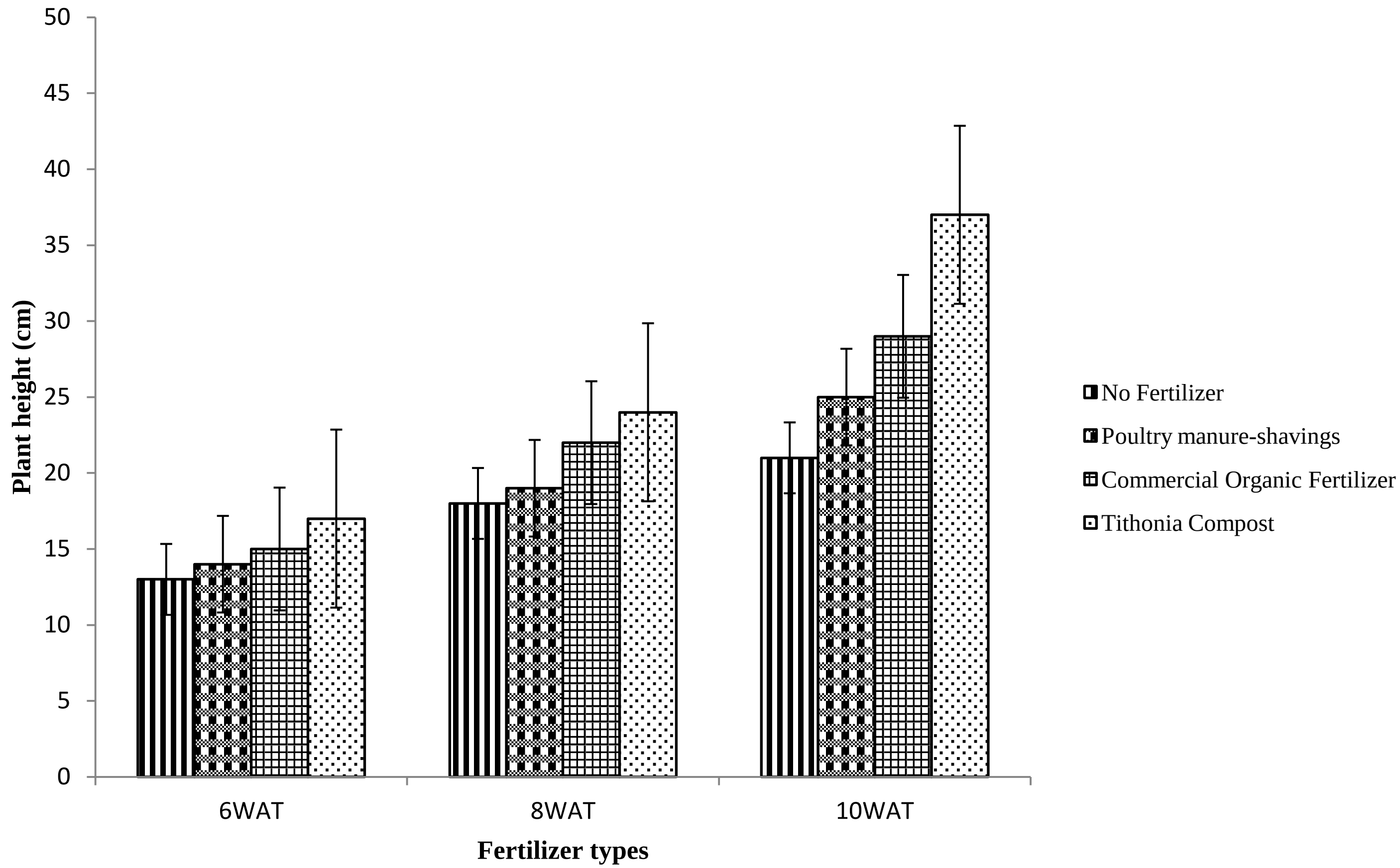

Fig. 4.2: Effect of three fertilizer types on plant height (cm) of two cultivars of long cayenne peppers in Ogbomoso

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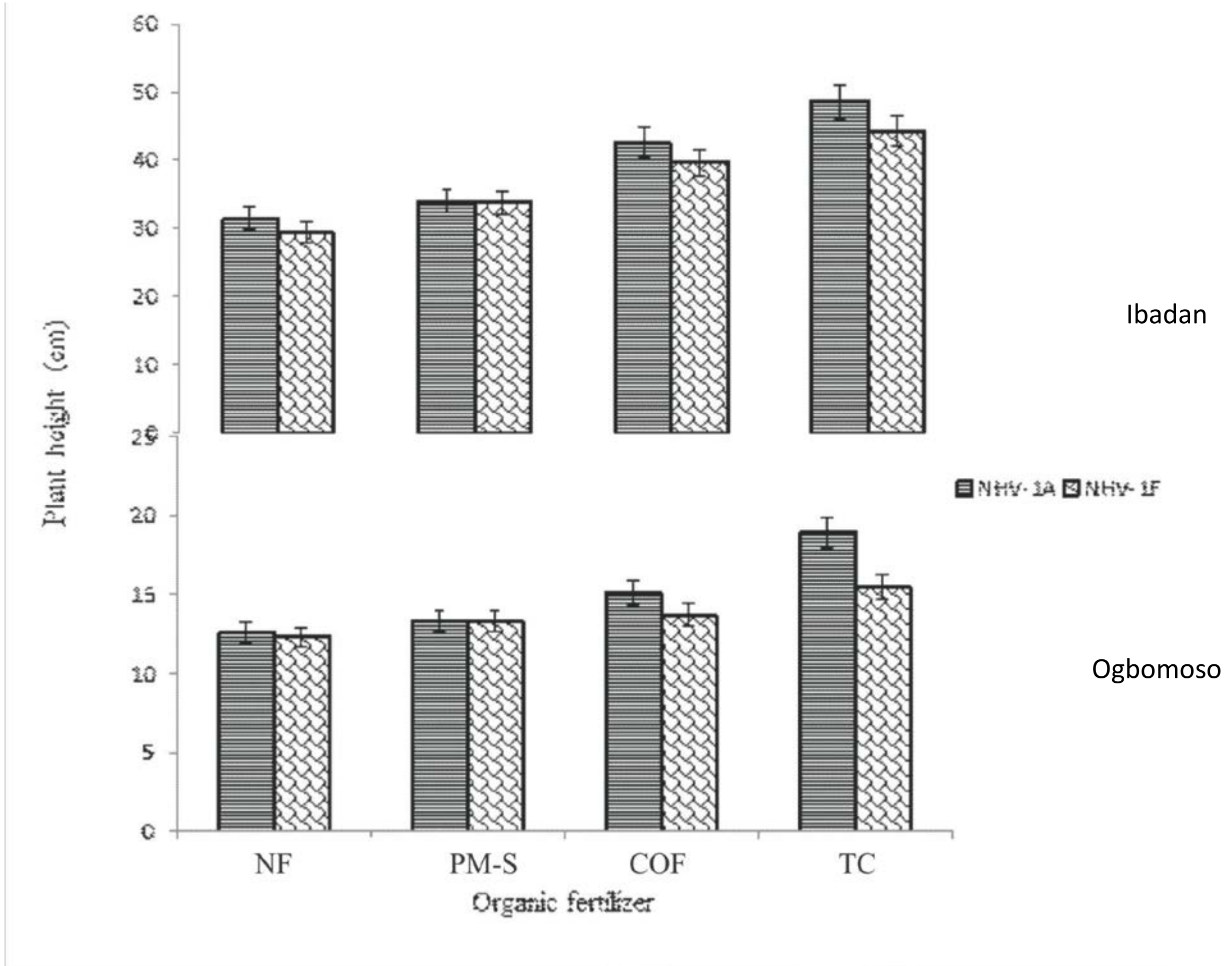

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Fig. 4.3: Interaction of organic fertilizer types × cultivar on the height of plant (cm) of long cayenne pepper at 8 WAT

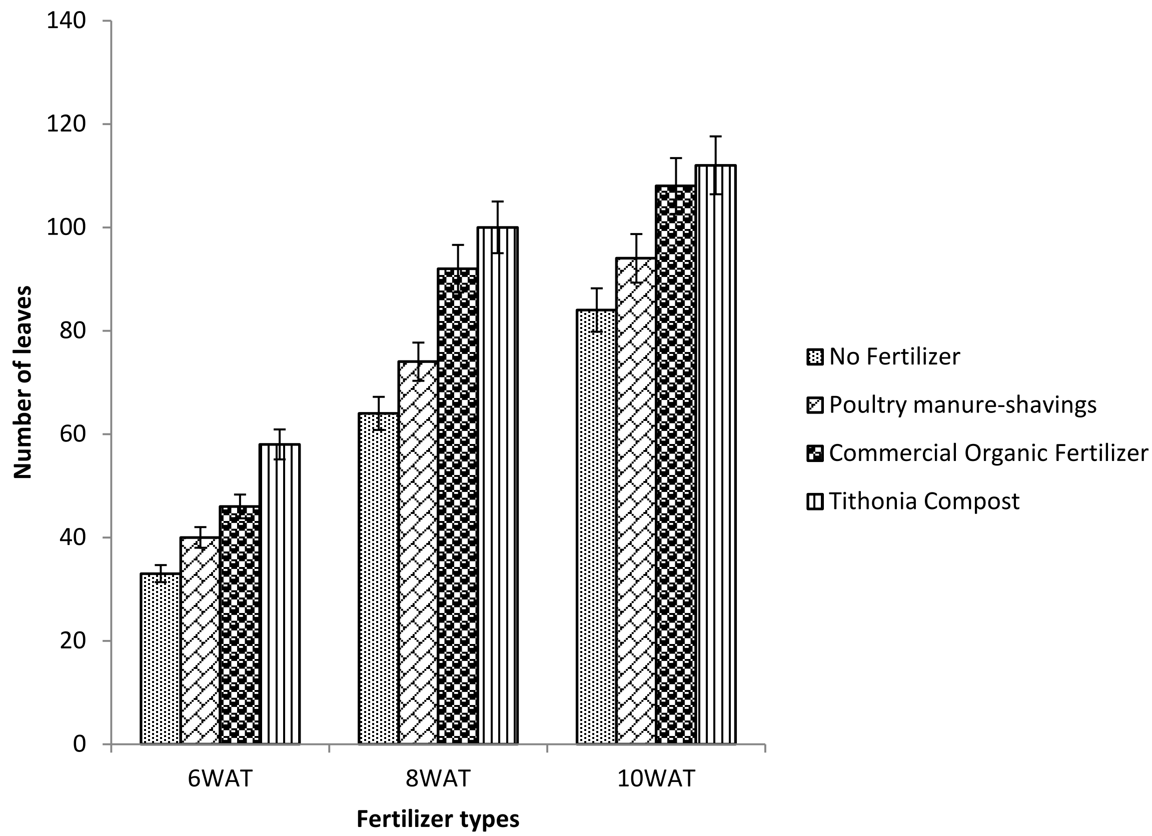

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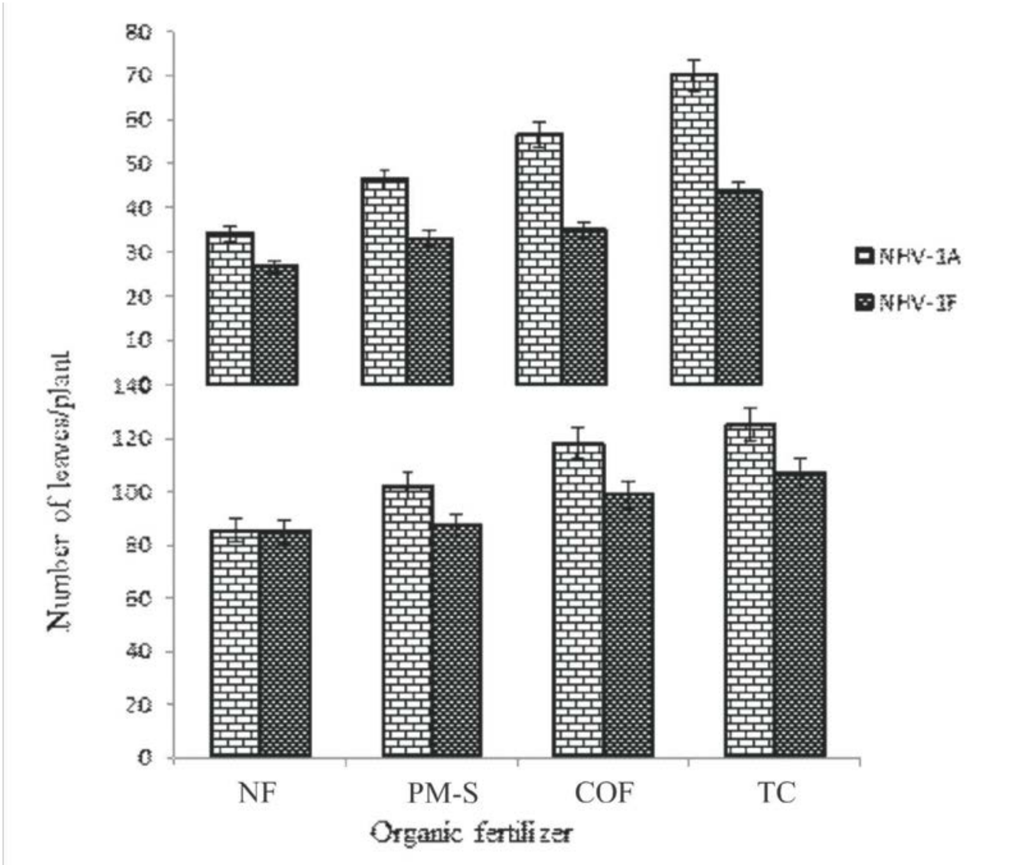
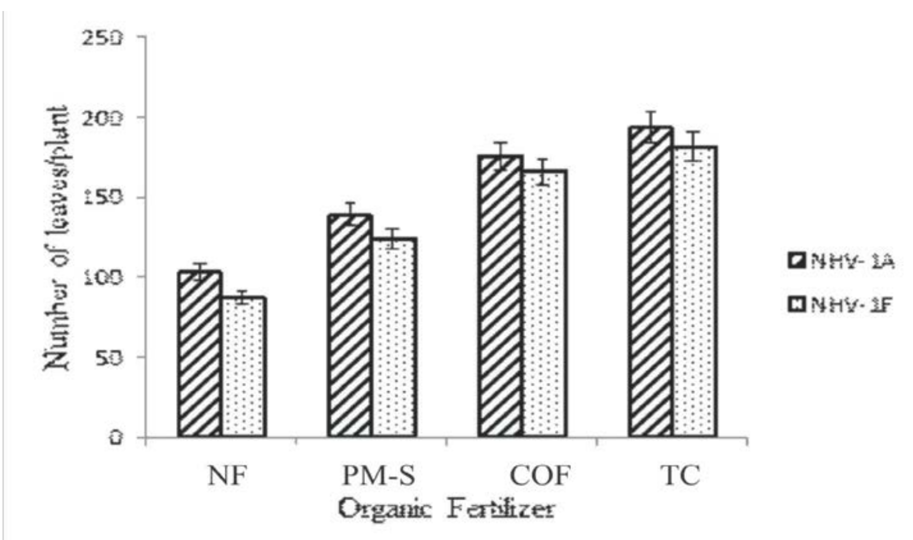
Fig. 4.4: Effect of organic fertilisers on number of leaves/plant cultivar NHV-1A of long cayenne pepper at Ogbomoso



6 WAT

8 WAT



10 WAT

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Fig. 4.5: Interaction of organic fertilisers by pepper cultivars on number of leaves per plant of long cayenne pepper in Ogbomoso.

Table 4.6: Effect of selected three organic fertilisers on the leaf area/plant (cm^2) of two long cayenne pepper cultivars at Ibadan and Ogbomoso.

Treatment	Ibadan			Ogbomoso		
	Weeks after transplanting			Weeks after transplanting		
	6	8	10	6	8	10
Cultivar						
NHV-1A	373.10	832.80	844.30	579.00	1474.00	1940.00
NHV-1F	371.60	743.00	856.90	424.00	918.00	1470.00
$LSD_{0.05}$	ns	19.32	ns	ns	512.40	73.70
Fertiliser source						
NF (Control)	285.40	540.80	696.70	369.00	818.00	1216.00
PM-S	384.10	641.00	742.50	445.00	973.00	1600.00
COF	403.60	892.20	879.90	561.00	1210.00	1763.00
TC	416.40	1140.70	1083.10	630.00	1784.00	2240.00
$LSD_{0.05}$	10.83	20.48	51.10	71.50	381.70	304.80

PM-S =Poultry manure without shavings; COF = Commercial organic fertiliser; TC = Tithonia based compost; NF = No fertiliser

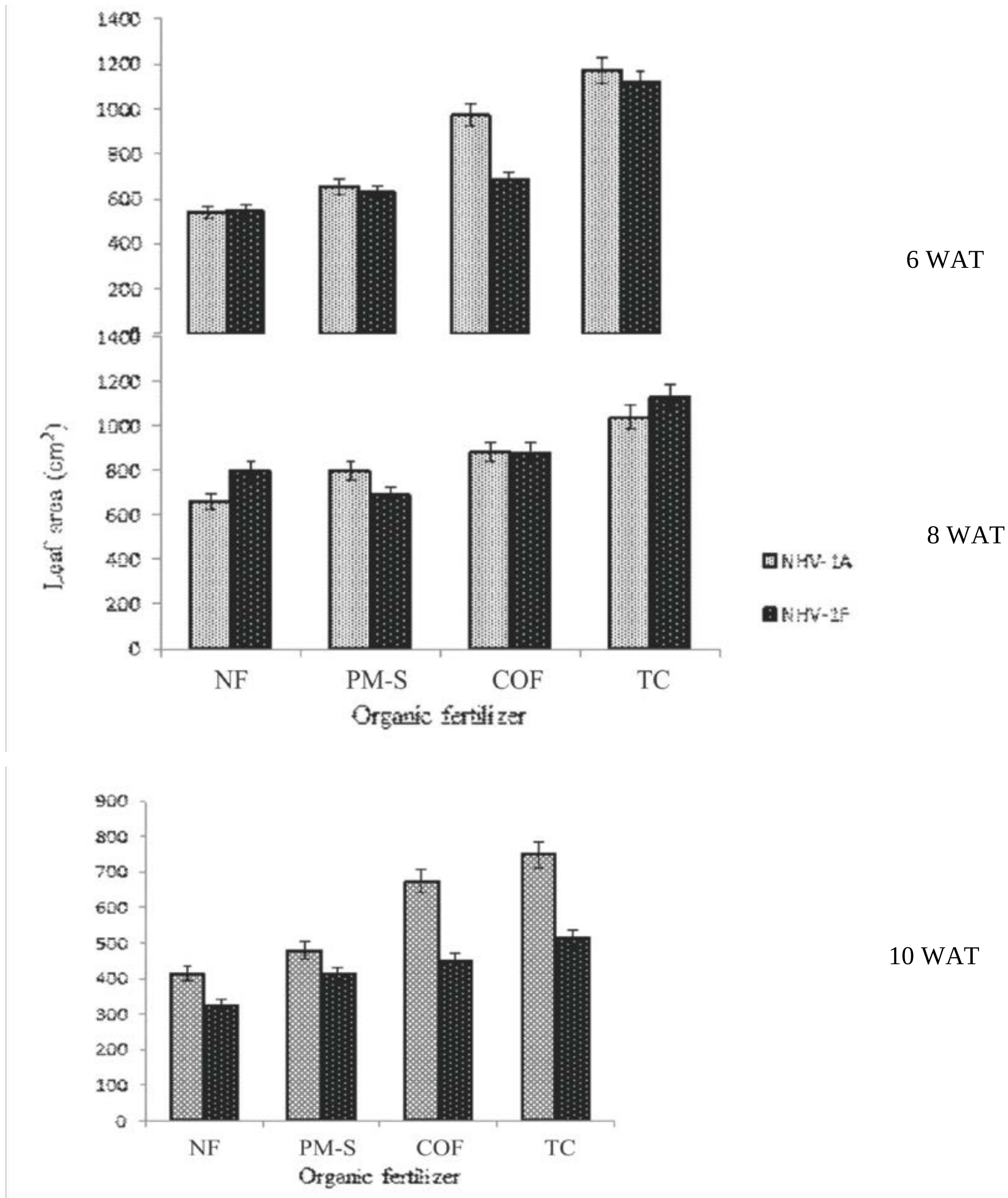

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Fig. 4.6 Interaction of selected Organic fertilisers and cultivar on leaf area development of long cayenne pepper in Ogbomoso

4.5.4 Number of branches per plant

Significant differences exited between the two cultivars on number of branches in response to applied OFs and the cultivars at 8 WAT and 6 WAT in Ibadan and Ogbomoso respectively (Table 4.7). The NHV-1A had greater number of branches per plant all thourgh the stages in both Ibadan and Ogbomoso. The tithonia compost and PM-S had similar response on the number of pepper plant branches per stand at 6 WAT but tithonia compost had significant effect at 10 WAT in Ibadan. Poultry manure without shavings and COF had similar but slightly better effects than NF on number of branches per plant at 10 WAT in Ibadan. In Ogbomoso, at 6 WAT COF and TC produced plants with similar number of branches per plant, and they were significantly better than PM-S while the control treatment recorded the least number of branches. However, at 10 WAT in Ogbomoso plots treated with TC had higher number of pepper branches per plant followed by COF and TC treated plots which were the highest (Table 4.7). Effect of interaction between fertiliser types and cultivars were significant at 6 WAT in Ibadan; whereas TC by NHV-1A gave the highest interactive combinations than all the others (Fig 4.7).

4.5.5 Days to first and 50% flowering

The applied OFs significantly affect the response of the two pepper cultivars to first flowering at Ibadan but not at Ogbomoso (Table 4.8). Ssignificant differences did exist between NHV-1A and NHV-1F in number of days to 50% flowering at Ibadan and Ogbomoso (Table 4.8). NHV-1F produced flower earlier in Ibadan and reached 50% flowering in both Ibadan and Ogbomoso earlier than NHV-1A.

4.5.6 Days to first fruit harvest

Cultivar NHV-1F produced fruits that were harvested earlier in Ibadan in response to the organic fertiliser types (Table 4.8). Significant cultivar difference was observed on days to first fruit harvest in Ibadan but not at Ogbomoso (Table 4.8).

Table 4.7: Response of pepper cultivars on number of branches per plant to three organic fertilisers at different growth stages

Treatment	Ibadan			Ogbomoso		
	6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Cultivar						
NHV-1A	4.50	10.92	17.33	5.17	15.83	21.17
NHV-1F	3.75	9.33	13.67	3.75	12.17	17.75
$LSD_{0.05}$	Ns	0.95	ns	1.29	ns	Ns
Fertiliser types						
NF (Control)	2.50	7.00	11.67	2.50	9.33	14.33
PM-S	5.33	8.33	14.50	4.17	12.83	18.17
COF	4.17	11.33	15.00	5.17	14.67	19.83
TC	4.50	13.83	20.83	6.00	19.17	25.50
$LSD_{0.05}$	1.75	ns	3.58	1.37	ns	3.84

PM-S = Poultry manure, COF = Commercial organic fertiliser TC = Tithonia compost; NF = No fertiliser

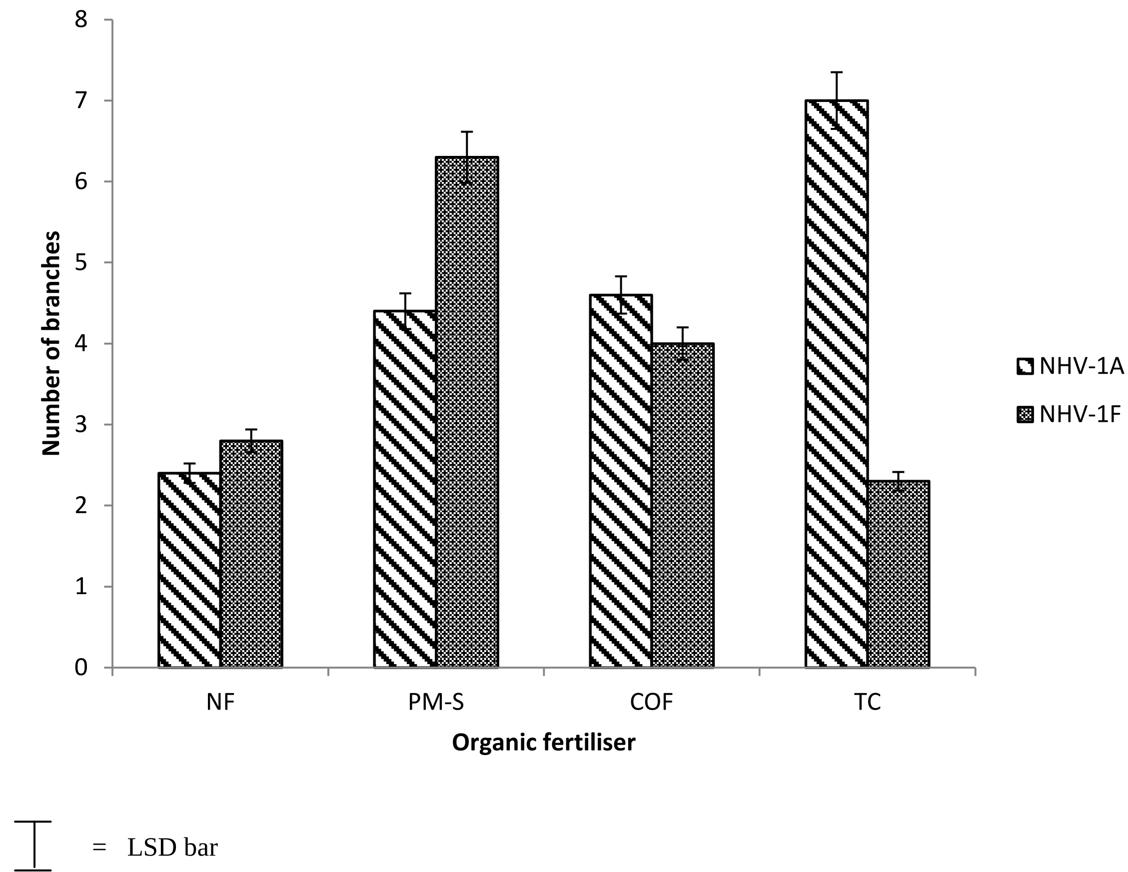

Fig. 4.7: Effect of OFs and pepper cultivar interaction on number of branches per plant of long cayenne pepper in Ibadan at 6WAT.

Table 4.8: Effect of cultivars on flowering pattern of long cayenne peppers

Treatment	Days to 1st flowering		Days to 50% flowering		Days to 1st harvest	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar						
NHV-1A	101.03	97.58	143.03	139.12	185.03	178.70
NHV-1F	100.52	96.77	142.52	138.48	184.52	178.52
$LSD_{0.05}$	0.41	Ns	0.41	0.10	0.41	ns

4.5.7 Effect of three selected organic fertilisers on fruit diameter of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso.

Variations in fruit diameter were not significantly different between the two pepper cultivars at the two experimental locations (Table 4.9). There was significant influence of fertiliser types with respect to fruit diameter at Ogbomoso but not at Ibadan. At Ogbomoso, application of TC produced the highest value followed by COF whereas that of PM-S and control were similar but produced the least fruit diameter (Table 4.10). In Ibadan, effects of cultivars by OFs were significant on fruit diameter and the value was highest in TC and NHV-1A (Table 4.9). In Ogbomoso, cultivar by fertiliser types was not significant.

4.5.8 Effect of selected organic fertilisers on fruit length of two cultivars of long cayenne pepper

There was no significant difference in fruit length of the two pepper cultivars tested at the two locations (Table 4.9). However, application of different OFs produced significant effect on fruit length. The TC produced fruits that were longer than that of COF. Tithonia compost, COF and PM-S had fruit of longer length than with no fertiliser.

4.5.9 Effect of three selected organic fertilisers on number of pepper fruits per plant.

Number of fruits per plant was not significantly different between the two cultivars and at both locations (Table 4.9). The PM-S significantly increased the number of fruits per plant at Ibadan location, but TC produced highest fruits at Ogbomoso. Again, Ogbomoso, TC produced highest number of fruits, followed by SOF and PM-S, while NF gave the least values. The effect of COF on NHV-1A was highest on number of fruit per plant at Ibadan (Table 4.10). At Ogbomoso, both cultivars produced significant number of fruits per plant when treated with TC (Table 4.9). At both stations, NF gave the least number of fruits per plant. The effect of cultivars and OFs interaction at Ibadan showed that when NHV-1A and NHV-1F were treated with TC, fruit diameter in cm (4.27, 3.8), number of fruit per plant (16.36, 14.45) and number of seeds per fruit (38.33, 32.67) was the best (Table 4.10). The interaction was not significant at Ogbomoso.

Table 4.9: Effect of organic fertiliser types on the yield parameters of two long cayenne peppers grown at Ibadan and Ogbomoso

Treatment	Fruit diameter(cm)		Fruit length (cm)		No. of fruits per plant		No. of seeds per fruit	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar								
NHV-1A	3.37	5.52	7.21	10.70	15.29	28.92	25.92	26.92
NHV-1F	3.23	4.96	6.91	9.45	16.37	26.33	30.58	30.75
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	ns	0.72
Organic fertilisers								
NF (Control)	2.70	4.52	5.96	8.52	15.26	21.67	21.83	24.67
PM-S	3.11	4.88	6.65	9.75	17.20	22.33	28.00	29.67
COF	3.37	5.38	7.44	10.30	16.15	29.67	30.17	29.17
TC	4.04	6.17	8.18	11.73	15.41	34.00	35.50	33.50
$LSD_{0.05}$	ns	0.45	0.24	1.03	0.85	4.91	ns	1.58

PM-S = Poultry manure; COF = Commercial organic fertiliser; TC = Tithonia compost; NF = No fertiliser, ns = not significant

Table 4.10: Interaction of organic fertiliser types on fruit yield components of two long cayenne pepper cultivars grown at Ibadan

Fertiliser Source	Fruit diameter (cm)		No. of fruit per plant		No. of seeds per fruit	
Cultivar	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F
NF	2.73	2.68	15.02	15.50	24.00	19.67
PM-S	3.00	3.21	16.51	16.29	25.50	23.00
COF	3.49	3.25	17.38	14.92	32.00	28.33
TC	4.27	3.80	16.36	14.45	38.33	32.67
$LSD_{0.05}$	0.24		1.19		1.70	

PM-S = Poultry manure; COF = Commercial organic fertiliser; TC = Tithonia compost;

NF = No fertiliser

4.5.10 Effect of selected organic fertilisers on 1000 seed weight of two cultivars of long cayenne pepper

The TC produced higher 1000 seed weight than those of COF, PM-S and NF all of which gave similar but significant values at Ogbomoso location (Table 4.11). The response of pepper cultivars to fertiliser types in Ogbomoso was significant while in Ibadan location there was no significant difference (Table 4.11). Cultivars, fertiliser types and their interaction in Ibadan had higher 1000 seed weight over and above those of Ogbomoso. Irrespective of the location, 1000 seed weight were not significantly different between the two cultivars.

4.5.11 Effect of selected organic fertilisers on mean fruit weight of two cultivars of long cayenne pepper.

The TC fertiliser gave the highest fruit weight followed by COF at both locations. The two varieties had similar mean fruit weight at both locations (Table 4.11). At Ibadan, COF was significantly better than PM-S while at Ogbomoso, COF and PM-S OFs gave similar values. At both locations, NF gave the least mean fruit weight. The interactive effect of cultivars x OFs showed the superiority of both cultivars treated with TC over and above all other interactions (Table 4.12).

4.5.12 Effect of selected organic fertilisers on fruit weight per plant of two cultivars of long cayenne pepper

Effect of OFs on fruit weight per plant followed the same trend in the two locations and was in the order TC > COF > PM-S > NF. Both cultivars gave similar mean fruit weight at Ibadan, while at Ogbomoso, cultivar NHV–1A performed significantly better than cultivar NHV–1F (Table 4.11). The effect of interaction between cultivar x fertiliser types gave the highest mean fruit weight when NHV – 1A was treated with TC, this was not significant at Ibadan but significant at Ogbomoso (Table 4.12).

4.5.13 Effect of selected organic fertilisers on fruit yield of two cultivars of long cayenne pepper

Response of cultivars to fertiliser was significantly affected in terms of fruit yield per ha in Ibadan whereas only organic fertiliser types significantly influenced pepper cultivars in Ogbomoso (Table 4.11). Cultivar NHV-1A had higher fruit yield per hectare irrespective of the location. TC, COF and PM-S influenced plants to produce higher fruit yield than NF at Ibadan and Ogbomoso. At Ogbomoso, yield of both cultivars were better than at Ibadan. Cultivars NHV-1A gave significantly higher fruit yield than cultivar NHV-1F at Ibadan, while the yields of both cultivars were similar at Ogbomoso. At both locations the effect of organic fertiliser types on fruit yield were significantly different in the order TC > COF > PM-S > NF, while the least fruit yield was obtained in the control (Table 4.11).

4.6 EXPERIMENT III

Effect of tithonia compost rates on growth and fruit yield of two cultivars of long cayenne pepper

4.6.1 Effect of tithonia compost rates on plant height

At 10 WAT, 45 kg N/ha significantly increased in height than 0, 90 and 135 kg N/ha. In Ogbomoso location, fertiliser rate positively improve plant height at 6 and 10 WAT. At 6 WAT, 90 kg N/ha significantly increased in height than 0, 45 and 135 kg N/ha (Table 4.13). However, no fertiliser application was significantly shorter than other fertiliser rate at 6 and 10 WAT in Ogbomoso. Moreover, at 10WAT, plants treated with 45 kg N/ha produced the tallest plants followed by those treated with 135 kg N/ha and 90 kg N/ha (Table 4.13). Cultivar and fertiliser in Ibadan was only significant at 10 WAT. Cultivar NHV-1A with 45 kg N/ha showed better response than the other treatment combinations (Fig 4.8). Similarly in Ogbomoso location, at 6 WAT, cultivar NHV-1A combined with 135 kg N/ha was significantly taller than other treatment combinations (Fig 4.8). The effect of cultivars does not influence plant height in Ibadan at 6, 8, and 10 WAT. In Ogbomoso location, the situation was different, at 6 WAT, NHV-1A produced significantly higher plant height than NHV-1F (Table 4.13).

Table 4.11: Effect of three organic fertilisers on the fruit yield parameters of two long cayenne peppers cultivars grown at Ibadan and Ogbomoso

Treatment	1000-seed weight (g)		Mean fruit weight (g)		Fruit weight per plant (g)		Fruit yield (t/ ha)	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar								
NHV-1A	0.41	0.37	6.69	6.17	1173.70	1190.00	6.85	11.58
NHV-1F	0.42	0.38	7.15	6.62	1018.50	1034.50	5.94	10.19
$LSD_{0.05}$	ns	ns	ns	ns	ns	47.26	0.27	ns
Fertiliser source								
NF (Control)	0.40	0.36	5.70	5.16	869.1	885.70	5.07	9.18
PM-S	0.41	0.37	6.73	6.30	1091.1	1106.80	6.37	10.33
COF	0.41	0.37	7.07	6.50	1143.8	1159.50	6.67	11.40
TC	0.45	0.40	8.30	7.75	1280.5	1297.10	7.47	12.63
$LSD_{0.05}$	ns	0.01	ns	0.40	ns	33.40	0.19	0.51

PM-S = Poultry manure; COF = Commercial organic fertiliser; TC = Tithonia compost; NF = No fertiliser, ns = not significant

Table 4.12: Interactive effect of selected organic fertilisers on fruit yield parameter of two long pepper cultivars grown at Ibadan and Ogbomoso

Organic Fertilisers	Mean fruit weight (g)		Fruit weight/plant (g)		Fruit yield (t/ha)	
	Ibadan		Ogbomoso		Ibadan	
	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F
NF	6.03	5.37	922.40	848.0	5.28	4.86
PM-S	6.62	6.52	1139.30	1074.40	6.55	6.18
COF	7.21	6.93	1269.80	1049.30	7.31	6.03
TC	8.64	7.95	1428.60	1165.60	8.24	6.70
$LSD_{0.05}$	0.50		47.24		0.27	

PM-S = Poultry manure; COF = Commercial organic fertiliser; TC = Tithonia compost;
NF = No fertiliser

4.6.2 Effect of tithonia compost rates on stem diameter of two cultivars of long cayenne pepper

The no organic ferliser applied pepper plant gave the least stem diameter. While the value increased with the level of organic fertiliser applied, but 135 kg N/ha produced the biggest stem diameter (Figure 4.9). The figure also proved that only fertiliser rates significantly enhanced the stem diameter throughout the growth period but cultivars had significant effect only at 8 WAT in Ibadan. At 6 and 10 WAT there was no significant difference due to cultivars and fertiliser rate combination. NHV-1A had higher stem diameter than NHV-1F. At Ogbomoso, significant difference did not occur in stem diameter due to cultivars, fertiliser rates and their interaction (Fig 4.9). Stem diameter varied with age of plant. The most robust plants were obtained at 10 WAT (Fig.4.9)

4.6.3 Effect of tithonia compost rates on number of leaves per plant

At 10 WAT, fertiliser rate showed significant difference with 0 kgN/ha producing more pepper leaves than other treatments. Whereas at Ogbomoso, and especially at 8 WAT 45 kgN/ha produced more number of leaves than others. Significant higher number of leaves per plant was observed in Ibadan due to cultivars at 10 WAT. Cultivar NHV-1F also produced more leaves than NHV-1A (Table 4.14). At 6 and 8 WAT, cultivars effects were not significantly different. Cultivars, fertiliser rates and fertiliser rates and cultivars influenced this trait except fertiliser at 10 WAT (Figure 4.10). Cultivar NHV-1A had more leaves than NHV-1F at 6 and 8 WAT but not at 10 WAT. At 6 WAT in Ogbomoso, leaves of pepper per plant decreased with fertiliser rate increase. At 8 WAT, 90 kg N/ha had less number of leaves; this was followed by 135 kg N ha^{-1} which had fewer leaves than control or no fertiliser and 45 kgN/ ha produced higher number of leaves per plant. Effects of cultivars × fertiliser rates varied. At 6 WAT, the quantity of functional leaves on each plant was more as NHV-1A × 135 kg N/ha was greater than NHV-1A × 45 kgN/ha greater than NHV-1A × 0 kg N/ha. Interaction of both varieties with 90 kg N ha^{-1} produced the higher number of leaves per plant. NHV-1A × 0 kg N/ha and NHV-1F × 45 kg N/ha had more leaves under respective treatments at 8 WAT. At 10 WAT, NHV-1A × 45 kgN/ha and NHV-1F × 135 kg N/ha had more leaves under respective treatments (Figure 4.10).

Table 4.13: Effect of cultivars and tithonia compost rates on plant height of long cayenne pepper at Ibadan and Ogbomoso

Treatment	Ibadan			Ogbomoso		
	6 WAT	8 WAT	10 WAT	6 WAT	8 WAT	10 WAT
Cultivars						
NHV-1A	23.47	35.47	59.07	21.38	25.16	72.14
NHV-1F	22.65	33.50	57.57	18.98	25.45	66.75
$LSD_{0.05}$	ns	ns	ns	1.78	ns	ns
Fertiliser rate (kgN /ha)						
0	22.11	37.65	46.05	18.45	25.02	62.95
45	22.84	33.96	64.81	20.12	25.08	72.65
90	24.96	34.21	61.29	21.27	25.93	69.88
135	22.33	32.12	61.13	20.88	25.18	72.30
$LSD_{0.05}$	ns	ns	2.74	1.12	ns	2.44

WAT = weeks after transplanting

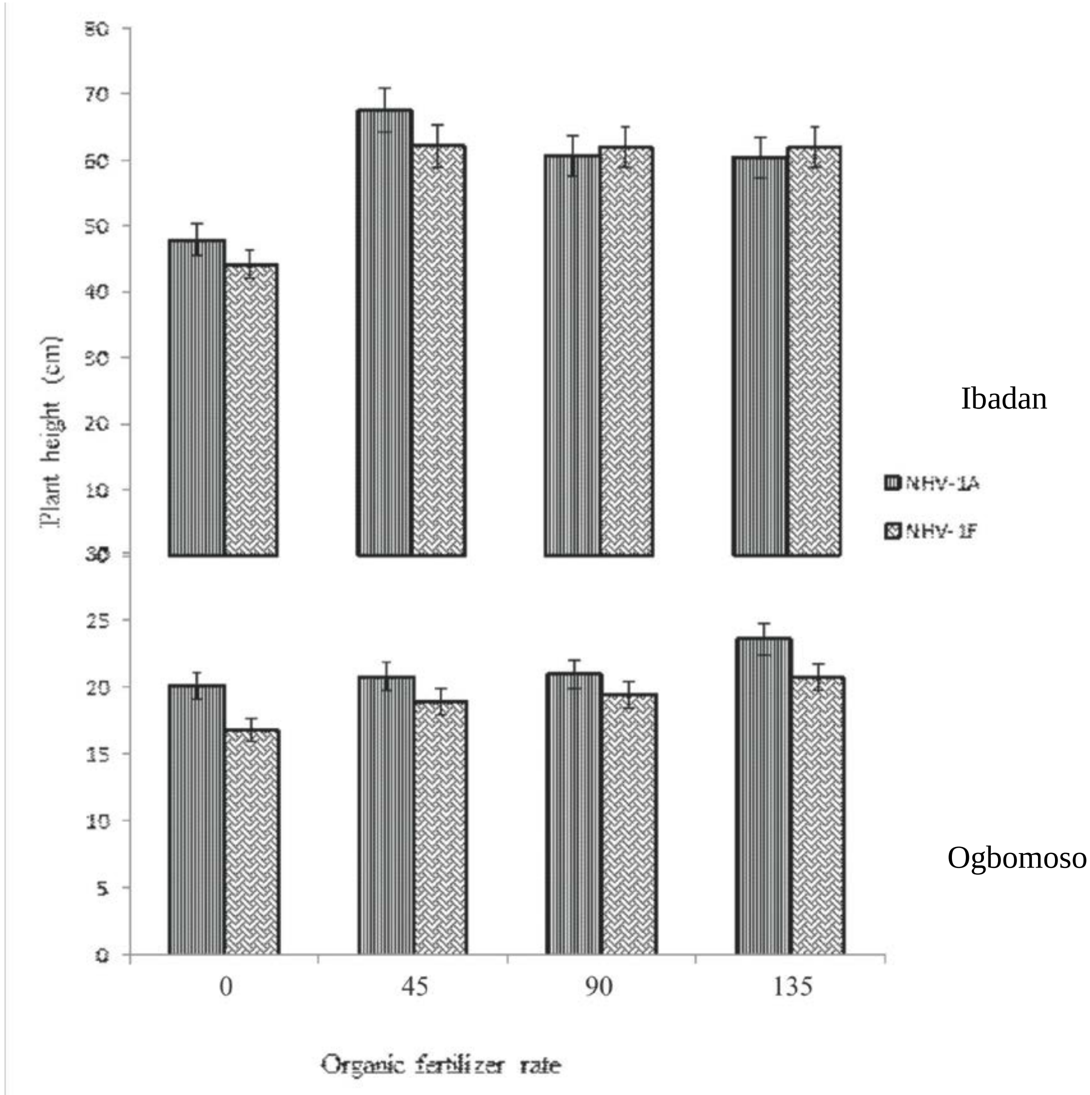

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Fig. 4.8: Plant height of two long cayenne pepper cultivars as affected by tithonia compost rates.

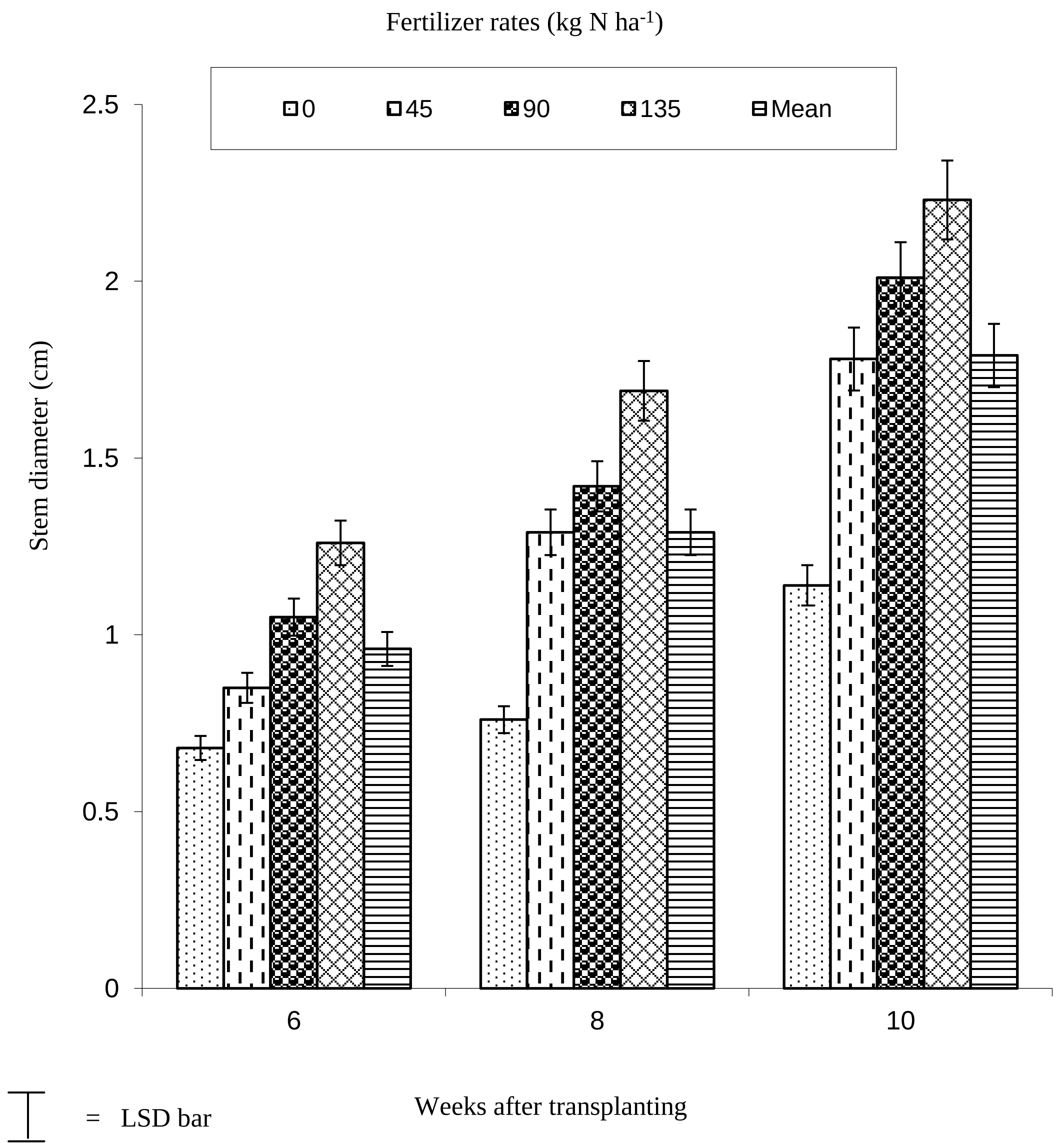

Fig. 4.9: Effects of tithonia compost rates on stem diameter of two cultivars of long cayenne pepper grown in Ibadan

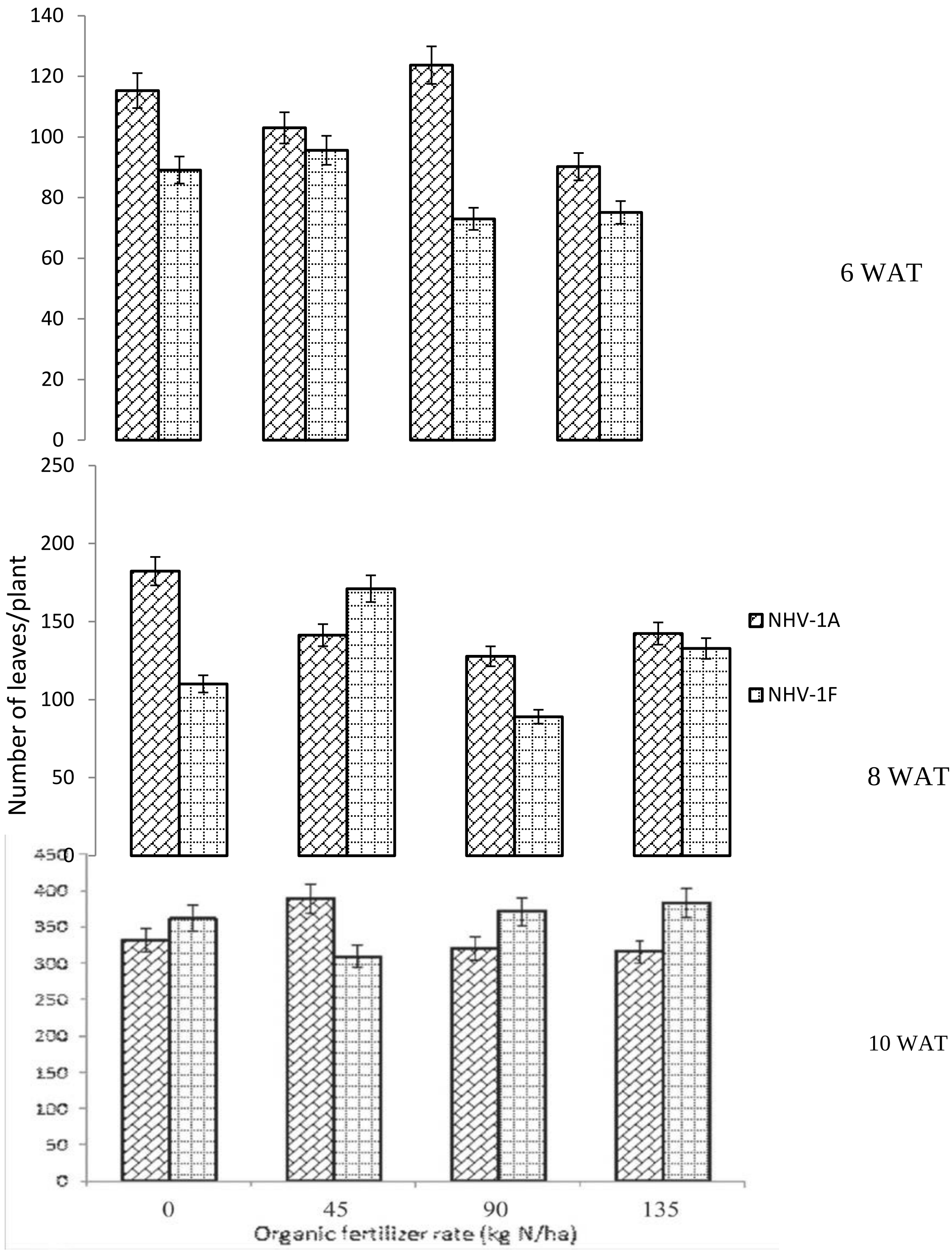

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Fig. 4.10: Interaction of tithonia compost rates and cultivar on number of leaves of long cayenne pepper in Ogbomoso.

4.6.4 Effect of tithonia compost rates on number of branches per plant of two cultivars of long cayenne pepper

Increased fertiliser rate brought about increase in number of branches at both fertiliser rates. In Ibadan, significant differences existed among number of branches at 8 and 10 WAT but not at 6 WAT (Table 4.14). Cultivar NHV-1A had higher branches than NHV-1F. Significant difference did not exist within the cultivars with number of branches per plant at Ogbomoso except at 10 WAT where NHV-1A had more branches than NHV-1F (Table 4.14). Number of pepper branches per plant increased with increase in fertiliser rates at 6, 8 and 10 WAT except that the effects of 135 kg N/ha and 90 kg N/ha were not significantly different. The response of cultivars with fertiliser rates interaction followed the trend of fertiliser rates. Effect of fertiliser rate on number of branches was similar at both locations (Figure 4.11and 4.12).

4.6.5 Effect of tithonia compost rates on leaf area of two cultivars of long cayenne pepper

In Ibadan at all ages, 135 kg N/ha, 90 kgN/ha and 45 kg N/ha were significantly better than the control while the least occurred when plants were not fertilized. In Ogbomoso, and at 6 and 10 WAT, leaf area was significantly different with different fertiliser rates and this is in the order 135kgN/ha > 90 kg N/ha > 45 kg N/ha > 0 kg N/ha. In Ibadan, at 10 WAT leaf area was significant but at 6 and 8 WAT, there were no significant differences (Table 4.15). Cultivar NHV-1A had better leaf area than NHV-1F whereas in Ogbomoso, at 6 and 10 WAT there were significant differences. Cultivar NHV-1F had more leaf area than NHV-1A at 6 WAT, whereas at 10 WAT NHV-1A had better leaf area. In Ibadan, the interactive effect of cultivar and fertiliser showed that leaf area was highest in both cultivars treated with 135 kg N/ha organic fertiliser. In Ogbomoso, cultivars by fertiliser rate were significant at 6 and 8 WAT. The interactive effect of cultivar and fertiliser showed that leaf area did not follow any specific trend in both cultivars but at 10 WAT, Cultivars NHV-1A treated with 90 kg N/ha gave the highest leaf area (Figure 4.13).

Table 4.14: Effect of pepper cultivars and tithonia compost rates on number of leaves of long cayenne pepper at Ibadan and Ogbomoso

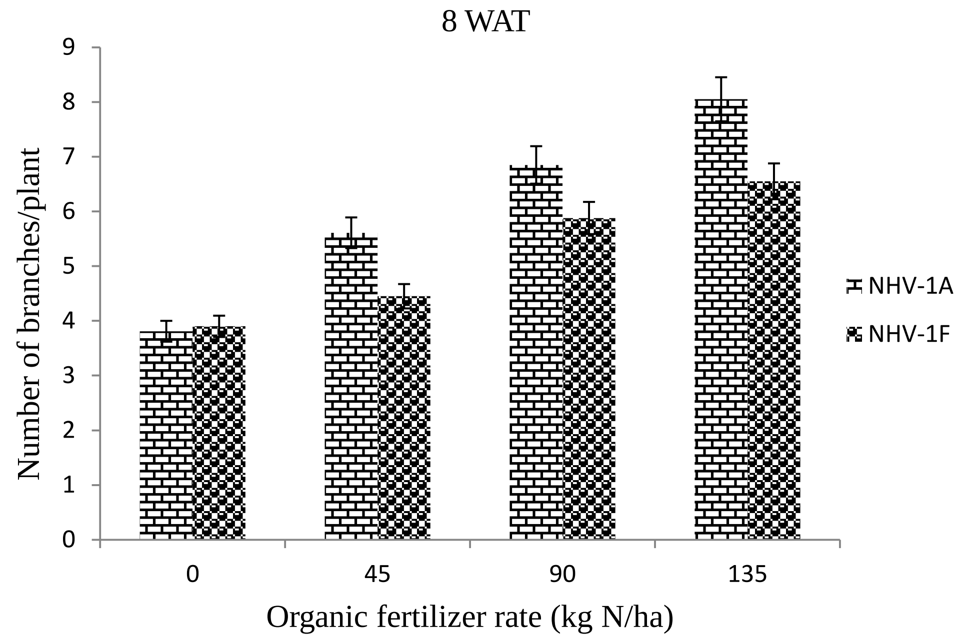
Treatment	Ibadan			Ogbomoso		
	6WAT	8 WAT	10 WAT	6 WAT	8 WAT	10 WAT
Cultivar						
NHV-1A	25.96	43.7	130.11	108.1	148.45	338.97
NHV-1F	22.85	37.8	136.17	83.20	125.76	356.47
$LSD_{0.05}$	ns	ns	4.24	6.86	1.49	9.21
Organic fertiliser rate (kg N/ha)						
0	25.88	37.3	88.22	102.2	146.22	346.88
45	23.46	38.2	128.29	99.3	156.22	349.28
90	26.21	47.3	141.84	98.3	108.42	345.50
135	22.08	40.2	174.21	82.7	137.57	349.22
$LSD_{0.05}$	ns	ns	5.64	7.32	1.32	ns

WAT = weeks after transplanting

Table 4.15: Effect of cultivars and tithonia compost rates on number of branches/plant of long cayenne pepper at Ibadan and Ogbomoso

Treatment	Ibadan			Ogbomoso		
	6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Cultivar						
NHV-1A	1.85	6.08	9.38	6.23	8.53	9.73
NHV-1F	1.69	5.20	7.90	6.48	8.42	8.97
$LSD_{0.05}$	ns	0.62	0.71	Ns	ns	0.28
Organic fertiliser rate (kgN/ha)						
0	1.57	3.86	5.96	5.45	7.98	8.73
45	1.69	5.03	7.39	6.13	8.05	9.12
90	1.81	6.36	9.84	6.68	8.80	9.58
135	2.01	7.30	11.37	7.15	9.05	9.95
$LSD_{0.05}$	ns	0.35	0.43	0.15	0.63	0.60

WAT = weeks after transplanting



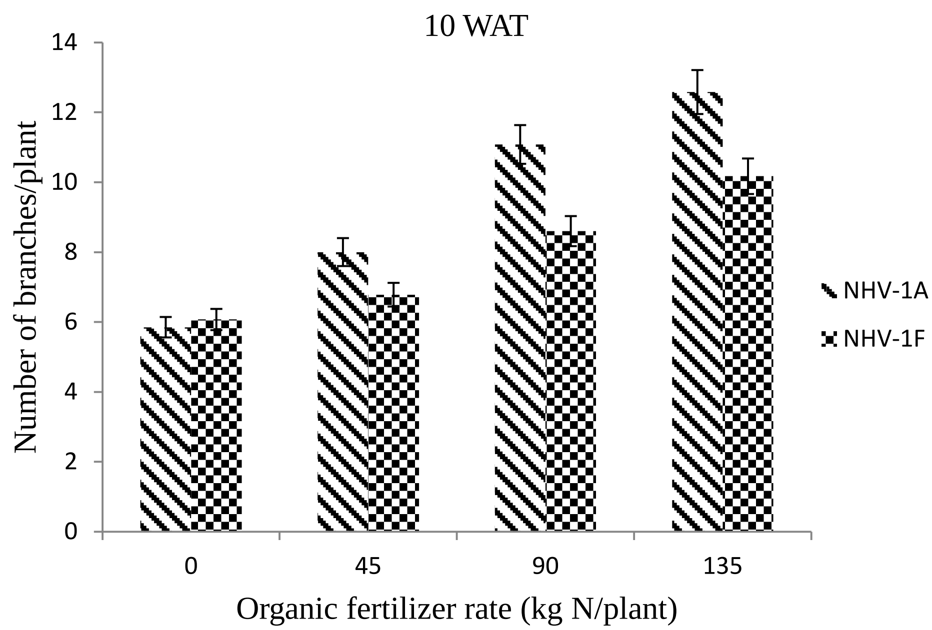


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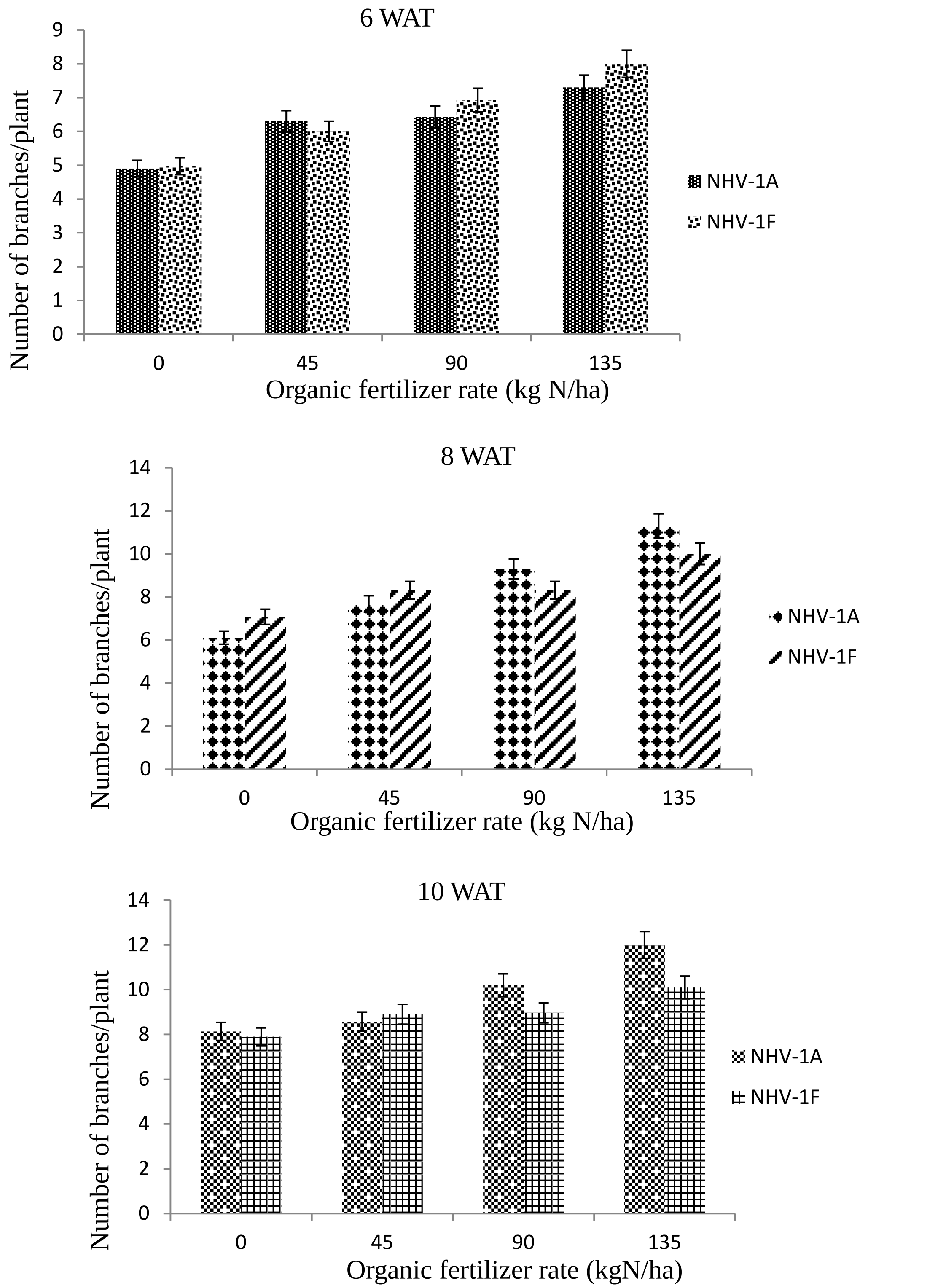
Fig. 4.11: Interaction of tithonia compost rates and cultivar on number of branches of long cayenne pepper in Ibadan

WAT = Week After Transplanting



= LSD bar WAT = week after transplanting

Fig. 4.12: Interaction of organic fertiliser rates and cultivar on number of branches of long cayenne pepper at different growth stages in Ogbomoso.

Table 4.16: Effect of cultivars and tithonia compost rates on leaf area/plant (cm^2) of long cayenne pepper at Ibadan and Ogbomoso

Treatment	Ibadan			Ogbomoso		
	6 WAT	8 WAT	10 WAT	6 WAT	8 WAT	10 WAT
Cultivar						
NHV-1A	409.90	863.30	880.50	136.9	150.86	1025.00
NHV-1F	405.50	872.10	835.90	156.0	153.75	709.00
$LSD_{0.05}$	ns	ns	13.63	9.33	ns	96.70
Organic fertiliser rate (kg N/ha)						
0	328.00	626.60	662.30	147.50	154.45	473.00
45	368.70	673.30	766.90	138.20	149.22	898.00
90	392.70	916.70	888.00	148.40	156.38	984.00
135	541.40	1254.10	1115.50	149.17	151.70	1112.0
$LSD_{0.05}$	33.35	12.85	13.84	6.45	6.08	ns

WAT= weeks after transplanting

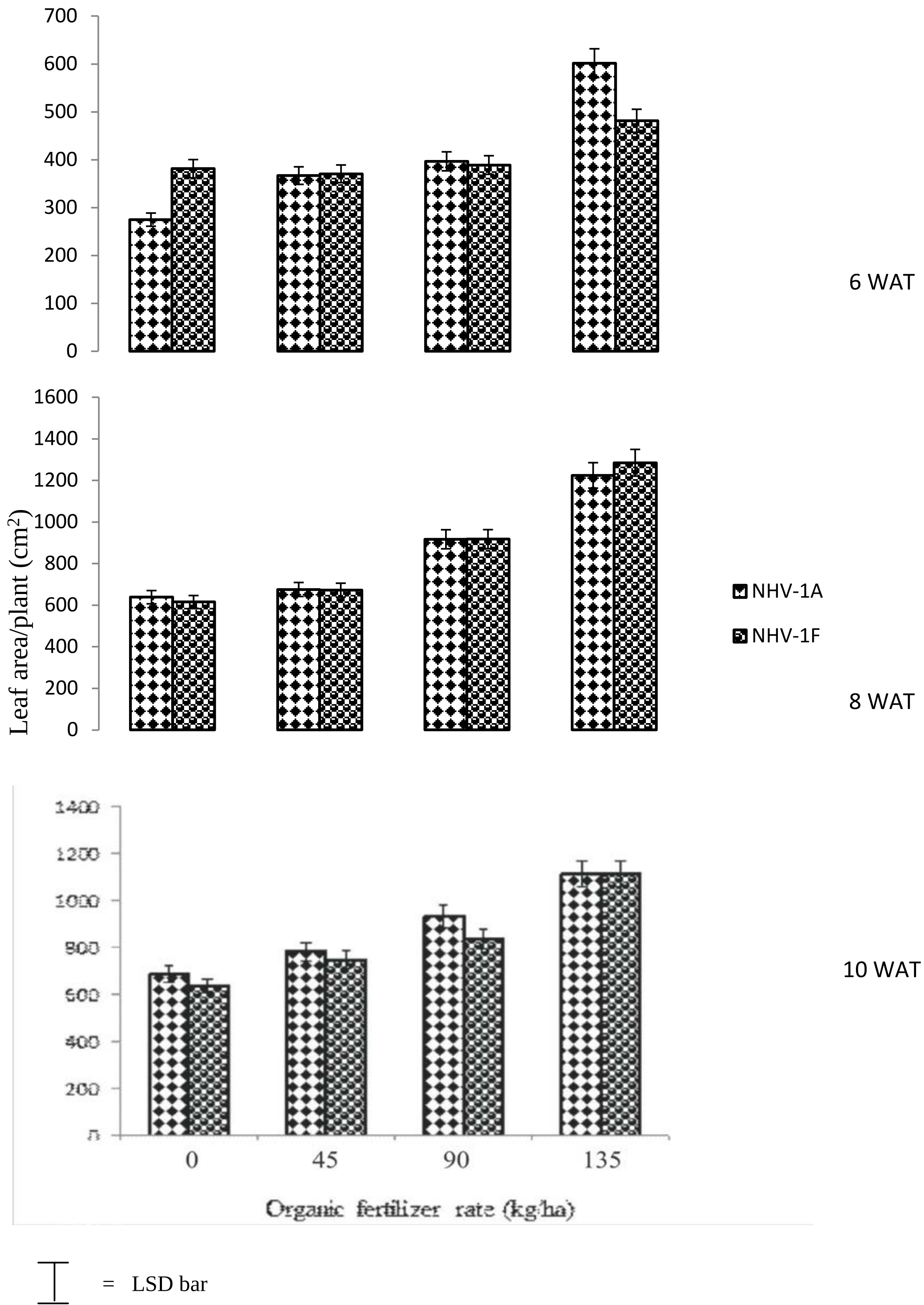


Fig. 4.13: Interaction of organic fertiliser rates and cultivar on leaf area of long cayenne pepper in Ibadan.

Response of cultivars to fertiliser rates were also significantly improved at all the growth stages measured. At Ogbomoso location, leaf area of pepper cultivars differ at 6 and 10 WAT; fertiliser rates and response of cultivars to fertiliser rates at 8 and 10 WAT (Figure 4.13). Cultivar NHV-1F had higher leaf area at 6 WAT but not at 10 WAT. At 6 and 8 WAT, 45 kg N/ ha had smaller leaves than at 135, 90 and 0 kg N/ha. Cultivar NHV-1A × 90 kg N/ha had larger leaf area whereas other interactions between NHV-1A × fertiliser rates were similar to NHV-1A × 0 kg N/ha. Cultivar NHV-1F × 0 kg N ha^{-1} was significantly higher at 8 and 10 WAT than other interactions. At 8 WAT, NHV-1A × 90 kg N ha^{-1} and NHV-1A × 135 kg N/ha was significantly higher than NHV-1A × 45 kg N/ha and the control (Figure 4.13).

4.6.6. Effect of tithonia compost rates on days to first flowering of two cultivars of long cayenne pepper

Fertiliser rate did not influence early flowering because there was no response at all the fertiliser rate and at both locations. Variation existed in days to first flowering between the two cultivars in Ibadan. NHV-1F flowered earlier than NHV-1A. At Ogbomoso The emergence of flower on both cultivars were similar (Table 4.17).

4.6.7 Effect of tithonia compost rates on days to 50% flowering

Similarly fertiliser rate did not have any influence on 50% flowering at any of the locations. Significant difference existed among the two cultivars at Ibadan location and NHV-1A attained 50% flowering earlier than NHV-1F. Significant differences did not exist between the cultivar at Ogbomoso (Table 4.17).

4.6.8 Influence of tithonia compost rates in response to first fruit harvest of two cultivars of long cayenne pepper

Days to first fruit harvest significantly varied between the cultivars in Ibadan. Fruits of NHV-1F were harvested first. There was no significant difference due to cultivars in Ogbomoso. Fertiliser rate also did not influence first fruit harvest at the two locations (Table 4.17).

Table 4.17: Response of cultivars on days to flowering pattern of long cayenne pepper at Ibadan and Ogbomoso

Treatment	Days to 1st flowering		Days to 50% flowering		Days to 1st harvest	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar						
NHV-1A	101.03	98.58	143.03	138.75	185.03	178.83
NHV-1F	100.52	98.92	142.52	139.00	184.52	179.00
$LSD_{0.05}$	0.41	ns	0.41	ns	0.41	ns

4.6.9 Effect of tithonia compost rates on 1000 seed weight of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso.

Only the TC fertiliser rates showed significant effect on 1000 seed weight in Ibadan. Pepper 1000 seed weight increased with increase in fertiliser rates but effects of all the rates were significantly similar (Table 4.18). Cultivars and cultivars × fertiliser rates did not affect 1000 seed weight in Ibadan.

4.6.10 Effect of tithonia compost rates on seed weight per fruit of two cultivars of long cayenne pepper.

At Ibadan location, both cultivars did not show significant difference on seed weight per plant. At Ogbomoso, the case was different, cultivar NHV-1F had significantly higher seed weight per fruit compared with NHV-1A. Conversely, Fertiliser rate showed no significant difference at Ogbomoso location, whereas at Ibadan location, as the organic fertiliser rate increased, the seed weight per fruit also increased significantly (Table 4.18).

4.6.11 Influence of tithonia compost rates, on number of seeds per fruit of two cultivars of long cayenne pepper.

In Ibadan, seeds per fruit increased with increased fertiliser rates. In Ogbomoso, NHV-1F had higher seeds per fruit than NHV-1A. Fertiliser increased 1000 seed weight but 90 kg N ha^{-1} produced more seeds per fruit than other TC rates. The effects of cultivars × fertiliser rates were similar to the effects of fertiliser rates. Fertiliser rates and cultivars by fertiliser rates affected quantity of seeds in a fruit at Ibadan and Ogbomoso locations, but cultivars affected 1000 seed weight in Ibadan only (Table 4.18).

4.6.12 Effect of tithonia compost rates on mean fruit weight of two cultivars of long cayenne pepper

Fertiliser rate significantly influence fruit weight in Ibadan, with 135 kg N/ha producing heaviest fruit (8.42 g). In Ogbomoso there was no significant different at any of the fertiliser rate. In Ibadan cultivar significantly influence mean fruit weight with NHV-1A having higher weight than NHV-1F, but in Ogbomoso there was no significant different between the cultivars (Table 4.19).

Table 4.18: Effect of cultivars and tithonia compost rates on yield components of long cayenne pepper at Ibadan and Ogbomoso

Treatment	1000 seed weight (g)		Seed weight/fruit (g)		No. of seeds/fruit	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar						
NHV-1A	0.62	0.62	0.39	1.20	60.27	68.60
NHV-1F	0.59	0.59	0.38	1.25	58.29	92.40
LSD($P\leq0.05$)	ns	ns	ns	0.01	ns	15.34
Organic fertiliser rates (kg N/ha)						
0	0.45	0.66	0.28	1.10	49.08	48.5
45	0.63	0.58	0.38	1.22	55.02	77.5
90	0.67	0.58	0.39	1.28	64.49	104.3
135	0.67	0.60	0.48	1.30	68.54	91.7
LSD($P\leq0.05$)	0.05	ns	0.05	ns	3.18	8.60

4.6.13 Effect of tithonia compost rates on fruit yield.

Effect of tithonia organic fertiliser based on fruit yield showed that 90 kg N/ha produced more fruit yield than other rates in Ogbomoso, while 135 kg N/ha produced more fruit yield than other rates at Ibadan. Fertiliser rates significantly affected fruit yield per ha across location. The two cultivars gave similar fruit yields at the two locations. In Ibadan, increase in fertiliser rates increased fruit yield per hectare, and 90 kg N ha^{-1} produced fruit with more weight than other rates at Ogbomoso.

4.6.14 Effect of tithonia compost rates on number of fruits per plant of two cultivars of long cayenne pepper.

Only fertiliser rates affected number of fruits per plant at Ibadan, however, cultivars, fertiliser rates and cultivars × fertiliser rates affected the trait in Ogbomoso (Table 4.19). Number of fruits per plant increased with increased fertiliser rates in Ibadan and Ogbomoso. NHV-1F had more fruits per plant in Ogbomoso. Cultivars and fertiliser rates interaction in Ogbomoso increased number of fruits per plant significantly. NHV-1F × 90 kg N ha^{-1} and NHV-1A × 45 kg N ha^{-1} had highest number of fruits per plant in associated treatment (Table 4.21).

4.6.15: Effect of tithonia compost rates on fruit weight per plant of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso.

Fertiliser rates significantly increased fruit weight per plant in Ibadan. Both pepper cultivars increased as fertiliser rates increases. Significant difference did not exist due to cultivars and cultivars × fertiliser rates. Conversely, cultivars, fertiliser rates and fertiliser rates × cultivars produced significant effects as regards fruit weight on each plant in Ogbomoso (Table 4.19). NHV-1A had heavier fruits. The weight of the fruits increased with increase in fertiliser rates.

Table 4.19: Effect of cultivars and tithonia compost rates on fruit yield and yield components of long cayenne pepper at Ibadan and Ogbomoso

Treatment	Fruit weight/plant (g)		No. of fruits /plant		Mean fruit weight (g)		Fruit yield (t/ha)	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar								
NHV-1A	732.8	742.00	133.73	377.60	6.76	6.86	26.78	43.28
NHV-1F	609.7	771.20	150.69	278.20	6.54	6.59	24.05	44.99
LSD($P \leq 0.05$)	ns	13.25	6.33	151.95	ns	0.13	ns	ns
Fertiliser rates (kg N/ha)								
0	595.7	500.0	113.78	239.50	7.25	5.06	21.23	29.17
45	600.6	658.0	151.05	279.30	6.11	6.34	22.68	38.38
90	790.3	850.2	157.73	360.20	6.45	7.07	30.25	49.59
135	698.5	1018.2	146.27	432.70	6.78	8.42	27.50	59.40
LSD($P \leq 0.05$)	10.21	45.88	3.28	52.17	ns	0.33	2.41	2.68

4.6.16: Effect of tithonia compost rates on fruit diameter of two cultivars of long cayenne pepper

As fertiliser rates increases, fruit girth also increased in Ibadan, but only 135 kg N ha^{-1} increased fruit girth than 0 kg N/ha at Ogbomoso. Significant difference did exist on fruit diameter due to cultivars and fertiliser rates but not cultivars by fertiliser rates (Table 4.20). NHV-1A had higher fruit girth only in Ibadan.

4.6.17: Effect of tithonia compost rates on fruit length of two cultivars of long cayenne pepper

Higher rates of fertiliser produced higher fruit length at both locations. Cultivar with fertiliser rate combinations were significant in Ogbomoso with NHV-1F with 90 kg N/ha and NHV-1A with 135 kg N/ha produced fruits with longer fruit length than other interactions (Table 4.20). Significant difference existed among fruit length influenced by cultivars and fertiliser rates in both Ibadan and Ogbomoso, but cultivars versus fertiliser rates interaction was not significant in Ibadan and Ogbomoso (Table 4.21). The effects of cultivars were similar to what was obtained on fruit girth. NHV-1A produced longer fruits in Ibadan, whereas in Ogbomoso NHV-1F produced longer fruits.

4.6.18 Effects of Tithonia compost rates on crude protein of the two pepper cultivars.

Fertiliser rates and cultivars by fertiliser rates affected crude protein content of the pepper fruits at Ibadan and Ogbomoso (Table 4.22). The NHV-1A had higher crude protein than NHV-1F at both locations. The crude protein content increased with increase in fertiliser rates. Increased fertiliser rates in cultivar x fertiliser interaction also increased fruits crude protein content (Table 4.23).

Table 4.20: Effects of cultivars and tithonia compost rates on fruit yield and yield components of long cayenne pepper at Ibadan and Ogbomoso

Treatment	Fruit diameter (cm)		Fruit length (cm)	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar				
NHV-1A	3.10	4.87	7.10	9.97
NHV-1F	2.76	4.49	6.61	10.28
LSD($P \leq 0.05$)	0.23	0.35	0.26	0.20
Fertiliser rates (kg N/ha)				
0	1.59	4.62	4.84	9.68
45	2.70	4.18	6.81	9.30
90	3.38	4.58	7.53	10.40
135	4.04	5.33	8.25	11.13
LSD($P \leq 0.05$)	0.19	0.49	0.25	0.97

Table 4.21: Interaction effect of tithonia compost rate and cultivar on fruit yield components of long cayenne pepper in Ibadan and Ogbomoso

Fertiliser Rate (kg N/ha)	Fruit Length (cm)		Number of fruits/plant		Number of seeds/fruit			
	Ogbomoso		Ogbomoso		Ibadan		Ogbomoso	
Cultivar	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F
0	10.33	9.03	98.00	129.57	52.89	45.26	32.0	65.0
45	9.27	9.33	165.00	137.10	57.04	53.00	68.7	86.2
90	7.87	12.93	131.47	184.00	63.40	65.58	84.3	124.2
135	12.43	9.83	140.43	152.10	67.74	69.33	89.3	94.0
$LSD_{0.05}$	1.19		5.30		4.57		13.33	

4.6.19 Effects of tithonia compost rates on crude fibre and extractable ether of the fruits of two pepper cultivars.

There were significant differences in crude fibre and extractable ether due to applied fertiliser rates in both locations. The cultivars and fertiliser rates interactions was not significant only in Ogbomoso. Cultivar effect was similar on the parameters at any of the two locations. Cultivars x fertiliser rates did not have effect in Ibadan (Table 4.23). Applied fertiliser rates increased crude fibre and extractable ether, but the effect of 45 kg N ha^{-1} and 90 kg N ha^{-1} applied organic fertiliser rates were similar to crude fibre in the two locations. Interaction effects between fertiliser rates and cultivars increased fruits crude fibre and extractable ether at Ogbomoso. Interactive effects of NHV-1A and fertiliser rates and in NHV-1 F and fertiliser rates on crude fibre were significantly similar in Ogbomoso.

4.6.20 Effects of tithonia compost rates on total soluble solids (TSS) of the fruits of two pepper cultivars.

Fertiliser rates significantly affected TSS across locations. There were significant differences in TSS among cultivars at both locations, but cultivars and fertiliser rates did not have any effect on TSS (Table 4.22). NHV-1F had higher TSS than NHV-1A. Fertiliser rates increased TSS, as fertiliser rate increased; TSS also increases significantly in both locations.

4.6.21 Effect of tithonia compost rates on the vitamin C content of the fruits of two pepper cultivars.

Fertiliser rates had significant effect on the quantity of vitamin C in pepper at both locations. As fertiliser rate was increased, the vitamin C content also increased. Significant difference did not exist in the content of vitamin C of both cultivars at both locations (Table 4.22).

Table 4. 22: Effect of cultivars and tithonia compost rates on fruit quality of long cayenne pepper at Ibadan and Ogbomoso

Treatment	Crude protein (%)		Crude fibre (%)		Extractable ether (%)		Total soluble solids		Vitamin C	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar										
NHV-1A	5.20	5.50	6.68	6.80	3.61	3.74	5.81	6.40	80.40	77.85
NHV-1F	4.78	5.14	6.76	6.92	3.70	3.65	5.95	6.54	80.24	78.55
$LSD_{0.05}$	0.39	0.33	ns	ns	ns	ns	0.10	0.10	ns	ns
Fertiliser rate (kg N/ha)										
0	3.84	4.21	5.70	5.67	2.63	2.63	4.65	5.24	71.00	68.44
45	4.64	5.13	6.66	6.51	3.24	3.27	5.55	6.14	76.35	73.85
90	5.26	5.62	6.73	7.53	4.34	4.37	6.61	7.20	83.97	83.11
135	6.24	6.32	7.79	7.74	4.43	4.52	6.70	7.29	89.97	87.39
$LSD_{0.05}$	0.20	0.08	0.16	0.14	0.22	0.09	0.16	0.16	2.13	2.64

Table 4.23: Interaction effect of tithonia compost rate and cultivar on fruit quality of long cayenne pepper in Ibadan and Ogbomoso

Fertiliser Source (kg N/ha)	Crude protein (%)				Crude fibre (%)		Extractable ether (%)	
	Ibadan		Ogbomoso		Ogbomoso		Ogbomoso	
Cultivar	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F
0	3.84	3.84	4.07	4.35	5.56	5.79	2.61	2.65
45	4.72	4.55	5.30	4.95	6.53	6.48	3.25	3.28
90	5.58	4.95	5.91	5.34	7.38	7.68	4.47	4.27
135	6.68	5.79	6.73	5.91	7.74	7.75	4.65	4.38
$LSD_{0.05}$	0.32		0.26		0.31		0.12	

4.6.22 Effects of tithonia compost rates on nitrogen, phosphorus and potassium (NPK) contents of fruits of two cultivars of long cayenne pepper.

Fruits of NHV-1F had higher P and K than NHV-1A. The NHV-1F had less N than NHV-1A only in Ibadan. As fertiliser rates are higher, N P and K quantity increased within the pepper fruits across locations. Also cultivars and fertiliser rates interaction significantly increased fruit N and K contents at Ibadan, but only K in Ogbomoso. The effect was higher in NHV-1A and fertiliser rates than NHV-1F and fertiliser rates in all treatments. Both cultivars and fertiliser rates caused variation in N P and K contents of the fruits at the two locations. Cultivars and fertiliser rates affected only K across locations, N at Ibadan only and did not affect P in any of the two locations (Table 4.24).

4.6.23 Effects of tithonia compost rates on calcium and iron contents of fruits of two cultivars of long cayenne pepper.

Significant differences do existed in calcium and iron quantity in the fruit at Ibadan and Ogbomoso due to varieties and fertiliser rates. Cultivars and fertiliser rates interaction affected the contents of the two nutrients at Ogbomoso, but only iron in Ibadan (Table 4.24). Fruits of NHV-1F had higher calcium and iron. Increase in fertiliser rates increased calcium and iron contents in the fruits. Cultivars × fertiliser rates increased the contents of the nutrients with increased fertiliser rates but not calcium in Ogbomoso (Table 4.25).

Table 4.24: Effect of cultivars and tithonia compost rates on nutrient content of long cayenne pepper at Ibadan and Ogbomoso

Treatment	Calcium (Ca)		Iron (Fe)		Nitrogen (N)		Phosphorus (P)		Potassium (K)	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar										
NHV-1A	62.03	62.32	3.33	3.51	0.83	0.92	0.62	0.86	5.64	5.40
NHV-1F	64.28	64.84	3.64	3.68	0.77	0.96	0.66	0.89	6.11	5.62
$LSD_{0.05}$	1.68	0.45	0.17	0.10	0.06	0.01	0.03	0.03	0.21	0.06
Fertiliser rate (kg N/ha)										
0	56.70	56.88	2.71	2.89	0.61	0.75	0.38	0.61	5.53	4.84
45	60.38	61.18	3.51	3.72	0.74	0.88	0.66	0.89	5.90	5.49
90	66.84	67.54	3.80	3.82	0.84	0.96	0.73	0.97	5.99	5.77
135	68.68	68.72	3.92	3.95	1.00	1.15	0.79	1.03	6.08	5.93
$LSD_{0.05}$	0.86	0.29	0.11	0.05	0.03	0.02	0.01	0.01	0.16	0.06

Table 4.25: Interaction of tithonia compost rates and cultivar on Calcium, Iron, Nitrogen and Potassium content of long cayenne pepper fruit in Ibadan and Ogbomoso

Fertiliser Source (kgN/ha)	Calcium		Iron				Nitrogen		Potassium			
	Ogbomoso		Ibadan		Ogbomoso		Ogbomoso		Ibadan		Ogbomoso	
Cultivar	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F
0	55.40	58.36	2.36	3.05	2.63	3.15	0.61	0.61	5.49	5.56	4.69	5.00
45	59.61	62.75	3.30	3.72	3.65	3.78	0.76	0.73	5.63	6.16	5.34	5.64
85	66.07	69.01	3.76	3.83	3.79	3.85	0.89	0.79	5.72	6.26	5.72	5.82
135	68.20	69.24	3.89	3.95	3.95	3.95	1.07	0.93	5.70	6.46	5.84	6.02
$LSD_{0.05}$	0.42		0.16		0.08		0.05		0.22		0.08	

4.7 EXPERIMENT IV: Residual effects of tithonia compost on growth of two cultivars of long cayenne pepper.

4.7.1 Residual effects of tithonia compost on plant height of two cultivars of long cayenne pepper.

Variations existed among the residual organic fertiliser rates with plant height of the pepper crop in Ibadan and Ogbomoso. Table 4.26 showed significant increase in the influence of TC rates when the growth was at 6, 8 and 10 WAT at both locations, except at 6WAT in Ogbomoso. Tithonia compost rates increased plant height as the rate increases. At Ibadan, the effects of 135 kg N ha^{-1} compared to 90 kg N ha^{-1} were not different from 6 and 8 WAT but effect of 135 kg N ha^{-1} was more significant. Effect of the interaction from 10 WAT in Ibadan was significant, with NHV-1A at 135 kgN/ha producing the tallest plant (81.33 cm). At Ogbomoso, effects of all the fertiliser rates treatments were similar though taller in height compared to 0 kg N ha^{-1} at 8 WAT. The effect under 135 kg N ha^{-1} was highest when growth was 10 WAT whereas those of 45 kg N ha^{-1} and 135 kg N ha^{-1} were similar. There were no variations in plant height between the two cultivars in both locations, effects of fertiliser rates at 6 WAT in Ogbomoso and response of cultivars to fertiliser rates at 6 and 8 WAT in Ibadan and 6 and 10 WAT in Ogbomoso (Fig. 4.14).

4.7.2 Residual effects of tithonia compost on stem diameter of two cultivars of long cayenne pepper.

Fertiliser rates affected stem diameter across locations. Variations due to varieties existed in Ibadan only at 10 WAT but at 8 and 10 WAT in Ogbomoso. Cultivars and fertiliser rates interaction caused variations in Ibadan only at 10 WAT, but at 6, 8 and 10 WAT at Ogbomoso (Table 4.27). Significant differences did not exist in Ibadan at 6 and 8 WAT and 6 WAT in Ogbomoso due to cultivars; or due to cultivars and fertiliser rates interaction at 6 and 8 WAT. Stem diameter increased with increased fertiliser rates across locations. Ccultivars and residual organic fertiliser rates followed similar trend of fertiliser rates (Figure 4 .15).

Table 4.26: Tithonia compost residual effect on plant height of two cultivars of long cayenne pepper at different growth stages in both location

Fertiliser rate	Ibadan			Ogbomoso		
(kg N/ha)	6 WAT	8 WAT	10 WAT	6 WAT	8 WAT	10 WAT
0	19.38	40.67	60.67	23.22	49.67	63.33
45	29.17	57.17	71.17	23.17	66.17	74.50
90	33.17	63.33	74.67	23.67	67.33	77.83
135	33.83	68.17	79.00	22.50	67.00	79.00
$LSD_{0.05}$	3.95	2.84	1.97	ns	4.65	4.12

WAT = Weeks after Transplanting.

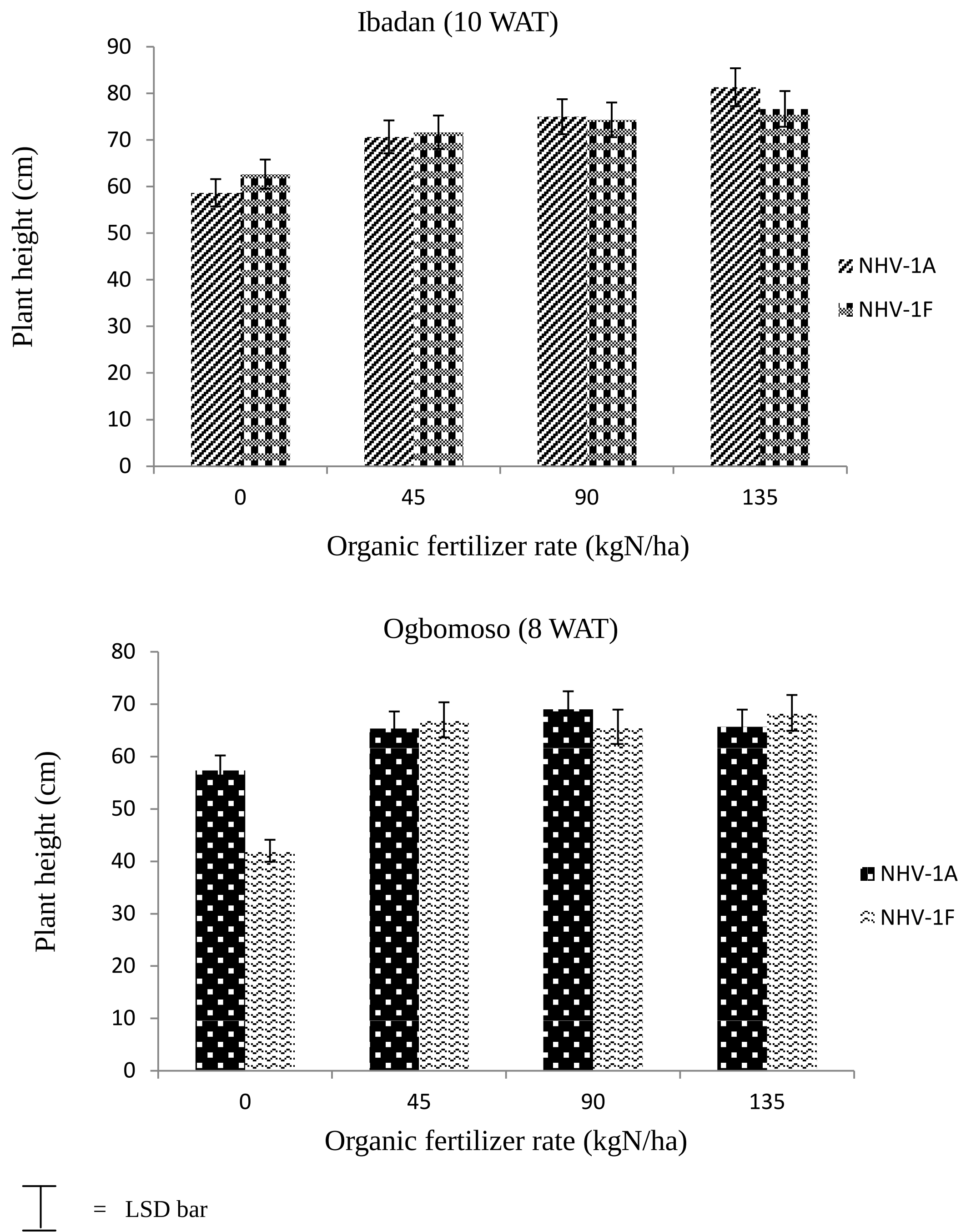


Fig. 4.14: Interaction of residual effect of tithonia compost rates × cultivar on plant height of long cayenne pepper.

Table 4.27: Tithonia compoct residual effect on stem diameter of two cultivars of long cayenne pepper

Treatment	Ibadan			Ogbomoso		
	6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Cultivar						
NHV-1A	0.97	1.16	1.34	0.94	1.17	1.24
NHV-1F	0.96	1.14	1.70	0.92	1.01	1.06
$LSD_{0.05}$	ns	ns	0.03	ns	0.11	0.05
Fertiliser rate (kg N/ha)						
0	0.71	0.97	1.27	0.78	0.90	1.01
45	0.95	1.04	1.44	0.83	0.98	1.05
90	1.04	1.24	1.60	1.00	1.20	1.24
135	1.17	1.36	1.78	1.11	1.28	1.31
$LSD_{0.05}$	0.04	0.03	0.04	0.03	0.03	0.03

WAT= weeks after transplanting

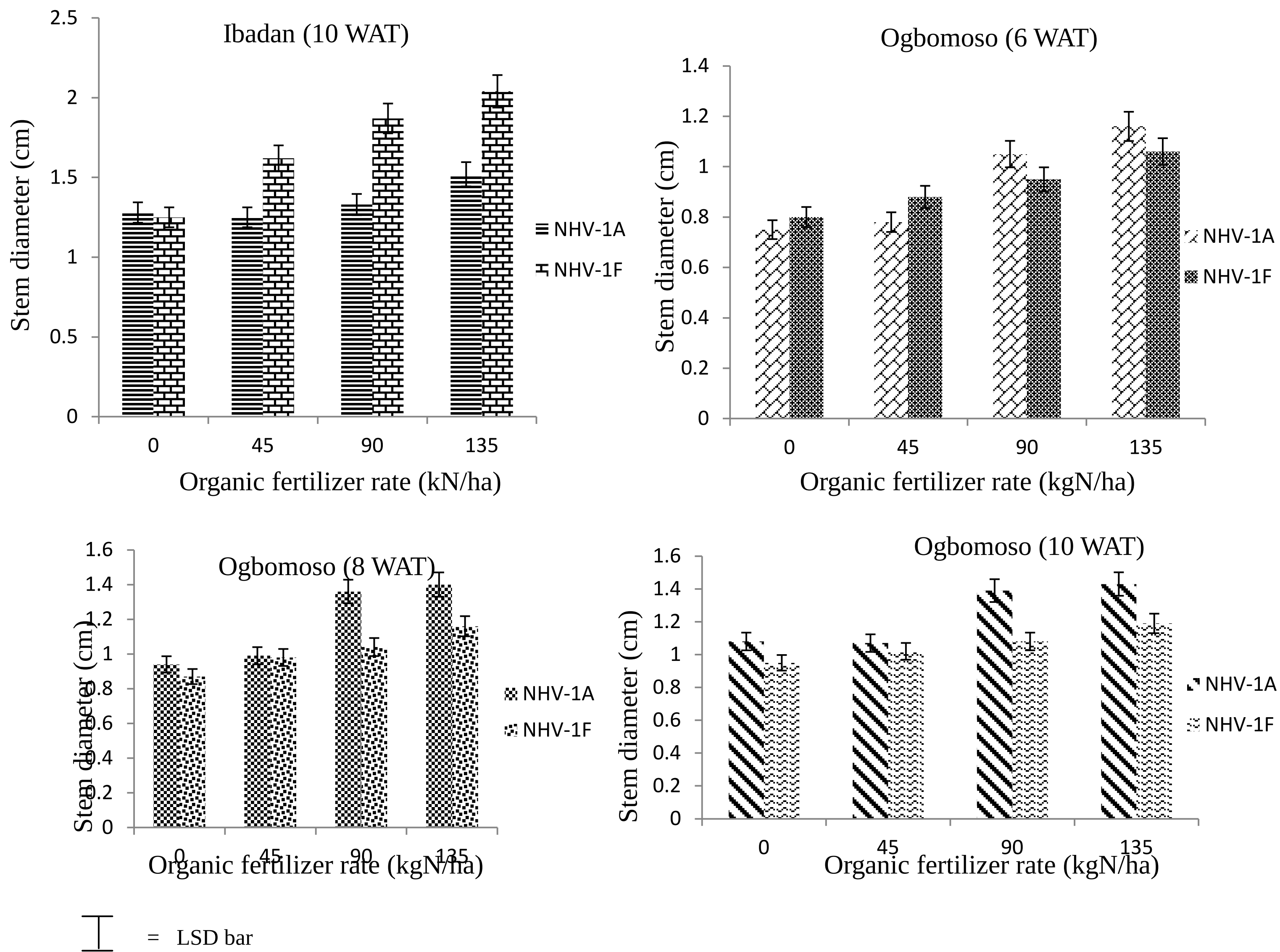


Fig. 4.15: Effect of Tithonia compost on stem diameter of long cayenne pepper cultivars at different growth stages in both locations.

4.7.3 Residual effects of tithonia compost on number of leaves per plant of two cultivars of long cayenne pepper

There was significant difference in the residual influence of TC fertiliser as it increased number of pepper leaves per plant in the two cultivars at 8 and 10 WAT in Ibadan. Cultivar NHV-1A produced higher number of leaves than NHV-1F at both periods. Number of leaves per plant increased with increase in fertiliser rates at both locations. Effects of cultivars and fertiliser rates interaction at 8 WAT followed the same trend of increase fertiliser rates increased leaves per plant at 8 WAT in Ibadan. The effects of 45 kg N ha^{-1} and 135 kg N ha^{-1} were similar and highest at 6 WAT. All the treatments significantly similar and increased number of leaves per plant at 8 WAT in Ogbomoso NHV-1A × fertiliser rates increased leaves per plant whereas NHV-1F × 90 kg N ha^{-1} had least effect at 6 WAT in Ogbomoso. At 10 WAT, all interactions increased number of leaves per plant above NHV-1F× 0 kg N ha^{-1}. Significant difference did not exist due to cultivars at 6 WAT or cultivars × fertiliser rates at 6 and 10 WAT in Ibadan (Figure 4.16). Table 4.28 also showed that significant differences did not exist in Ogbomoso due to cultivars at 6, 8 and 10 WAT, fertiliser rates at 10 WAT and cultivars by fertiliser rates at 8 WAT (Figure 4.16).

4.7.4 Residual effects of tithonia compost on leaf area of two cultivars of long cayenne pepper

Residual effect of TC significantly increased pepper leaf area in Ibadan at 8 and 10 WAT. At 8WAT, NHV-1A produced better leaf area than NHV-1F but at 10WAT, NHV-1F was significantly better than NHV-1A. In Ogbomoso, significant differences existed at 6 and 8 WAT. NHV-1F was better than NHV-1A at 6WAT, but at 8WAT NHV-1F was significantly better. The variation due to fertiliser rates was significant across locations and the interactive effect of cultivars and fertiliser rates on leaf area was significant across location except at 6 WAT in Ibadan (Table 4.29). The effects of 90 kg N ha^{-1} and 135 kg N ha^{-1} were similar and significantly higher in Ibadan at 6 and 10 WAT but the effect increased with increased fertiliser rate at 8 WAT. Similarly, in Ogbomoso, the effect of all the fertiliser rates was similar but increased leaf area at 6 and 10 WAT. At 8 WAT, 135 kg N ha^{-1} produced more leaves. The interactive effects of the cultivars and fertiliser rates in their respective fertiliser rates were similar (Figure 4.17 and 4.18).

Table 4.28: Tithonia compost residual effect on number of leaves/plant of two cultivars of long cayenne pepper

Treatment	Ibadan			Ogbomoso		
	6WAT	8 WAT	10 WAT	6 WAT	8 WAT	10 WAT
Cultivar						
NHV-1A	141.0	263.7	273.7	150.8	198.4	268.9
NHV-1F	137.1	234.4	253.0	120.5	192.5	262.7
$LSD_{0.05}$	ns	8.2	14.91	Ns	ns	Ns
Fertiliser rate (kg N/ha)						
0	104.2	202.0	225.5	110.8	182.0	222.8
45	127.7	236.5	256.3	149.7	193.7	273.2
90	151.8	272.2	278.2	133.3	201.0	280.8
135	172.5	285.5	293.3	148.7	205.2	286.3
$LSD_{0.05}$	9.3	6.7	8.8	10.8	ns	25.3

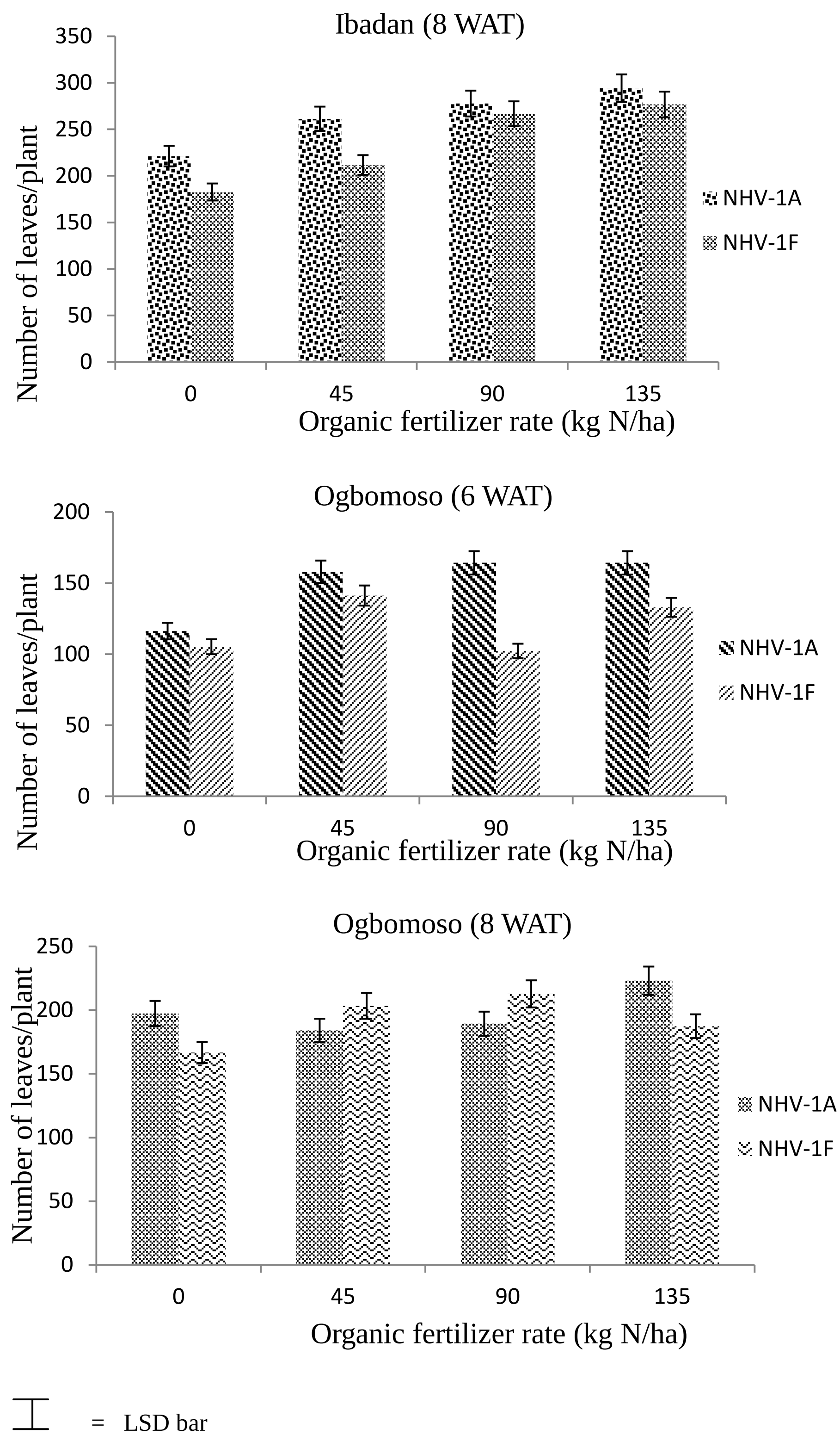


Fig. 4.16: Residual effect of organic fertiliser rate and cultivar on number of leaves of long cayenne pepper.

Table 4.29: Tithonia compost residual effect on leaf area/plant (cm^2) of two cultivars of long cayenne pepper

Treatment	Ibadan			Ogbomoso		
	6 WAT	8 WAT	10 WAT	6 WAT	8 WAT	10 WAT
Cultivar						
NHV-1A	141.8	833.3	1018.5	139.7	893.0	1335.0
NHV-1F	141.7	515.9	1079.2	157.8	656.4	1189.0
$LSD_{0.05}$	ns	25.17	42.03	12.73	43.64	Ns
Fertiliser rate (kg N/ha)						
0	119.8	379.2	637.3	138.5	372.7	922.0
45	138.3	689.7	1084.0	145.3	829.0	1361.0
90	151.7	757.8	1202.8	150.2	867.8	1452.0
135	157.0	871.8	1271.2	160.8	1029.4	1312.0
$LSD_{0.05}$	6.65	13.98	25.96	15.5	61.18	102.3

WAT= weeks after transplanting

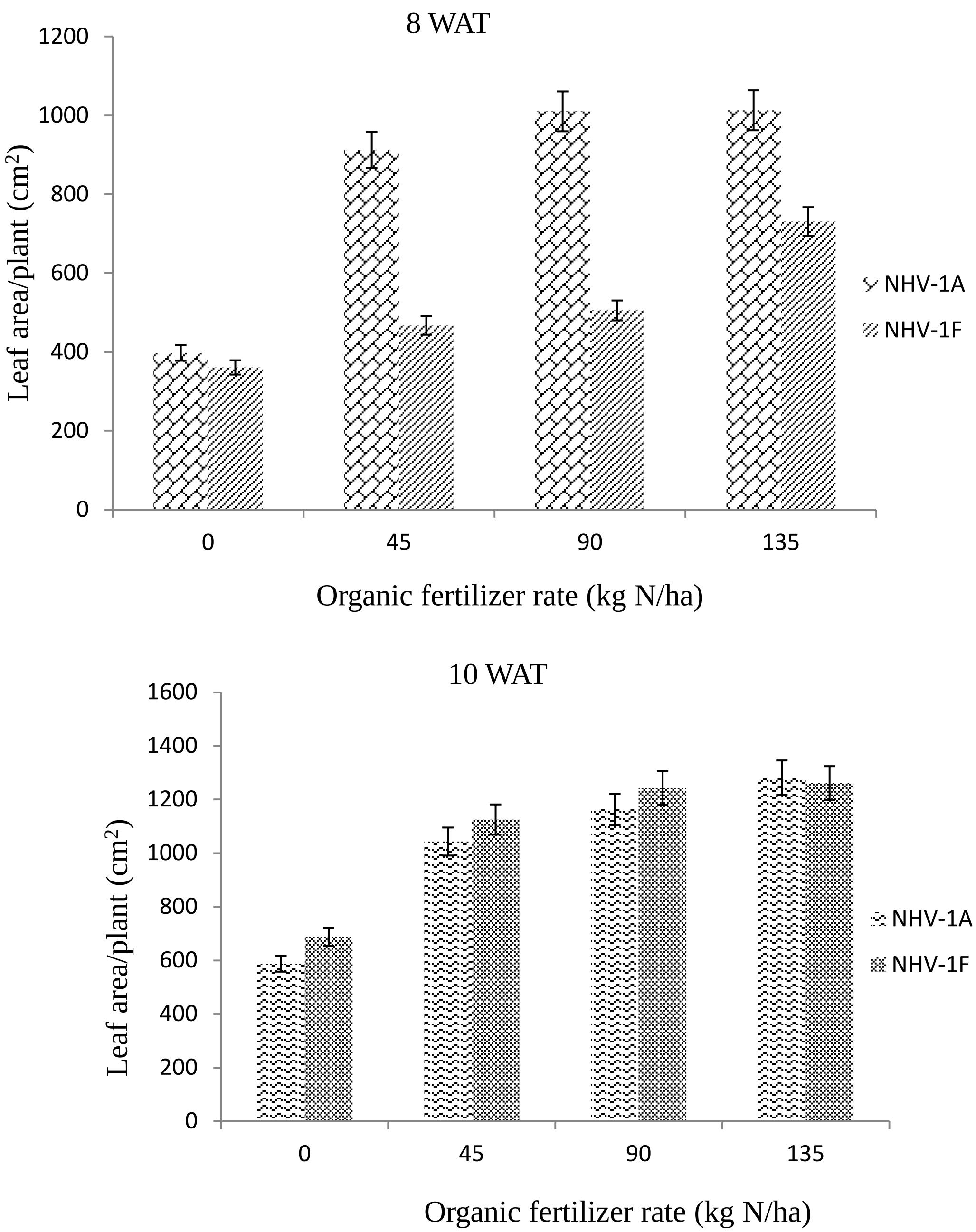


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Fig. 4.17: Interaction of residual effect of tithonia compost rate × cultivar on leaf area of long cayenne pepper in Ibadan.

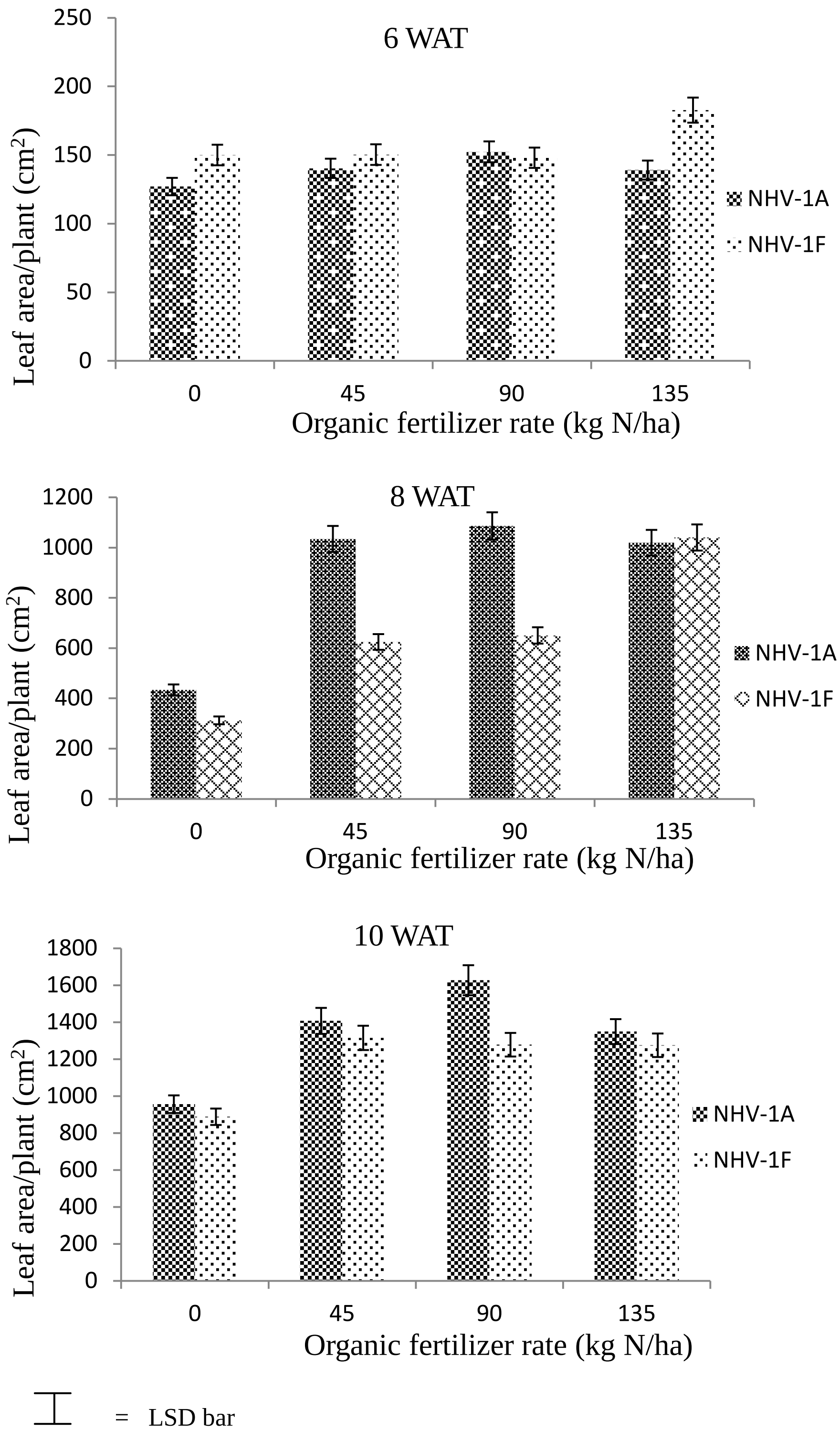

Fig. 4.18: Residual effect of tithonia compost and cultivar on leaf area/plant of long cayenne pepper in Ogbomoso.

4.7.5 Residual effects of tithonia compost on number of branches per plant of two cultivars of long cayenne pepper.

Only fertiliser rates and cultivars by fertiliser rates significantly increased the number of branches in each plant in Ibadan and Ogbomoso. Fertiliser rates at Ogbomoso and cultivars by fertiliser rates at Ibadan were not significant at both locations respectively (Table 4.30). The influence of organic fertiliser rates on the number of pepper branches increased with increase in fertiliser in Ibadan. NHV-1A × 45 kg N ha^{-1} produced significantly highest number of branches per plant at 6, 8 and 10 WAT than NHV-1A × 90 kg N ha^{-1} and NHV-1A × 135 kg N ha^{-1} which similarly reduced branches per plant. All NHV-1F × fertiliser rates increased pepper branches per plant but NHV-1F × 90 kg N ha^{-1} had the highest effect (Figure 4.19).

4.7.6 Residual effect of tithonia compost on days to flowering of two cultivars of long cayenne pepper

The residual effect of the applied organic fertiliser does not influence days to first flowering and days to 50% flowering because cultivars, rate, and location had similar results.

4.7.7 Residual effect of tithonia compost on days to first fruit harvest of two cultivars of long cayenne pepper. Cultivars, fertiliser rates and cultivars × fertiliser rates did not have appreciable influence on the number of days before fruit harvesting commenced across locations except fertiliser rate at Ogbomoso where 45 kg N ha^{-1} reduced days to first harvest and 90 kg N ha^{-1} increased it (Fig. 4.20).

4.7.8 Residual effect of tithonia compost on fruit diameter of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Fertiliser rates and cultivars by fertiliser rates had significant effect on fruit diameter in Ibadan. Cultivars did not have any effect at both locations; fertiliser rates cultivars by fertiliser rates did not have effects at Ogbomoso (Table 4.31). Fertiliser rates increased the fruit girth. The higher the fertiliser rate, the higher the diameter of the pepper fruit.

Table 4.30: Tithonia compost residual effect on number of branches per plant of two cultivars of long cayenne pepper at different growth stages

Fertiliser rate	Ibadan			Ogbomoso		
(kg N/ha)	6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
0	6.17	7.83	8.67	6.33	7.33	9.00
45	7.50	8.83	10.00	7.58	8.50	10.50
90	8.67	10.17	11.33	7.50	8.67	10.67
135	10.17	11.50	13.33	7.17	8.70	10.53
$LSD_{0.05}$	1.44	1.28	1.13	ns	Ns	Ns

WAT= weeks after transplanting

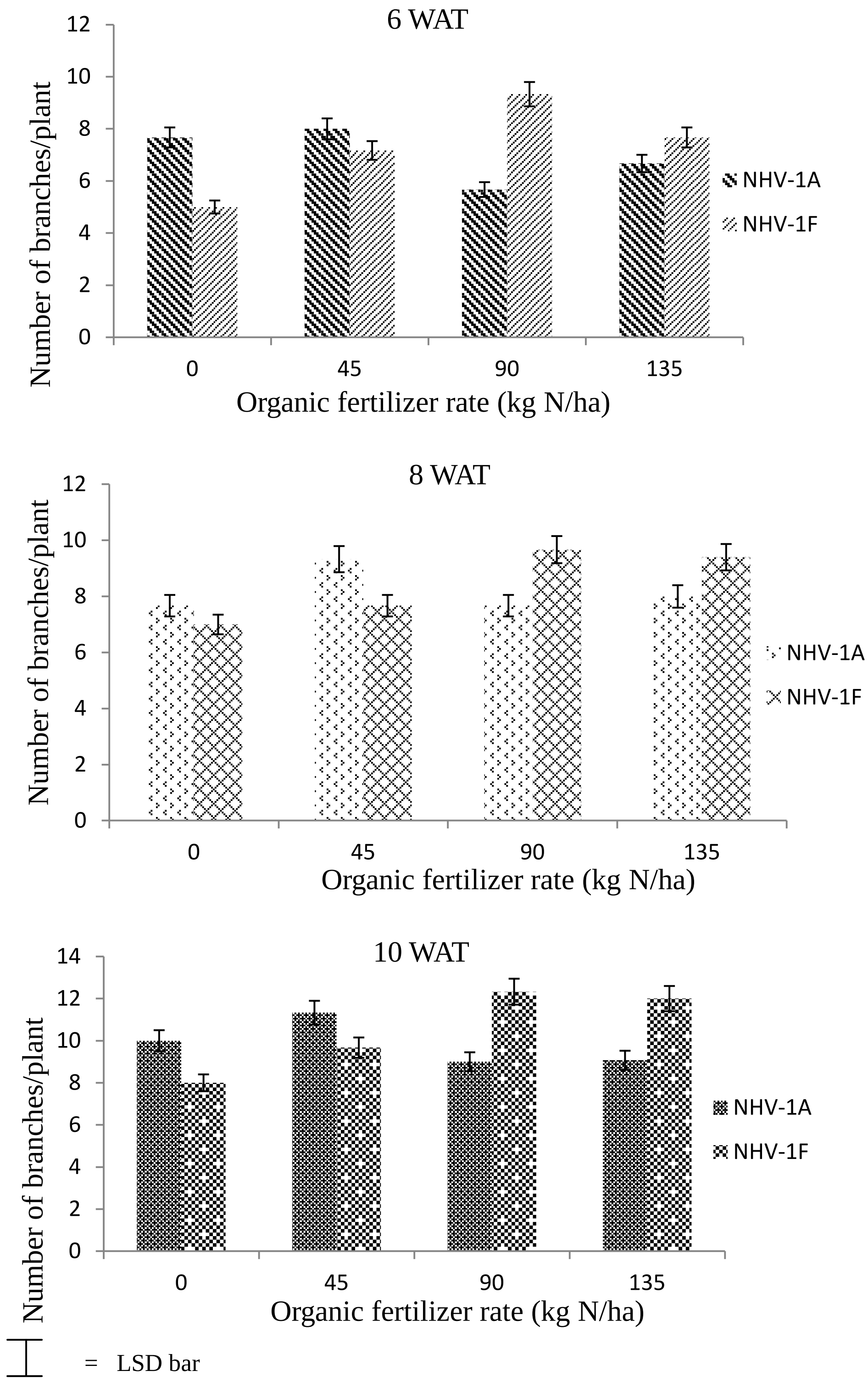

Fig. 4.19: Residual effects of tithonia compost and cultivar on number of branches of long cayenne pepper in Ogbomoso.

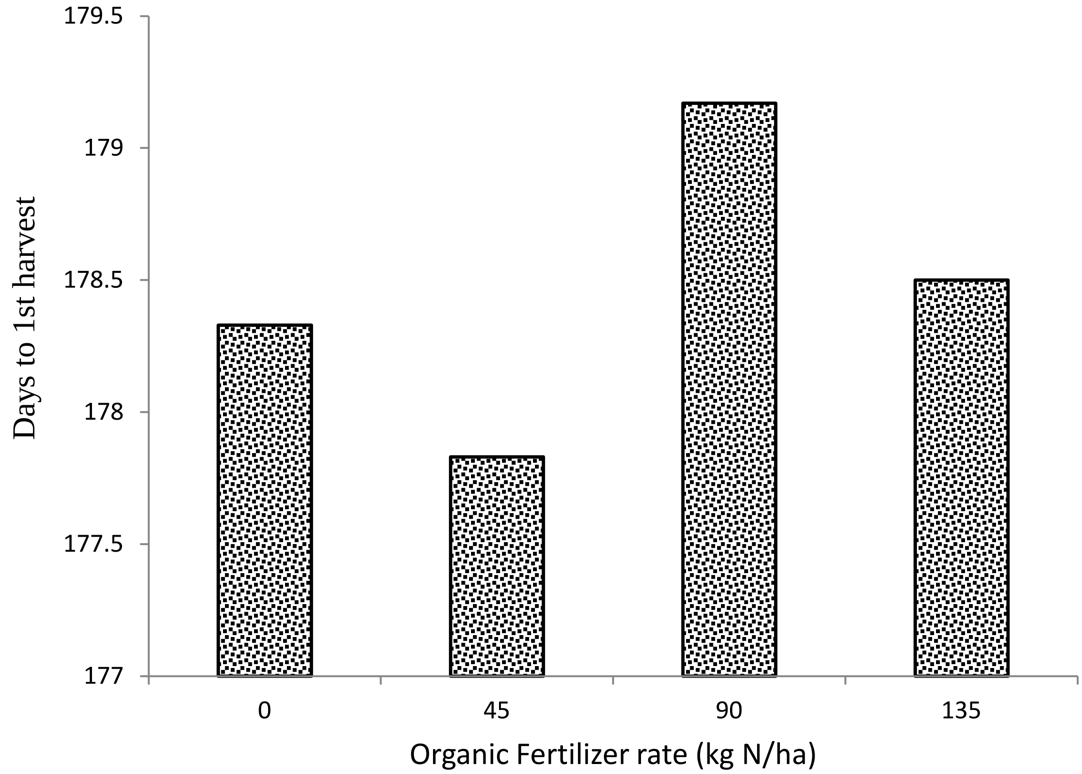

Fig 4.20: Residual effect tithonia compost on days to harvest of two cultivars of long cayenne pepper.

4.7.9 Residual effect of tithonia compost on fruit length of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Only fertiliser rates had significant difference on the fruit length across locations. Cultivars affected it in Ibadan only but cultivars by fertiliser rates did not have any effect (Table 4.31). NHV-1F had longer fruits than NHV-1A. Higher fertiliser rates had higher fruit length thereby making 135 kg N ha^{-1} to produce highest fruit length and 45 kg N ha^{-1} least.

4.7.10 Residual effect of tithonia compost on number of fruits per plant of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Cultivars, fertiliser rates and cultivars by fertiliser rates had significant effect on fruits per plant only in Ogbomoso whereas only fertiliser rates had significant effect in Ibadan (Table 4.31). NHV-1F had more fruits per plant than NHV-1A at both locations. Higher fertiliser rates increased fruits per plant and the interactions of cultivars and fertiliser rates followed the same trend.

4.7.11 Residual influence of tithonia compost on weight of fruit among two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Significant difference did exist among the average weight of fruit due to fertilizer rates in Ibadan and Ogbomoso. Weight of the fruit increased with increase in fertilizer rates. Cultivars by fertiliser rates only influenced the trait in Ogbomoso and not in Ibadan. But varieties did not influence the trait in any of the two locations (Table 4.32).

4.7.12 Residual influence of tithonia compost on weight of fruit per plant among two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Among the treatments, there were significant differences and within the interactions across locations apart from varieties in Ibadan (Tables 4.32 and 4.33). NHV-1A had significant higher fruit weight than NHV-1F in Ogbomoso. The various fertiliser rates increased fruit weight significantly. Higher rates of fertiliser had higher fruits. The interactive effect of cultivars and fertiliser rates was as that of fertiliser rates.

Table 4.31: Tithonia compost residual effect on yield components of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Treatment	Fruit diameter (cm)		Fruit length (cm)		No. of fruits/plant	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar						
NHV-1A	3.57	3.49	8.58	8.42	75.83	78.8
NHV-1F	4.72	3.81	9.00	9.11	79.08	112.3
$LSD_{0.05}$	1.00	ns	ns	ns	ns	15.51
Fertiliser rate (kg N/ha)						
0	3.73	3.63	8.00	8.67	64.83	82.2
45	3.75	3.20	7.83	7.67	72.67	92.5
90	4.20	3.67	9.33	9.17	78.17	98.8
135	4.88	4.10	10.00	9.55	94.17	108.8
$LSD_{0.05}$	0.42	0.51	0.96	ns	3.30	11.41

4.7.13 Residual influence of tithonia compost on yield of fruit among two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

The effect of cultivars, fertiliser rates and cultivars and fertiliser rates interaction among the weight of the fruit per ha was similar to the influence of fruit weight per plant (Tables 4.32 and 4.33). Only cultivars did not affect fruit yield per ha in Ibadan. Increase in fertiliser rates brought about increase in fruit yield.

4.7.14 Residual effect of tithonia compost on 1000 seed weight of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Significant difference did not exist in 1000 seed weight among NHV-1A and NHV-1F in Ibadan due to cultivars and cultivars × fertiliser rates (Tables 4.34 and 4.35). But significant differences existed in the treatment due to cultivar, fertiliser rates and cultivars by fertiliser rates in Ogbomoso. NHV-1A with 0.69g was significantly better than NHV-1F with 0.67g. 1000-seed weight was higher in Ogbomoso than Ibadan within the same cultivar. Fertiliser rates also affected 1000 seed weight in Ibadan (Table 4.34). NHV-1A had higher seed weight (0.62g, 0.69g) than NHV-1F (.0.59g, 0.67g) at Ibadan and Ogbomoso respectively. Fertiliser rates increased the seed weight. As the rate increased seed weight increased in Ogbomoso.

4.7.16 Residual influence of tithonia compost among number of seeds per fruit of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Significant variation existed in the number of seeds contained in a fruit due to cultivars in both locations. NHV-1F had more seeds per fruit in both locations. Fertiliser rates were significant at every level. As fertiliser rate increased in each location, available seeds contained in a fruit also increased tremendously. Response of pepper cultivars with fertiliser rates in Ogbomoso was significant but not in Ibadan (Table 4.34). Increased fertiliser rates also increased the number of seeds per fruit in Ibadan but not in Ogbomoso. 90 kg N ha^{-1} produced the highest number of seeds in a fruit and the higher the fertiliser rates in response of cultivars to fertiliser rates, the higher their influence.

Table 4.32: Tithonia compost residual effect on fruit yield and its components among two cultivars of long cayenne pepper pepper grown in Ibadan and Ogbomoso

Treatment	Fruit weight (g)		Fruit weight/plant (g)		Fruit yield (t/ha)	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar						
NHV-1A	7.70	7.40	728.2	696.50	29.13	27.86
NHV-1F	7.76	7.48	715.2	634.92	28.61	25.40
$LSD_{0.05}$	ns	ns	Ns	15.47	ns	0.62
Fertiliser rate (kg N/ha)						
0	6.23	6.69	626.4	591.33	25.06	23.65
45	7.07	7.03	683.2	598.67	27.33	23.95
90	8.70	7.55	748.3	693.50	29.93	27.74
135	8.92	8.48	829.0	779.33	33.16	31.17
$LSD_{0.05}$	0.11	0.26	12.60	5.21	0.50	0.21

Table 4.33: Tithonia compost residual effect on fruit yield of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Fertiliser Source (kgN/ha)	Fruit weight/plant (g)				Fruit yield (t/ha)			
	Ibadan		Ogbomoso		Ibadan		Ogbomoso	
Cultivar	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F
0	604.1	648.7	621.33	561.33	24.16	25.95	24.85	22.45
45	683.1	683.2	633.00	564.33	27.32	27.33	25.32	22.57
85	776.1	720.5	750.00	637.00	31.05	28.82	30.00	25.48
135	849.7	808.3	781.67	777.00	33.99	32.33	31.27	31.08
$LSD_{0.05}$	19.51		11.81		0.78		0.47	

Table 4.34: Tithonia compost residual effect on fruit yield of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Treatment	1000-seed weight (g)		Seed weight/fruit (g)		No of seeds/fruit	
	Ibadan	Ogbomoso	Ibadan	Ogbomoso	Ibadan	Ogbomoso
Cultivar						
NHV-1A	0.62	0.69	0.99	1.16	42.00	58.17
NHV-1F	0.59	0.67	1.11	1.18	52.75	75.08
$LSD_{0.05}$	ns	0.02	0.09	ns	0.62	13.84
Fertiliser rate (kg N/ha)						
0	0.63	0.64	0.83	0.98	40.00	43.33
45	0.67	0.64	0.88	1.17	43.00	65.83
90	0.67	0.69	1.10	1.26	50.67	81.33
135	0.45	0.76	1.38	1.28	55.83	76.00
$LSD_{0.05}$	0.05	0.03	0.10	ns	2.78	4.55

Table 4.35: Tithonia compost residual effect on yield components of two cultivars of long cayenne pepper grown in Ibadan and Ogbomoso

Fertiliser Source (kgN/ha)	Fruit length (cm) Ibadan		No. of fruits/plant Ogbomoso		No. of seeds/fruit Ogbomoso	
Cultivar	NHV-1A	NHV-1F	NHV-1A	NHV-1F	NHV-1A	NHV-1F
0	7.67	8.33	61.7	102.7	27.33	59.33
45	7.67	8.00	71.3	113.7	52.33	79.33
85	8.33	10.33	79.0	118.7	81.67	81.00
135	10.67	9.33	103.3	114.3	71.33	80.67
$LSD_{0.05}$	1.43		15.90		10.56	

CHAPTER 5

5.0 DISCUSSION

The composition of any organic fertiliser is a function of both the source and the materials from which they were prepared. Variations exist in nutrient compositions of organic fertilisers used because they were made from different biological materials. The tithonia (TC), Poultry Manure without Shavings (PM-S), Poultry Manure with Shavings (PM+S) and Commercial Organic Fertiliser (COF) were significantly similar in their ability to improve pepper fruits production basically due to their nutrient composition. Pepper planted performs differently in response to the applied organic manure because the nutrient content of different organic fertiliser types differs. The level of the nutrient content may vary in the same quantity of different fertiliser type. Adetiloye *et al.* (1985); and Titiloye *et al*. (1985) had also reported that organic fertilisers vary with materials from which they are composted. The PM+S, though was significantly similar in enhancing pepper growth and yield, but did not have as much nitrogen content as TC, PM-S and COF. Thus only TC, PM-S and COF were selected for further experimentation.

The two test long cayenne pepper cultivars did not have significant differences in plant height, stem girth and number of leaves/plant throughout the plant growth period due to both locations, except the stem girth at 8 WAT in Ibadan. This indicated that the cultivars may be genetically similar and less influenced by the environment under cultivation. The significant difference observed at 8 WAT in stem girth, which coincided with the plant flowering period, confirmed that the effect of cultivars and prevailing climatic conditions during the growth period has influence on the growth response of pepper. Grubben and El-Tahir (2004) confirmed that the prevailing environmental condition could have vital effects on the growth and yield of pepper. Higher value in stem diameter at 8 WAT of NHV-1F may be due to the NHV-1A channelled nutrients to flowering because this cultivar flowered earlier. Though organic fertilisers showed significant influence on height of plant and number of leaves/plant, however the effects were probably more prominent in Ogbomoso due to the drier weather that enhance nitrogen accumulation of this site during the growing periods.

The effect of cultivars was not significantly different on leaf area/plant at both locations at 6 WAT which might be due to the fact that the seedlings were still adapting to the transplanting shock from nursery to the field at this period. This may be due the fact that NHV-1A could recovered faster from transplanting shock producing higher leaf area than NHV-1F especially at eight weeks after transplanting. Tithonia compost and COF and their interaction produced the highest leaf area at both locations throughout growth periods. This also confirmed that compost was superior to other fertiliser types. This is contrary to the observations of Ghosh *et al.* (2004) that poultry manure enhances higher yield of pepper than cattle manure and phosphorus compost. However their study did not indicated the type and source of the poultry manure used.

The significant differences observed in number of branches/plant of the cultivars at 8 WAT and 6 WAT in Ibadan and Ogbomosho respectively showed variations in the responses of cultivars to the applied organic fertiliser types. The conditions at 8 WAT in Ibadan was almost similar to that of 6 WAT in Ogbomoso thereby causing similar effects. The cultivar NHV-1A was a better cultivar based on the number of branches/plant irrespective of the locations. Tithonia based compost and COF had similar but higher effects at 6 WAT in Ibadan but not under other treatments. Organic fertilisers from TC and other types can be quite variable from one production batch to another (Moyin-Jesu, 2008). This is an indication that TC and COF prepared from the combination of different materials can release nutrients earlier and also remain in the soil for a longer period than animal waste.

The two cultivars responded to variation due to soil conditions while the crop is still growing. The NHV-1F flowered and fruited earlier than NHV-1A, and thus recorded early 50% flowering and fruiting in NHV-1F. The non-significance in days to first harvest in Ogbomoso may be expected because there was also non-significance in days to first flowering in this location. This may be as a result environmental influence. Also, the non-significant effects of fertiliser as well as cultivars by fertiliser types on flowering and fruiting in both locations indicated that cultivar was more important than environmental influence on flowering and fruiting of the peppers. Grubben and El-Tahir (2004); Idowu-Agida *et al.* (2012) observed that different location of cultivation of pepper had a tremendous influence on number of days before flower emergence and 50% flower and fruit emergence.

Crops in which organic fertiliser is applied grew faster and gave significantly higher yield ($P < 0.05$) than Control (no fertilisers) indicating positive responses to organic fertiliser application. This could be due to the low level of the inherent soil fertility as evident in the pre planting soil analysis. The best plant performance was obtained by applying tithonia compost and COF. Adediran *et al.*, (2003); Hole *et al.*, (2005); Shankara (2005) reported that organic fertilisers enhances soil productivity. Pepper has been reported to be sensitive to environmental changes. These have aided the mineralization of the organic fertiliser in Ogbomoso than in Ibadan, hence resulting in better growth and yield observed in Ogbomoso. Rainfall is capable of causing abortion and abscission of flowers, hence reduction in the yield of the crop. This may be responsible for higher fruit weight/plant in Ogbomoso than in Ibadan. The fruit weight/plant of NHV-1A being higher than that of NHV-1F in Ogbomoso. Based on this result, NHV-1A could be more sensitive to environmental influence and can therefore be recommended for Ogbomoso. Heavy rainfall may also result in leaching thereby preventing pepper from having access to nutrient uptake. This may be a reason why pepper performance in Ibadan was lower than that of Ogbomoso.

The organic fertilisers affected yield components and fruit qualities of the crop differently. This was possible because the organic fertilisers contain different components. Titiloye *et al.* (1985) Gaskell (1999) concluded from their trials that nutrients released by organic fertilisers vary with types of manure and from one location to the other, thereby affecting soil fertility in different ways. The mean fruit weights of the two cultivars were increased by TC and COF in Ogbomoso. This trend observed in the pepper cultivars and fertiliser types indicated that TC or COF may be applied for higher fruit yield in Ogbomoso irrespective of the cultivars. This confirms the observations of Alabi (2006) and Roy (2011) that organic fertiliser improves the quality of plant and fruit of *Capsicum*. The non-significant differences in fruit weight per plant of the two cultivars due to applied fertiliser and their interaction have shown that either of the cultivars may be recommended and fertiliser may not necessarily be used as a factor for fruit weight per plant. However, TC and COF that demonstrated their capability to increase fruit weight per plant of the crop over the other treatments may be utilized for optimum crop production.

Higher fruit yield ha^{-1} of NHV-1A in Ogbomoso is expected as the cultivar produced higher weight of fruit per plant. Fruit yield per hectare of NHV-1A though is significantly higher than that of NHV-1F in Ibadan despite that fruit weight per plant is similar because fruit size of NHV-1A is bigger than that of NHV-1F. Tithonia compost and COF as well as their respective pepper cultivars influenced plants to produce higher fruit yield indicated that the two types are promising. There were no significant differences observed in 1000 seed weights of both cultivars at both locations and due to cultivar and fertiliser. This indicates that the applied organic fertiliser did not significantly affect this parameter. Length of fruit and girth of the two cultivars did not show significant differences at both locations indicating that the parameters are not influenced by organic fertiliser applied and the locations. Tithonia compost and SOF significantly increased fruit length and girth in Ogbomoso but only fruit girth in Ibadan. Their interactions increased only fruit girth above other treatments in Ibadan. This result showed that fruit length and their girth cannot be used to determine the effectiveness of the organic fertiliser types used across locations. The TC and COF could be suggested for use in Ogbomoso because these fertiliser types positively influenced fruit yield. Despite the fact that NHV-1A had higher fruit yield than NHV-1F, quantity of seeds in each fruit of NHV-1F was higher in Ogbomoso. Influence of organic fertiliser was also prominent only in this location where all the organic fertiliser types increased yield but TC was the most superior. Influence of COF and PM-S was similar on this parameter. Therefore, only TC can be recommended due to its superiority over other organic fertiliser types.

Tithonia based organic fertiliser rates only had influence in later part of the crop's development in Ibadan, but at both early and later stages in Ogbomoso. Generally, the growth parameter of long cayenne pepper was better in Ogbomoso than in Ibadan. This may be due to variation in the factors that influence mineralization of the organic fertiliser. Variation in soil type between the two locations may have influence on the crop performance because literature has shown that organic matter mineralizes faster in drier and hotter environments than the humid area. Higher organic fertiliser rate increased almost all the vegetative character like height of plant, stem girth, the quantity of leaves in each plant, leaf area and branches available in each plant. Application of 135 kg N/ ha produced superior pepper stands because higher rate of applied organic fertiliser tends to release higher nitrogen which is required for vegetative growth of pepper. Roy *et al*. (2011) observed that length of fruit and breadth, and average fruit weight of pepper respectively increased with organic fertiliser rates to 100 and 150 kg N/ha. Additionally, this could be a pointer that high rate of tithonia based organic fertiliser may be needed for pepper growth and yield in soils used at both Ibadan and Ogbomoso. Adediran *et at* (2003) recommended the use of high organic fertiliser rates on tropical soils for high performances of crops due to poor nutrient status of the soils.

Variation that existed between the two cultivars in the flowering and fruiting parameters in Ibadan only showed that the crop was more sensitive to different location between Ibadan and Ogbomoso. Rainfall was more uniformly lower in Ogbomoso than in Ibadan during the experiment. So, the higher rainfall in Ibadan delayed flowering and fruiting in NHV-1A than NHV-1F because NHV-1A was more sensitive to the fluctuation of rainfall. Cultivar, NHV-1F flowered hence it produced mature fruits earlier than NHV-1A. There was no significant difference due to organic fertiliser rates as well as cultivars × organic fertiliser interaction across locations primarily because soil fertility does not influence earliness to flowering and fruiting as these are genetically controlled. Most yield components such as weight of seed in each fruit yield of pepper fruit in a hectare and 1000 - seed weight and fruit quality such as quantity of fruits in each plant and the quantity of seeds in each fruit of the two pepper cultivars were significantly similar in Ibadan. This indicates that the parameters were less influenced by the organic fertiliser applied. Therefore, mean fruit weight, fruit length and girth can be used to determine the differences in the responses of cultivars to fertiliser rates under Ibadan condition. Yield and yield components considered appreciably moved up with more organic fertiliser rates till 135 kg N/ha, particularly in Ibadan. In some parameters such as fruit weight on each plant, weight of seed in each fruit and weight of 1000 seeds, the variation due to fertiliser rates were not significant perhaps due to the weather conditions that were generally hotter in Ogbomosho, thereby making the organic matter mineralize faster. This shall obviously make adequate nutrient readily available for plant use earlier. In view of this, lower rates of organic fertiliser can be recommended in Ogbomoso.

All the fruits nutrient contents of the two cultivars were influenced by cultivars and fertiliser except Calcium and Nitrogen in Ibadan, and phosphorus at both locations. This indicates that the effect of the tithonia based compost rates as it enhanced nutrient contents of pepper is dependent on locations. The nutrient contents increased with organic fertiliser rates depending on locations. Depending on the concentration of calcium, iron, nitrogen, phosphorus and potasium in pepper that was higher in pepper grown in Ogbomoso, cultivating the crop in Ogbomoso is recommended. Variations due to cultivars only existed in CP and TSS at both locations. NHV-1A had higher CP and TSS in, Ogbomosho indicating that pepper could be produced for these attributes in Ogbomoso. Organic fertiliser significantly affected the other food qualities. Higher food qualities in form of CP, CF, EE, TSS and Vitamin C extracted at the application of 135 kg N/ha at both locations showed that organic fertiliser rates had influence on the parameters. It has been reported that the content of ascorbic acid of pepper fruit is influenced by growing conditions (Russo and Howard, 2002). Only CP was significantly affected by cultivars × fertiliser rates at both locations; whereas CF and EE were both influenced by cultivars × fertiliser rates only in Ogbomoso. It can therefore be said that CP is not location specific, but CF and EE can be obtained with higher rates of organic fertiliser only in Ogbomoso.

Residual effects of tithonia based organic fertiliser followed the trend of the initial application where all the vegetative parameters of the crop increased with increase in fertiliser rates at the two locations. Generally, the residual effects of the organic fertilisers were similar to the main application due to the fact that organic fertilisers are types of nutrients that are much slow nutrient-releasing than mineral fertilisers hence making nutrients readily available to crops at all the growth stages (Gezerel and Donmez, 1988; Enwall *et al.,* 2005). The non- significant tithonia based organic fertiliser residual effect on the growth parameters at the two locations indicated that the cultivars were similarly affected by the fertiliser following the trend of initial application. The variations that existed in the residual effects of organic fertiliser were more prominent with height of plant and branches/plant. The number of branches in a plant was not significantly different due to fertiliser rates in Ogbomoso, but the values were higher than those obtained at

Ibadan. This also made leaves/plant and leaf area greater in Ogbomoso. Residual effect of tithona based organic fertiliser was not significantly different, based on days to first flower emergence and fruit emergence. Tithonia compost fertiliser residual influence increased pepper fruit yield plus other yield components of the crop and its fruit quality because the fertiliser was able to release sufficient nutrients during the second cropping. However, the residual effects of fertilisers were significantly different from the main application on fruit yield and 1000 - seed weight across locations. There was significant difference on fruit yield ha^{-1} between the cultivars due to organic fertiliser rate in Ogbomosho contrary to the effect of main fertiliser application. The cultivars reacted to the available nutrients in the soil differently hence this made higher rates more effective and Ogbomoso a more suitable organic pepper production area.

CHAPTER 6

6.0 SUMMARY AND CONCLUSIONS

There has been a rapid increase in the cultivation of long cayenne pepper throughout Nigeria due to its numerous economic values but the physical and chemical conditions of the growing medium have considerably limited the yield of the crop. Also, the high cost of chemical fertilisers has placed them beyond the reach of many farmers. Due to continuous land usage, optimum pepper growth performance and fruit yield may not be attainable in the absence of organic fertiliser mineral fertiliser application to soil. Therefore it is expedient that continuous search for an alternative nutrient source is necessary. Hence, the need for this research: with the main objective of determining the effectiveness of some readily available organic materials as nutrient types for pepper growth and yield.

The conclusions made out of this research finding are enumerated as follows: Organic fertiliser types used were found to consist of variations in macro and micro nutrients.

(1) Different organic fertilisers used enhanced the growth of the two long cayenne pepper cultivar differently.

(2) The tithonia based compost (TC), Poultry Manure without shavings (PM-S), Poultry Manure with shavings (PM+S) and Commercial Organic Fertiliser (COF) were similar in their ability to release higher amount of nutrients for plant use.

(3) Fruit yield of cultivar NHV-1A was significantly higher than that of NHV-1F at both locations.

(4) Fruit yield was higher in Ogbomoso (10.89 t/ha) than at Ibadan (6.40 t ha^{-1}.

(5) For optimal performance of long cayenne pepper, it is expedient those soil nutrients are augmented with organic fertilisers' especially tithonia based compost.

(6) Tithonia compost rates influenced the yield of long cayenne pepper with 90 kg N/ha giving significantly higher yield than the other rates at both locations.

(7) Nutritional qualities in long cayenne pepper may be increased with the introduction of organic fertilisers. The crude protein, crude fibre, total soluble solid and vitamin C content were enhanced with the introduction of organic fertilisers.

(8) Residual effect of TC was significant in terms of growth characteristics such as plant height and stem diameter. The responses that were not significantly noticed at the initial application of organic fertiliser in terms of growth characteristics manifested in the residual experiment. This is an indication that TC stays longer in the soil for subsequent crop use. Furthermore, the slow nutrient release nature of the TC was evident, on the measured plant characteristics.

(9) The higher the application rate of the organic fertiliser to long cayenne pepper, the higher the residual effects in the soil. As application rates increased so also the performance of long cayenne pepper with 135 kgN/ha.

It is concluded that for optimum performance of long cayenne pepper 90 kgN/ha to 135 kgN/ha of equivalent weight of tithonia based compost should be applied. For effective utilization of the applied organic fertiliser, there is the need to cultivate the soil more than once as exemplified in the residual effect of this study.

CONCLUSION

Different organic fertilisers collected from different locations, consists of different levels of mineral components as evident in the analysis of the organic fertilisers.

Irrespective of the cultivar, Ogbomoso; Southern Guinea savanna ecology gave better and higher pepper yield than the transitional rainforest ecology of Ibadan.

The top three organic fertilisers (tithonia compost, poultry manure without shavings and commercial organic fertiliser), enhanced the growth and fruit yield of long cayenne pepper better than the other organic fertiliser.

Cultivar NHV-1A gave higher fruit yield than NHV-1F at both locations.

Tithonia compost fertiliser at 90 kgN/ha and 135 kgN/ha gave similar but significantly higher pepper yield than other lower fertiliser rates. Hence, 90 kgN/ha is recommended for economics of production of the long cayenne pepper used in this study.

The total soluble solids, vitamin C, Calcium and Iron contents of long cayenne pepper fruit were greatly improved with the application of any of the top three organic fertilisers.

The slow release nature of organic fertiliser was greatly demonstrated in this study by the residual effect of the applied organic fertilisers on the pepper crops that became more pronounced in the second trial.

It is concluded that for optimum performance of long cayenne pepper 90 – 135 kg N/ha from Tithonia compost organic fertiliser should be applied. Due to the slow release nature of the organic fertilisers, cropping of such farm more than once could be recommended for effective utilization of the applied nutrient.

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Appendix 1: Procedure for the determination of nitrogen equivalent in tithonia compost

Nitrogen (N) in TC = 16.1 g kg^{-1}

1000 g of TC contained 16.1 g of N

x kg of TC will contain 130 kg of N

$$\frac{x\ kg\ TC}{1000\ g\ TC} = \frac{130\ kg\ N}{16.1\ g\ N}$$

$$\frac{x\ kg\ TC}{1\ kg\ TC} = \frac{130\ kg\ N}{0.0161\ kg\ N}$$

$$x\ kg \times 0.0161\ kg = 1\ kg \times 130\ kg$$

$$x\ k = \frac{1\ kg \times 130\ kg}{0.0161\ kg}$$

$$= \frac{130\ kg}{0.0161\ kg}$$

$$= 8074.5\ kg\ ha^{-1}$$

$$= 8.1\ t\ ha^{-1}$$

8.1 t ha^{-1} of TC will supply 130 kg N ha^{-1}

Nitrogen (N) in PM-S =9.63 g Kg^{-1}

1000 g of PM-S contained 9.63 g of N

X kg PM-S /1000 g PM-S = 130 kg N /9.63 N

X kg PM-S / 1 kg PM-S = 130 kg N /0.00963 kg N

X kg x 0.00963 kg N = 1 kg x 130 kg

X kg = 1 kg x 130 kg / 0.00963 kg

= 130 kg / 0.00963 kg

= 13, 499 kg

= 13.5 t ha^{-1}

Nitrogen (N) in PM+S =8.70 Kg^{-1}

1000 g of PM+S contained 8.70 g of N

X kg of PM+S will contain 130 kg of N

X kg PM+S / 1000 g PM+S = 130 kg N / 8.70 g N

X kg PM+S /1 kg PM+S = 130 kg N / 0.0087 kg N

X kg x 0.0087 kg = 1 kg x130 kg

X kg = 1kg x 130 kg / 0.0087 kg

= 130 kg / 0.0087 kg

=14,942

= 14.9 t ha^{-1}

Nitrogen (N) in POF = 11.31g Kg^{-1}

1000 g of POF contained 11.31 g of N

X kg of POF will contain 130 kg of N

X kg POF / 1000 g POF = 130 kg N / 11.31 g N

X kg POF /1 kg POF = 130 kg N / 0.01131 kg N

X kg x 0.01131 g N = 1 kg x130 kg N

X kg = 1kg x 130 kg / 0.01131 kg

= 130 kg / 0.01131 kg

=11.499

= 11.5 t ha^{-1}

Nitrogen (N) in COF = 3.48 g Kg^{-1}

1000 g of COF contained 11.31 g of N

X kg of COF will contain 130 kg of N

X kg COF / 1000 g SOF = 130 kg N / 3.48 g N

X kg COF /1 kg SOF = 130 kg N / 0.0038 kg N

X kg x 0.0038 g N = 1 kg x130 kg N

X kg = 1kg x 130 kg / 0.0038 kg

= 130 kg / 0.0038 kg

=34.210

= 34.2 t ha^{-1}

Nitrogen (N) in AOF = 38.78 g Kg^{-1}

1000 g of COF contained 38.78 g of N

X kg of AOF will contain 130 kg of N

X kg AOF / 1000 g AOF = 130 kg N / 0.03878 Kg N

X kg AOF /1 kg AOF = 130 kg N / 0.03878 Kg N

X kg x 0.03878 g N = 1 kg x130 kg N

X kg = 1kg x 130 kg / 0.03878 kg

= 130 kg / 0.03878 kg

=3.352

= 3.4 t ha^{-1}

Nitrogen (N) in BW = 17.40 g Kg^{-1}

1000 g of BW contained 17.40 g of N

X kg of BW will contain 130 kg of N

X kg BW / 1000 g BW = 130 kg N / 0.0174 Kg N

X kg BW /1 kg AOF = 130 kg N / 0.0174 Kg N

X kg x 0.0174 g N = 1 kg x130 kg N

X kg = 1kg x 130 kg / 0.0174 kg

= 130 kg / 0.0174 kg

=7.471

= 7.5 t ha^{-1}

Nitrogen (N) in CD = 27.14 g Kg^{-1}

1000 g of CD contained 27.14 g of N

X kg of CD will contain 130 kg of N

X kg CD / 1000 g CD = 130 kg N / 24.14 g N

X kg CD /1 kg CD = 130 kg N / 0.02714 Kg N

X kg x 0.02714 g N = 1 kg x130 kg N

X kg = 1kg x 130 kg 0.02714 kg

= 130 kg / 0.02714 kg

=4.790

= 4.8 t ha^{-1}

Nitrogen (N) in OPBA = 17.86 g Kg^{-1}

1000 g of OPBA contained 17.86 g of N

X kg of OPBA will contain 130 kg of N

X kg OPBA / 1000 g OPBA = 130 kg N / 17.86 g N

X kg OPBA /1 kg OPBA = 130 kg N / 0.01786 Kg N

X kg OPBA x 0.01786 g N = 1 kg OPBA x 130 kg N

X kg OPBA = 1kg OPBA x 130 kg N / 0.01786 kg N OPBA

= 130 kg / 0.01786 kg

=7.279 Kg

= 7.3 t ha^{-1}

Nitrogen (N) in CPH = 17.40 g Kg^{-1}

1000 g of CPH contained 17.40 g of N

X kg of CPH will contain 130 kg of N

X kg CPH / 1000 g CPH = 130 kg N / 17.40 g N

X kg CPH /1 kg CPH = 130 kg N / 0.0174 Kg N

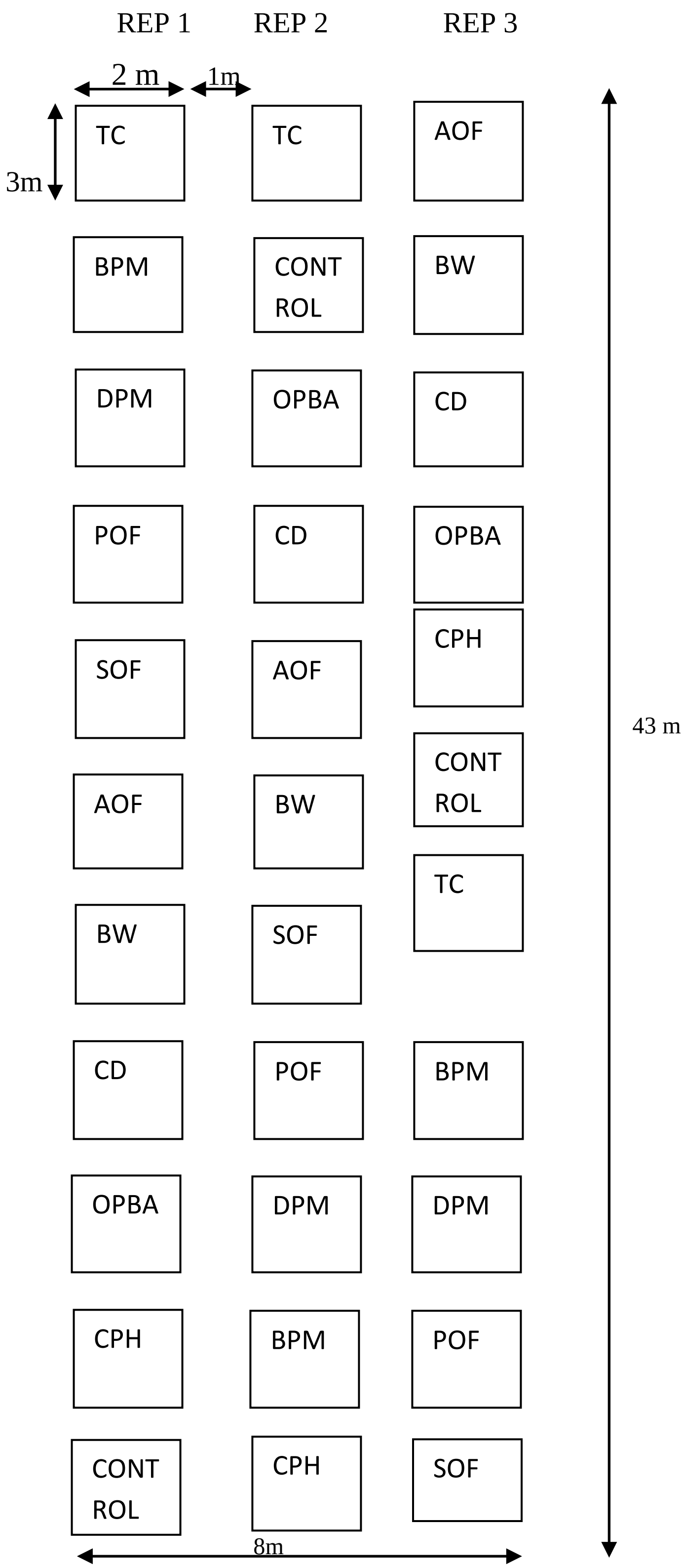
1 kg CPH x 130 Kg N = X kg CPH x 0.0174 kg

X kg CPH = 1kg CPH x 130 kg N / 0.0174 kg N

= 130 kg / 0.0174 kg

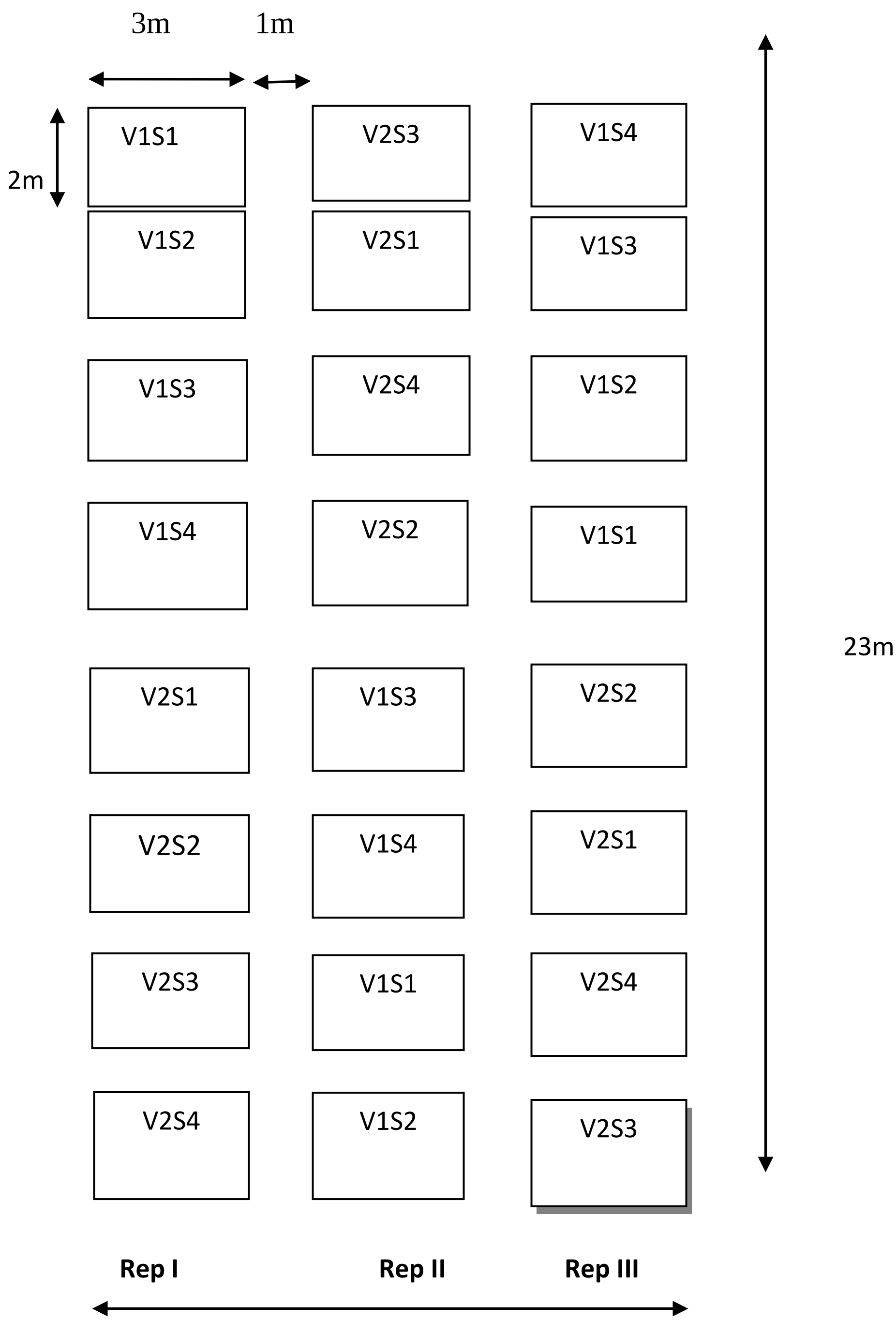
=7.471 Kg

= 7.5 t ha^{-1}



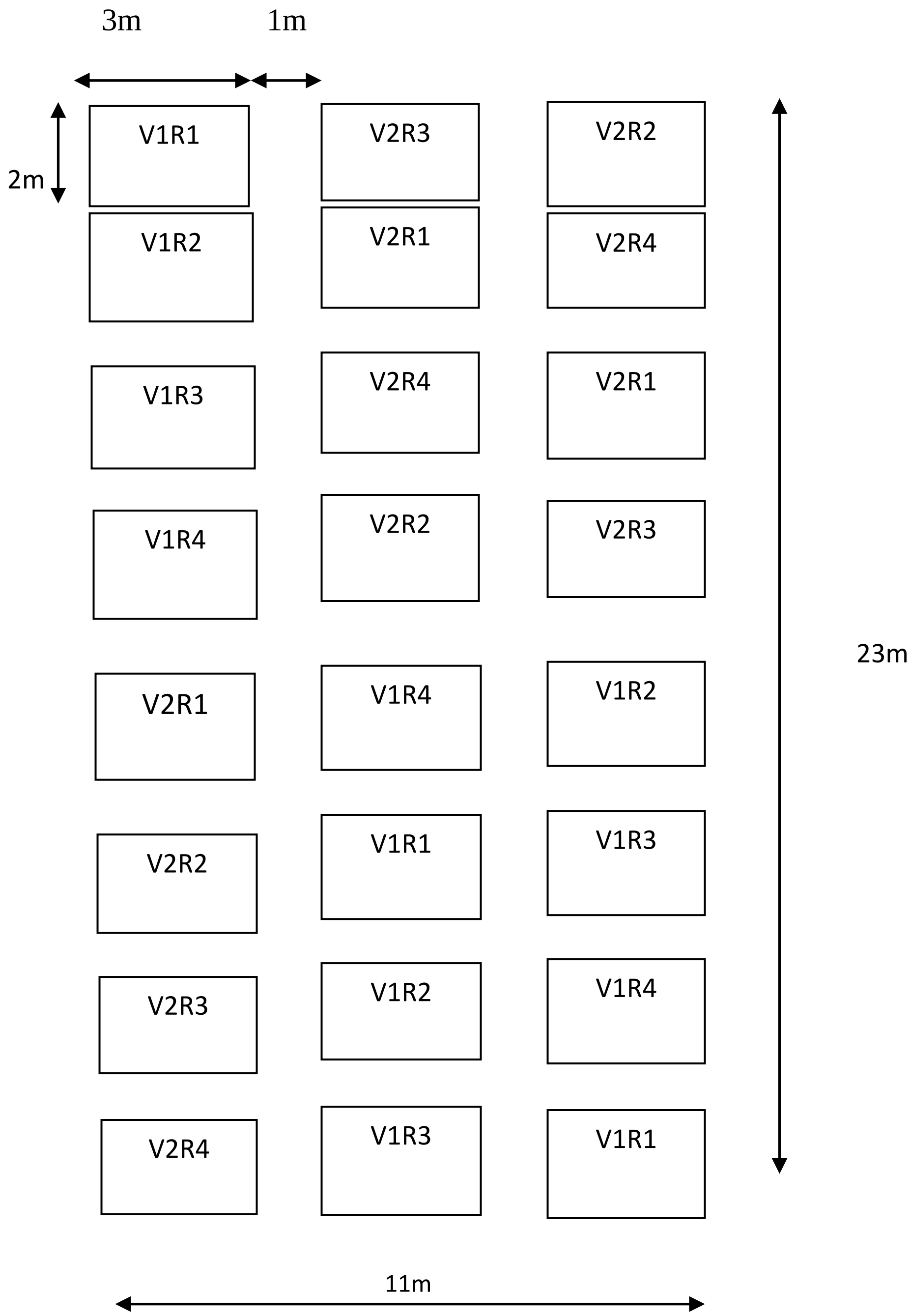
TC= Tithonia compost, BPM= Battery cage poultry manure, DPM= Deep litter poultry manure, POF= Pacesetter organic fertilizer, SOF= Sunshine organic fertilizer, AOF= Ayeye organic fertilizer, BW= Brewery waste, CD= Cow dung, OPBA= Oil palm bunch ash, CPH= Cacao pod husk, NOF= No organic fertilizer.

Appendix 2: Field layout for experiment 1 at Ibadan and Ogbomoso locations.



Key: V1 = NHV-1A S1 = Poultry manure without shavings S3 = Tithonia compostV2 = NHV-1F S2 = commercial organic fertiliser S4 = No fertiliser

Appendix 3; Experimental layout of four fertiliser types and two cultivars of pepper located in Ibadan and Ogbomoso.



Key: V1 = NHV-1A F1 = No fertiliser F3 = 90 kg N/ha

V2 = NHV-1F F2 = 45 kg N/ha F4 = 135 kg N/ha

Appendix 4: Experimental layout involving four fertiliser rates (F1-F4) and two pepper cultivars (NHV-1A and NHV-1F) in a RCBD replicated three times.

Appendix 5: Mean squares from the analysis of variance on effect of fertiliser rates on plant height and stem girth of two cultivars of pepper in Ibadan

Types	DF	Plant Height			Stem Girth		
		6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Replicate	2	21.34	29.54	85.20	0.01	0.00	0.01
Variety (V)	1	4.06	23.26	13.43	0.01	0.03*	0.15
Error	2	0.64	103.79	1.78	0.00	0.00	0.00
Fertiliser Rate (F)	3	10.14	31.83	418.95**	0.37**	0.91**	1.32**
V x F interaction	3	6.74	22.33	19.17*	0.00	0.00	0.03
Error	12	3.21	12.10	4.75	0.00	0.00	0.01
Total	23						
CV (%)		9.34	25.77	3.57	5.22	2.82	5.50

Appendix 6: Mean squares from the analysis of variance on effect of fertiliser rates on plant height and stem girth of two cultivars of pepper in Ogbomoso

Types	DF	Plant height			Stem girth		
		6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Rep	2	0.28	5.13	16.53	0.00	0.00	0.02
Variety (V)	1	34.80*	0.51	174.42	0.01	0.02	0.01
Error	2	1.05	3.28	16.53	0.01	0.01	0.02
Fert Rate (F)	3	9.35**	1.08	121.60**	0.03	0.07	0.12
V x F	3	6.01**	2.26	2.61	0.00	0.01	0.03
Error	12	0.79	4.16	3.77	0.06	0.12	0.17
Total	23						
CV (%)		4.50	7.94	3.41	24.62	28.86	24.48

Appendix 7: Mean squares from the analysis of variance on effect of fertiliser rates on number of leaves and leaf area of two cultivars of pepper in Ibadan

Types	DF	Number of leaves/plant			Leaf Area		
		6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Replicate	2	527.4	374.37	115.40	54.93	5.09	22.31
Variety (V)	1	206.1	57.82	220.58*	10.34	1.82	0.12
Error	2	166.4	370.38	5.82	24.20	16.01	43.84
Fertiliser Rate (F)	3	123.9	23.40	7607.03**	8.81	10.97	61.78**
V x F interaction	3	257.3	19.95	10.28	5.11	13.91	15.15
Error	12	109.7	21.04	20.12	4.79	11.26	10.32
Total	23						
CV (%)		26.63	34.51	3.19	23.66	20.42	16.14

Appendix 8: Mean squares from the analysis of variance on effect of fertiliser rates on number of leaves and leaf area of two cultivars of pepper in Ogbomoso

Types	DF	Number of leaves/plant			Leaf Area		
		6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Replicate	2	43.62	2.51	21.46	18.18	79.37	1813
Variety (V)	1	3710.11**	3089.47**	1839.25*	2198.42**	50.17	599673**
Error	2	15.23	0.72	27.46	28.20	6.90	3030
Fertiliser Rate (F)	3	464.17**	2543.02**	20.62	200.07**	81.24*	460319
V x F interaction	3	533.08**	2816.96**	6589.32**	737.21**	282.86**	74968
Error	12	33.90	1.11	10.94	26.29	23.34	2761
Total	23						
CV (%)		5.84	0.75	1.05	3.52	3.01	6.11

Appendix 9: Mean squares from the analysis of variance on effect of fertiliser rates on number of branches and days to flowering of two cultivars of pepper in Ibadan

Types	DF	Number of branches/plant			Days to 1st flowering	Days to 50% flowering	Days to 1st harvest
		6WAT	8WAT	10WAT			
Replicate	2	0.26	0.92	1.17	0.15	0.15	0.12
Variety (V)	1	0.17	4.67*	13.01**	1.60*	1.60*	1.60*
Error	2	5.91	0.12	0.16	0.06	0.06	0.06
Fertiliser Rate (F)	3	0.21	13.68**	35.24**	1.43	1.43	1.43
V x F interaction	3	0.07	0.71*	2.41**	3.13	3.12	3.13
Error	12	0.62	0.08	0.12	1.09	1.09	1.09
Total	23						
CV (%)		66.21	5.11	4.07	0.96	0.68	0.52

Appendix 10: Mean squares from the analysis of variance on effect of fertiliser rates on number of branches and days to flowering of two cultivars of pepper inOgbomoso.

Types	DF	Number of branches/plant			Days to 1st flowering	Days to 50% flowering	Days to 1st harvest
		6WAT	8WAT	10WAT			
Replicate	2	0.05	0.08	0.01	0.88	0.88	1.04
Variety (V)	1	0.35	0.07	3.45**	0.67	0.38	0.17
Error	2	0.62	0.14	0.03	2.79	3.38	3.04
Fertiliser Rate (F)	3	3.22**	1.72**	1.70**	1.50	1.38	1.17
V x F interaction	3	4.78**	16.15**	10.01**	1.33	1.38	1.61
Error	12	0.17	0.25	0.23	1.17	0.79	0.93
Total	23						
CV (%)		7.56	5.71	4.79	1.20	0.78	0.62

Appendix 11: Mean squares from the analysis of variance) on effect of fertiliser rates on fruit yield and yield components of two cultivars of long cayenne pepper in Ibadan.

Types	DF	1000 seed weight	Mean fruit weight	Fruit girth	Fruit length	Fruit weight/plant	No. of fruit/plant	Seed weight/fruit	No.of seeds/fruit	Fruit yield
Replicate	2	0.003	0.02	0.02	0.03	1304.0	10118.0	0.00	42.73	4.44
Variety (V)	1	0.004	0.44**	0.68*	1.43**	5103.0	59203.0	0.00	23.35	17.36
Error	2	0.001	0.00	0.01	0.02	1261.0	7483.0	0.00	7.32	4.92
Fertiliser Rate (F)	3	0.067*	11.80**	6.54**	12.93**	305539.0**	44381.0**	0.04**	470.24**	1039.68**
V x F interaction	3	0.003	0.34	0.08	0.07	1036.0	5101.0	0.00	33.10*	3.53
Error	12	0.001	0.07	0.02	0.04	1330.0	1720.0	0.00	6.41	4.53
CV (%)		5.59	3.59	5.00	2.76	4.80	15.38	10.39	4.31	4.80

Appendix 12: Mean squares from the analysis of variance on effect of fertiliser rates on fruit yield and yield components of two cultivars of pepper in Ogbomoso.

Types	DF	1000 seed weight	Mean fruit weight	Fruit girth	Fruit length	Fruit weight/plant	No. of fruit/plant	Seed weight/fruit	No. of seeds/fruit	Fruit yield
Replicate	2	0.00	0.11	0.21	0.25	97.33	2.17	0.08	64.57	8.09
Variety (V)	1	0.01	0.30	0.84*	0.57*	90847.82**	1727.21**	0.01**	3393.88*	44.47
Error	2	0.00	0.04	0.04	0.01	56.94	12.98	0.00	76.28	5.13
Fertiliser Rate (F)	3	0.01	1.42	1.37**	3.94**	51242.76**	2287.30**	0.05	3447.28**	105.32**
V x F interaction	3	0.00	0.31	0.26	16.87**	9029.78**	1759.63**	0.01	374.39**	7.18
Error	12	0.02	2.12	0.15	0.60	65.83	6.880	0.02	46.70	3.68
CV (%)		19.12	20.30	7.13	7.06	1.20	1.95	10.79	8.87	7.76

Appendix 13: Mean squares from the analysis of variance on effect of fertiliser types on plant height and stem girth of two cultivars of pepper in Ibadan.

Types	DF	Plant height			Stem girth		
		6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Rep	2	15,07	11.47	8.96	0.03	0.04	0.01
Variety (V)	1	1.45*	33.61	12.47	0.02*	0.36**	0.03
Error	2	0.81	6.00	1.02	0.02	0.01	0.00
Fertiliser Rate (F)	3	133.06	306.04	207.96	0.29	1.89	0.61
V x F interaction	3	0.32	4.35**	0.15	0.07	0.01	0.00
Error	12	0.90	0.80	3.08	0.01	0.00	0.00
Total	23						
CV (%)		5.38	3.28	3.28	7.64	3.04	3.35

Appendix 14: Mean squares from the analysis of variance on effect of fertiliser types on plant height and stem girth of two cultivars of pepper in Ogbomoso

Types	DF	Plant height			Stem girth		
		6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Rep	2	0.55	181.34	114.35	0.01	0.02	0.02
Variety (V)	1	9.13	55.82	65.34	0.02	0.00	0.00
Error	2	2.19	7.20	11.79	0.12	0.07	0.04
Fertiliser Rate (F)	3	25.48**	70.33**	209.42**	0.24	0.11	0.12
V x F interaction	3	3.77*	7.47	14.05	0.04	0.07	0.03
Error	12	0.99	4.65	5.57	0.07	0.08	0.05
Total	23						
CV (%)		7.52	10.12	8.62	16.71	14.97	10.20

Appendix 15: Mean squares from the analysis of variance on effect of fertiliser types on number of leaves and leaf area of two cultivars of pepper in Ibadan

Types	DF	Number of leaves/plant			Leaf area		
		6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Rep	2	92.17	63.29	357.13	68.54	16197.0	14010.0
Variety (V)	1	145.04	888.17	1027.04	42.96*	299512.0*	159349.0*
Error	2	1.17	0.29	0.29	2.77	8324.0	2623.0
Fertiliser Rate (F)	3	341.60	911.56	10155.71	1116.19	590311.0**	492619.0**
V x F interaction	3	1.82	18.39	13.71*	4.54	7950.0	13424.0
Error	12	1.67	0.68	3.88	2.79	16939.0	5226.0
Total	23						
CV (%)		3.89	0.96	1.26	7.09	3.36	15.27

Appendix 16: Mean squares from the analysis of variance on effect of fertiliser types on number of leaves and leaf area of two cultivars of pepper in Ogbomoso

Types	DF	Number of leaves/plant			Leaf area		
		6WAT	8WAT	10WAT	6WAT	8WAT	10WAT
Rep	2	52.17	1005.88	120.17	49889.00	744423.00	474348.00
Variety (V)	1	1768.17	651.04	1040.17	144817.00	1858877.00*	1325494.00**
Error	2	440.17	358.79	216.17	34517.00	85086.00	1761.00
Fertiliser Rate (F)	3	741.67**	1335.82**	1149.17**	81862.00**	1077787.00**	1080204.00**
V x F interaction	3	107.83*	44.60	115.83*	11636.00*	39098.00	42896.00
Error	12	32.00	36.83	31.67	3232.00	92056.00	58693.00
Total	23						
CV (%)		22.02	10.76	7.54	17.50	25.23	13.19

Appendix 17: Mean squares from the analysis of variance on effect of fertiliser types on number of branches and days to flowering of two cultivars of pepper in Ibadan.

Types	DF	Number of branches/plant			Days to 1st Flowering	Days to 50% Flowering	Days to 1st harvest
		6WAT	8WAT	10WAT			
Rep	2	1.63	2.63	24.50	0.15	0.15	0.15
Variety (V)	1	3.34	15.04*	80.67	1.60*	1.60*	1.60*
Error	2	2.38	0.29	6.17	0.06	0.06	0.06
Fertiliser Rate (F)	3	8.49*	56.38	88.78**	1.43	1.43	1.43
V x F interaction	3	10.82*	3.04	17.44	3.13	3.13	3.13
Error	12	1.94	0.29	8.11	1.09	1.06	1.09
Total	23						
CV (%)		34.33	5.33	18.06	0.96	0.68	0.52

Appendix 18: Mean squares from the analysis of variance on effect of fertiliser types on number of branches and days to flowering of two cultivars of pepper in Ogbomoso

Types	DF	Number of branches/plant			Days to 1st Flowering	Days to 50% Flowering	Days to 1st harvest
		6WAT	8WAT	10WAT			
Rep	2	44.04	39.12	129.54	0.54	0.09	0.21
Variety (V)	1	12.04*	80.67	70.04	3.84	2.41**	0.20
Error	2	0.54	17.79	46.79	23.22	0.00	0.56
Fertiliser Rate (F)	3	13.60**	100.56	129.15**	0.28	1.04	1.50
V x F interaction	3	0.60	5.44	27.26	0.76	2.69	4.57**
Error	12	1.18	12.62	9.33	0.43	1.11	0.66
Total	23						
CV (%)		23.41	26.11	19.69	1.98	0.70	0.45

Appendix 19: Mean squares from the analysis of variance on effect of fertiliser types on fruit yield and yield components of two cultivars of pepper in Ibadan,

Types	DF	1000 seed weight	Average fruit weight	Fruit girth	Fruit Length	Fruit weight/plant	No. of Fruit/plant	No. of seeds/Fruit	Fruit yield
Replicate	2	0.000	0.01	0.06	0.09	4712.5	56.94	153.13	0.16
Variety (V)	1	0.000**	1.28	0.12	0.54	144483.4	699.21*	130.67	4.92**
Error	2	0.000	0.06	0.01	0.06	686.0	44.57	0.04	0.02
Fertiliser Rate (F)	3	0.002**	6.98	1.88	5.58**	175683.8	212.50*	209.94	5.98**
V x F interaction	3	0.000	0.09*	0.12**	0.01	15425.8	273.50**	1.11*	0.53**
Error	12	0.000	0.07	0.02	0.04	684.4	46.08	1.19	0.02
Total	23								
CV (%)		0.89	3.99	4.36	2.84	2.39	4.28	3.59	2.39

Appendix 20: Mean squares from the analysis of variance on effect of fertiliser types on fruit yield and yield components of two of two cultivars of pepper in Ogbomoso

Types	DF	1000 seed weight	Average fruit weight	Fruit girth	Fruit Length	Fruit weight/plant	No. of Fruit/plant	No. of seeds/Fruit	Fruit yield
Replicate	2	0.00	0.02	0.20	0.00	4395.2	486.50	60.67	0.79
Variety (V)	1	0.00**	0.17	1.87	9.40	145095.5**	40.04	88.17**	11.62
Error	2	0.00	0.08	0.20	0.10	723.9	12.67	0.17	1.31
Fertiliser Rate (F)	3	0.00**	6.84**	3.10**	10.67**	175554.6**	172.71**	79.89**	13.04**
V x F interaction	3	0.00	0.06	0.28	0.57	15357.2**	8.71	0.28	0.11
Error	12	0.00	0.10	0.13	0.67	705.1	15.25	1.58	0.16
Total	23								
CV (%)		1.32	4.91	7.11	7.62	2.39	13.96	4.08	5.25