EVALUATION OF THE EFFECTS OF DATE PALM WASTE COMPOST AND NPK FERTILIZER ON PHYSIOLOGY AND GROWTH PERFORMANCE OF TWOIMPROVED *Phoenix dactylifera* VARIETIES IN JIGAWA STATE SUDAN SAVANNA, NIGERIA

BY

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CERTIFICATION

This is to certify that the research work for this Dissertation and subsequent write up by Mu'awiyya Yakubu with registration number (SPS/15/MPB/00013) were carried out under my supervision

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APPROVAL PAGE

This Dissertation has been examined and approved for the award of Masters Degree of Science in Botany

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DECLARATION

I hereby declare that this work is the product of my research effort undertaken under the supervision of Dr. Muhammad Hayatu and has not been presented elsewhere for the award of a degree or certificate. All sources have been duly acknowledged.

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DEDICATION

This research work is dedicated to my parents Alh. Yakubu Garba Dogo Chamo, Malama Binta Musa, my lovely wife Fatima Hussain Ishaq and Sons (Mahmud and Muhsin) who have been quite supportive to ensure successful completion of the programme.

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ABSTRACT

Date palm (*Phoenix dactylifera* L.) is afruit tree resilient to adverse climatic conditions predominating in hot arid regions of the Middle East and North Africa. The fruit contains numerous chemical components of high nutritional and medicinal values. The experiment was conducted at the Botanic garden of Bayero University Kano to evaluate the effects of date palm waste compost and NPK on physiology and growth of datepalm seedlings. The experiment comprised of nine treatments, three varieties of date palm with three replications arranged in Completely Randomized Design (CRD) that includes two levels of NPK fertilizer (5g and 10g), two levels of compost manure (50g and 100g), four levels of their combination (5g NPK+50g Compost, 5g NPK+100gCompost, 10g NPK+50g Compost and 10gNPK+100g Compost) and the control. The resultsshowed that there was significant increase in chlorophyll (105.96), Photosynthetically Active Radiation (335.67), Plant Height (79.42), Stem Girth (21.81), Number of Leaves (14.37) and Leaf Area (595.01) after 180 days of application of NPK and compost manure at 10 and 100 grams respectively.Similarly, the interaction between the varieties and the treatments showed that Deglet at 10 and 100 grams of combinations had significant response with respect to Plant Height and Chlorophyll contents. However, Substation material showed similar response on Stem Girth, Number of Leaves and Leaf area. Tirgal variety also had higher significant interaction on Photosynthetically Active Radiation only. Conclusively, it was found from the study that Compost only at 100 grams enhances Date palm seedlings growth and physiological performance. Meanwhile, NPK only also resulted in significant response with respect to stem girth and similar effects was observed on Chlorophyll. However, combinations of NPK and compost manure may be needed to improve seedlings physiology and growth. It is recommended that these waste compost could replace chemical fertilizer with satisfactory results.

CHAPTER ONE

1.0 INTRODUCTION

Date palm *(Phoenix dactylifera*. L) is a perennial long-living monocot plant of great socio-economic importance especially in North Africa and the Middle East (Gray *et al*., 1997). It belongs to the *Arecaceae* family with the chromosome number 2*n*=36. (Al-Ani *et al.*, 2010).

Date is cultivated in arid zones for food, fibre, and shelter. It is probably the most ancient cultivated tree crop in the world (Zaid and de Wet, 2002). The scientific name *Phoenix dactylifera* was derived from '*Phoenix'*, the legendary bird of old Greece, and '*dactylos'* meaning 'finger' taking into account the shape of the fruit (Bouguedoura *et al.*, 2015).

Date palm is a dioeciously species where the male and female reproductive organs are borne by separate trees. It is the tallest tree among all the *Phoenix* species and the non-branching trunk can grow, under some conditions, higher than 30m. The plant has one terminal shoot apex that ensures the growth lengthwise. The root system of a date palm is highly developed. The leaves are large 4–5 m, long 4–8 m, alternates, pinnate, ground upward in a spiral pattern on the trunk and sheathing in dense terminal rosettes or crown of 100–120 leaves. (Jehad *et al.*, 2015). The end of the leaves is needle sharp, which seems to be an adaptation to protect the growth tip from grazing animals. Each leaf has an auxiliary bud that may be vegetative, floral or intermediate (Bouguedoura *et al*., 2015). Auxiliary buds can form other shoots commonly called offshoots or suckers during the juvenile life of the date palm and can carry inflorescences to maturity. The fruiting apparel emerges from auxiliary buds as clusters at the top of the tree among the terminal rosettes.

Male and female flowers are issued on separate trees taking into account the dioeciously character of the species. Flowers are small and white on a richly branched spadix surrounded by a solitary, large spathe. The calyxes are cup-shaped, three-toothed while the petals are three-toothed, twice longer than the calyx in female flowers. The ovaries are three in general, but only one can develop into a fruit. The stamens are six with linear dorsi-fixed anthers. Pollination is generally wind borne and artificial pollination of pistillate trees by placing cut portions of the male flower spikes on the receptive female inflorescence is, nevertheless, usually practiced and recommended to ensure high productivity. A fully productive date palm tree can support up to 10 clusters, which can carry more than 100 kg of fruits. Single fruit date or dabino in Hausa is usually cylindrical, occasionally rounded or ovoid, a drupe single seeded of 2.5–7.5 cm long × 4 cm large with fleshy, sugary pericarp, yellowish to reddish brown

(Zohary and Hopf, 2000).

Though Nigeria is not ranked among the major Date producing countries in the world, yet the crop strives in Northern part of the country particularly regions above latitude 10^0 North of the equator (Okolo *et al*., 2000). The crop is cultivated within the natural spontaneous groove and as a homestead crop in most of the Sudan-Sahel region of Nigeria (Kano, Jigawa, Katsina, Kaduna, Sokoto, Kebbi, Zamfara and some part of Northeast and central) Aisueni, *et al.,* (2009). It is a plant with no tap root but fibrous root system, the trunk is vertical and columnar of the same girth all the way up. The girth does not increase once the canopy of fronds has fully developed except the terminal bud (Abdulqadir *et al.,* 2011). The tree vertical growth is ensured by its terminal bud called phyllopod and its height could reach 20m (Zaid and de Wet, 2002). The trunk and leaves are similar to those of Oil palm.

The fronds (Leaves) has average length of 4 metres carry the spines and the leaflets. The fruit is single, oblong, one seeded berry with terminal stigma, a flesh pericarp and a membranous endocarp. (Abdulqadir *et al.*, 2011)

The word compost refers to plant matter that has been decomposed and recycled for use as a fertilizer or manure also called bio compost. It is considered as a key ingredient in organic farming for being full of nutrients required for the growth and development of plants. Bio-compost is applied in numerous ways mainly in gardens, landscaping, horticulture and agriculture (Alkoaik *et al*., 2011). Simply the bio-composting is done by piling up wastes in the garden or any outdoor place and then has to be left undisturbed for quite some time. Bio-compost has proved to be useful for controlling soil erosion, its efficiency in wetland construction and as landfill cover is undoubtedly remarkable. (Gandahi and Hanafi, 2014).

Composting of plant materials depends on the metabolic activities of a wide variety of microorganisms which during the process microorganisms generate substantial heat. The heat from this biological fire can cause dramatic temperature increase in the composting materials. It also degrades a portion of the fibre in wastes, and mixing and shredding break down of the physical structure.

These processes produce compost that is both chemically and physically homogeneous, which is an important quality in the horticultural industry. In the process toxic chemicals such as pesticides or fertilizers are not added, instead, they are based on the development of biological diversity and the maintenance and replenishment of soil fertility. The systems are based on specific and precise standards of production which aim at achieving agro-ecosystems which are socially and ecologically sustainable. (Gray *et al.*, 1997).

1.1 PROBLEM STATEMENT:

Date palm waste are very rarely utilized and in addition are discarded or burnt in the plantations, despite the fact that they contain some essential nutrients which if composted could help in the growth and development of date seedlings in the nursery (Aisueni *et al.*, 2009).

The availability and affordability of chemical fertilizers to the average farmers is less than optimal, hence the need to source for locally available compostable organic materials

Date palm seedlings experience stunted growth and physiological shocks when treated with chemical fertilizers, that is why most nurseries prefer compost or farm yard manure to raise their seedlings. Therefore, composts manure could serve as alternative and or substitute of inorganic fertilizer as they are purely of plants origin (Hamdan *et al.*, 1998)

1.2 JUSTIFICATION

The loss of nutrient through surface erosion and runoff has resulted in the use of fertilizer (organic/inorganic) in supplementing poor indigenous soil nutrient supply in date palm cultivation. Organic farming is one of the fastest growing sectors of agriculture worldwide. The regulation of nutrient regime in organic farming is achieved through balanced crop rotations and application of organic fertilizers such as compost, green manure and animal wastes. In the date palm plantation, nutrients removed in the harvested crop are replaced by recycling crop residues such as empty fruit bunches (EFB). Composting is the most attractive on account of its environmental impacts and cost as well as its capacity for generating valuable products used for increasing soil fertility or as a growing medium in horticulture (Alkoik *et al.*, 2011). However, composting is of utmost importance and can be used for fertilization of date palm seedlings and are often proposed as alternate to commercial mineral fertilizer (Hamdan *et al.*, 1998, Akanbi *et al.*, 2007). The study is therefore aimed at evaluating the effects of compost that is chemically and physically homogeneous which is an important quality in the horticultural industry. Recycling of waste material by converting it to soil enriching product is useful in maintaining the structure and fertility of agricultural soil and at the same time leading to a cleaner environment (Berwick, 1990).

1.3 AIM OF THE STUDY

To evaluate the effectiveness of composted date palm waste, NPK fertilizer and the combinations on physiology and growth parameters of some Date palm seedlings.

1.4 OBJECTIVES OF THE STUDY

The study has the following objectives;

1- To determine of the effects of Date Palm Waste Compost on physiological and growth parameters of Date Palm seedlings
2- To determine of effects of Nitrogen Phosphorus Potassium (NPK) fertilizer on physiology and vegetative growth of Date Palm seedlings
3- To evaluate of the combined effects of Compost and NPK fertilizer on physiology and vegetative growth performance of Date palm seedlings

1.5 HYPOTHESES:

1- Composted date palm waste does not significantly increase growth parameters of date palm seedlings.

2- NPK fertilizer does not significantly affect growth and physiology of Date Palm seedlings.

3- Combination of NPK and compost does not significantly affect the growth and physiology of Date Palm seedlings.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 ORIGIN AND DISTRIBUTION OF DATE PALM

Dates have been a staple food of the Middle East and the Indus Valley for thousands of years. They are believed to have originated around Iraq, and have been cultivated since ancient times from Mesopotamia to prehistoric Egypt, possibly as early as 4000 BCE. The Ancient Egyptians used the fruits to make date wine, and eat them at harvest (Zohary and Hopf, 2000).

There is also archeological evidence of date cultivation in Mehrgarh around 7000 BCE, a Neolithic civilization in what is now western Pakistan. Evidence of cultivation is continually found throughout later civilizations in the Indus Valley, including the Harappan period 2600 to 1900 BCE, in later times, traders spread dates around South West Asia, northern Africa, and Spain. They can be easily grown from seed, but only 50 percent of seedlings will be female and hence fruit bearing, and Dates from seedling plants are often smaller and of poorer quality. Most commercial plantations thus use offshoots of heavily cropping cultivars. (Zaid and De wet, 2002).

Dates are naturally wind pollinated but in both traditional oasis horticulture and in the modern commercial orchards they are entirely pollinated manually. Natural pollination occurs with about an equal number of male and female plants. However, with assistance, one male can pollinate up to 100 females. Since the males are of value only as pollinators or for landscaping, wind break and beautifications of the environments. This allows the growers to use their resources for many more fruit producing female plants. Some growers do not even maintain any male plants as male flowers become available at local markets at pollination time. Manual pollination is done by skilled labourers on ladders.

Dates are an important traditional crop in Iraq, Arabia, and north Africa west to Morocco. The crop was mentioned more than 50 times in the Bible and 20 times in the Holy Qur'an. In Islamic culture, Date fruits and yoghurt or milk are traditionally the first foods consumed for Iftar after the sun has set during Ramadhan. Dates (especially Medjool and Deglet Noor) are also cultivated in America in southern California, Arizona and southern Florida in the United States and in Sonora and Baja California in Mexico. (El-Hadrami and El-Hadrami, 2009)

2.2 SYSTEMATIC CLASSIFICATION

Date palm belongs to the family, Arecaceae. It is a family of about 200 genera and 1500 species (FAO, 2002)

According to (Dransfield and Uhl, 1996, USDA, 2017). Date palm were classified as follows

Date palm Systematic Classification

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Liliopsida
Subclass	Arecidae
Order	Arecales
Family	Arecaceae
Sub-family	Coryphyoideae
Tribe	Phoeniceae
Genus	*Phoenix*
Species	*dactylifera*

USDA, 2017

2.3 BOTANICAL DESCRIPTION

Phoenix dactylifera L., date palm, is among the most important species in the Palm family (*Arecaceae*), which encompasses about 200 genera and more than 2,500 species (El Hadrami and El Hadrami, 2009) and includes *P. canariensis* (Canary Islands date palm), *P. reclinata* (Senegal date palm) and *P. sylvestris* (Indian sugar palm). The species name was inspired by the finger like shape of the fruit and the genus from the legendary bird of Ancient Greece. It is a long-lived monocotyledonous species and one of the tallest domesticated trees.

This perennial and dioecious species represents a cornerstone of the economy in many producing countries, especially in North Africa and the Middle East. Over 100 million trees are currently grown worldwide on an estimated area of 1 million ha. Date palm provides fruit, fuel, fiber and shade for other essential cover crops. The annual world production of dates has reached 6-8 million mt, representing a market exchange value of over 1 billion United State Dollars. The top three producing countries are Egypt, Iran and Saudi Arabia; the largest importer of dates is India (El Hadrami and El Hadrami, 2009; El Hadrami *et al.*, 2011).

The Date palm is an impressive feather palm and may therefore be immediately distinguished from all fan palms. It has 4-6m pinnate leaves called fronds with distinct conical mid-rib which tapers along the length of the frond. The trunk is vertical and columnar having almost the same girth (100-150cm) all the way up. It is covered with base of pruned leaves; in time these bases wither away making the trunk smoother. Being a monocot the tree has adventitious roots of roughly uniform thickness along their length (Robinson and Williams, 2012).

The independent male and female inflorescence are enveloped in spathe, which arise the axil of leaves whorls and the males are wider than the female. Male spathes enclose 10,000-15,000 flowers against 2000-3000 in female spathe. Male flowers are sweet scented and densely arrange on strands of the inflorescence with three sepals, three distinct petals and six stamens. Female flowers are bead like structures individually spaced on the inflorescence. Each flower has distinct sepals and petals. There are three carpels with a hook like stigma. Only one of these develops into a fruit and the other two usually abort during development. (FAO, 2002)

2.4 CULTIVARS OF DATE PALM

Barhi

The fruit is nearly round, light amber to dark brown in color, soft with thick flesh and rich flavor. Picked when yellow, this semi-sweet date is crisp like an apple. It is somewhat tolerant of rain and high humidity, and yields up to 10-13 bunches per palm (Robinson and Williams, 2012)

Dayri

Is a variety from Iraq, its fruit is long, slender, dark reddish to nearly black and soft. These trees require special care. This tree grows well in heavy soils with ample irrigation. It can yield from 12-15 bunches per tree (Jehad *et al.*, 2015)

Deglet Noor

Deglet Noor is a semi-dry date from Algeria. It has a delicate flavor, not overly sweet, with a firm-texture. The color is light red to amber or straw. It is not tolerant of rain or high humidity. This tree should be planted in sandy soils, as it does not adapt well to heavy soils (Tomlinson, 1990)

Halawy (Halawi)

Is a small to medium sized date from Iraq. It has a soft, thick flesh, and an extremely sweet caramel taste. The dates are yellow, and ripen to a light amber or golden brown. This date palm is tolerant of higher humidity and occasional rains (Sakr *et al.*, 2010)

Hayany (Hayani)

The dark-red to nearly black soft dates are sold fresh. This is one of the coldest hardy of the date palms (FAO, 2002)

Khadrawy (Kadrawi)

Is an import from Iraq and Saudi Arabia, this is the smallest edible Date fruits, it has a soft caramel-like texture and sweet flavor. However, because of its dark color, it is not popular here. This palm is tolerant of rain and humidity (Robinson and Williams, 2012)

Medjool

It is a large, soft, sweet date producing the uniform extra-large dates it is usually heavily thinned by cutting out a large percentage of the center strands (Zaid and De- Wet, 2002)

Theory (Thuri)

Is called the Bread Date when cured, it is brown-red with very wrinkled skin. The flesh can be hard and brittle with a good, sweet nutty flavor. It keeps well and is used for food when traveling across deserts. This palm tree is stout with short, stiff leaves. It has very large clusters that bear heavy yields (Isyaku *et al.*, 2010)

Zahdi (Zahidi)

Is the oldest known cultivar, and is widely used in the Middle East. It is a medium size date that is light golden-brown, semi-dry, and very sugary. It keeps well for months and is used in cooking. It has a very large seed and a crunchy, fibrous flesh. The palm is stout and fast growing. It is drought resistant and a heavy bearer of fruits. (Tomlinson, 1990)

2.5 DATE PALM WASTE

According to Safwat, (2007) date palm wastes are parts of date tree removed as a result of agricultural maintenance in the plantation. They include long twigs that contain the fronds, leaflets, thorns/spines, fibres harvested during annual pruning, trunks, spoiled or unviable seeds, inflorescence, spathes, offshoots, spikelet, empty fruit bunches, bunch stalks, petiole, midribs and spoiled fruits and seeds etc. Although these agricultural wastes consist of cellulose, hemicellulose, lignin and other compounds which could be used in many biological processes, they were burn in farms causing serious threats to environment (Khiyami *et al.*, 2008). Generally, date palm residues as agricultural wastes are very rarely utilized and considered as a source of environmental pollution. The utilization of these wastes in the production of compost is very important from the environmental, agricultural and industrial point of view (Alkoaik *et al.*, 2011)

2.6 COMPOSTING

Composting is a biological process in which biodegradable organic wastes are stabilized and converted by the action of microorganism under controlled condition into hygienic humus-rich product (compost) for use as a soil conditioner and as organic fertilizer.

Currently, bio-composting process refers to monitoring of the compost as commonly practiced, it is usually done by shredding the plant matter, addition of adequate water to maintain the required level of moisture and then to provide better aeration, the mixture is turned on regular basis. It is worth to mention that the process of decomposition is enhanced when worms and fungi added to the mixture. (Safwat, 2007), these processes produce compost that is both chemically and physically homogeneous, which is an important quality in the horticultural industry.

The complex compounds are broken into simpler ones and consequently greater amounts of heat, carbon dioxide and ammonium are produced. Later on, microbes utilize this ammonium available to the plants in the form of nitrites and nitrates. (Abdelhamid *et al.*, 2004). The worms and other microbes require $N0_3$ carbon (C) for energy resultantly heat is released when the microbes oxidized this C. The materials that carry higher quantity of C appear to be brown and dry. For the growth and the reproduction of more organisms' nitrogen (N) is essential so that C could be oxidized. Those materials which appear to be green and wet have higher N. Availability of water in sufficient amount is required so as to maintain the moisture level and to prevent the anaerobic condition. Water also helps in reducing heat generated by the microbes during the process of oxidation of C. Bio-composting is, therefore, considered to be an efficient and easier way for the decomposition of organic wastes that yield into useful manure or fertilizer. Moreover, it is a very cost effective process. Bio-compost supplied for meeting the nutrient needs of crops, liberates growth promoting substances and vitamins, help to maintain soil fertility, increases crop yield by 10–20 %, cheaper and based on renewable energy sources, improves soil physical, chemical, biological properties, tilth and soil health in general, supply various macro and micro nutrients, provides organic matter in significant quantity and beneficial microorganisms to the soil and play prominent roles in bioremediation of wastes and contaminants. (Abdelhamid *et al.*, 2004).

Composting is one of the biological processes that have proven to be among suitable ways of converting organic wastes into products responsible for the growth and development of plants.

Transformation of various organic wastes into beneficial products through composting is viable and hazard free, more appropriately it yields into products that can successfully be used as bio-fertilizers so as to retain fertility and other condition related matters. Composting resolves a number of issues related to the utilization of agricultural wastes meant for soil amendments, bad odors, human pathogens and unnecessary physico chemical characteristics.

Mineralization takes place and unavailable plant nutrients are converted to available forms. Through the composting process, disease infestation is minimized and pathogens are destroyed, as pressed partial sterilization is done. Pollutants are detoxified and bad odors are abated (Parr and Hornick, 1992). The growth and activity of mixed populations of bacteria is the major component on which composting, as a microbiological process depends. Simultaneously, fungi as well as active bacteria, which are native to the wastes, are also composted. Rising unease concerning land degradation, menace to ecosystems from over and improper synthetic fertilizers, atmospheric contamination, soil health, soil biodiversity and hygiene have fascinated the worldwide attention to organically reuse practice like composting (Abdelhamid *et al*., 2004).

Nowadays a large amount of organic waste is produced as a by-product by human activities, which has impact on the environment and has the ability to cause danger for animal and human health. Managing this huge quantity of wastes is important to protect the environment and reduce the amount of these wastes. As reported by many researchers composting is an efficient alternative way to reduce the residue of organic wastes (Alburquerque *et al.*, 2006, Baharuddin *et al.*, 2009).

Composting is a biological process used to speed up the decomposition process under controlled conditions. This process converts organic wastes to a much stable product which is free of phytotoxicity and pathogens. Compost is used safely and beneficially as organic fertilizer and soil conditioner (Arslan *et al*., 2008; Bustamante *et al.*, 2008; Bernal *et al.*, 2009). The use of compost as fertilizer improves soil structure, water-holding capacity of the soil as well as improving the aeration. Compost could also provide humus or organic matter, vitamins, hormones, and plant enzymes that are not incorporated by synthetic fertilizers. The amount of C: N ratio of soil is reduced by compost and it also perform as buffer to adjust soil pH. Composting also kills pathogenic organisms, weeds and other unwanted seeds. Fully established compost rapidly comes into symmetry with the soil. It has the ability to be blended or mixed with different materials which increases the nutrient content of the compost fertilizers (Campitelli and Ceppi, 2008; De Guardia *et al.,* 2012). With technology innovation and research investigations, agricultural waste is no longer an environmental concern, on the other hand, it has become a source for energy production.

A remarkable potential in improving the common status of sanitation, constructive environmental measures to lessen greenhouse gas emissions, considerably enhanced the crop production, soil fertility, decreased the universal reliance on synthetic fertilizers, fossil fuel, etc.

2.7 ECOLOGICAL REQUIREMENT

Climatic elements such as rainfall, temperature, light, humidity and wind are the most important factors which determine the suitability of a specific site for growing date palm.

The cultivation of date palm requires high temperature, much sunlight, low humidity, low rainfall and absence of high winds. Date tolerates quite low temperatures, but ceases growth activity below 10^oC. They are very resistant to heat and may tolerate temperature up to 58^oC for a short while. (Zaid and De wet, 2002)

2.8 ECONOMIC IMPORTANCE

Date fruits are a high energy staple food widely consumed in the growing regions in Nigeria. The fruits can also be processed into different products like jam, syrup, confectioneries, non alcoholic fruit juice, wines and organic acids. Dates are very nutritious, assimilative and energy producing fruits (Elleuch *et al.*, 2008). Dates are reported to contain at least 15 essential minerals, including phosphorus, potassium, sodium, zinc, manganese, magnesium, copper, iron, fluorine and selenium (Al-Shahib and Marshall, 2003). With the present uncertainties in the world food supply and the expected increase in demand, the date fruit could be a good source of food of high nutritional value. In fact, the fruit is rich nutrients and due to its dietetic values, it has always been held in high esteem by people.

Dates contain about 3000 calories of energy per kilogram against other foods (apricot 520cal/kg, banana 970cal/kg, orange 480cal/kg, cooked rice 1800cal/kg, wheat bread 2,295cal/kg, meat without fat 2245cal/kg etc.) furthermore, the date consists of carbohydrate (mostly sugars) 70%, making it one of the most nourishing natural foods available to humankind. In most varieties the sugar content is almost entirely in inverted form (glucose and fructose) which even a diabetic patient can take because the inverted sugar when consumed are directly and immediately absorbed by the human body without been subjected to the digestion process which ordinary sugar undergoes. (FAO, 2002).

The flesh contains 60-65% sugar, 2.5% fibre, 2.0% protein and less than 2% each of fat, minerals and pectin substances. They are also good sources of iron, potassium and calcium with a very low sodium and fat content, moderate quantities of chlorine, phosphorus, copper, magnesium, silicon and sulphur etc. (FAO, 2002)

2.9 USES

Date palms produce many products that are useful to humans. The primary product is the date fruit, which can be eaten fresh, dried and in various processed forms. In North Africa and the Middle East, some dates are harvested and consumed during the Khalal stage, when the fruit are still very astringent with a high tannin content (Glasner *et al.,* 2002, Kader, 1992). However, most dates are harvested during the fully ripened Rutab and Tamar stages, when they are high in sugar and low in moisture and tannin.

Through the centuries, the use of palm products in the date producing areas was diffused in all sectors of the economy from agriculture, transport and construction to domestic use and reaching out also into urban centers on occasion.

The production of these palm products equally became more important than the date crop itself. The internal section of the trunk or stem can be pulverized and turned into coarse flour for human consumption in the time of food scarcity. It is also used as rafters, lintel, poles girders pillars, jetties and light foot bridges. When the trunk is sawn into coarse planks they are made up by sticking them into the group and holding them together with whole leaves may be laid across the ceiling beams in a thick bending upon which a layer of mud is spread to form the first floor or roof cover. Whole palm leaves have a special meaning in Jewish and Christian religious festivals. Mid-rib makes effective building boards of about 50 by 200cm and are used as partitioning or roofing, fibre source for rope making, light wood charcoal, the leaf bases were used by fishermen to floats their nets and by the same principles helps children to learn to swim, leaflet mainly used in making baskets, mats, fans, hats, broom and sacks (FAO, 2002)

2.10 DATE PALM WASTE AS A RAW MATERIAL FOR COMPOST

The biomass produced by date palm includes the following; leaves/fronds, fruit clusters, inflorescence, trunks, pruned thorns and leaves, spoiled seeds and fruits, fibres etc. It was revealed from the recent literature that these waste contain some constituents of nutrients as analysed by Aisueni *et al.*, 2009. (See Appendix 1.) which when composted would be desirable and substitute the use of chemical fertilizer especially at Nursery stage.

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 STUDY AREA

The experiment was carried out at the Botanic Garden of the Department of Plant Biology, Bayero University Kano which lies on latitude $11^{o}58$N and longitude $8^{o}30$E with altitude of 44m above the sea level old campus in the Sudan Savannah ecological zone of Nigeria.

3.2 SEEDS COLLECTION

Two improved varieties (Deglet and Substation Material) of date palm were obtained from the Nigerian Institute for Oil Palm Research (NIFOR) Date palm substation, along Kiyawa Road Dutse and the local variety (Tirgal) from Shuwarin market along Maiduguri expressway, Kiyawa LGA Jigawa state.

3.3 SOIL SOURCING

The top soil (sandy loam) used for the experiment was sourced from Dutse town Jigawa state. The pots were filled to 3 quarters and weighed to 7 kilograms each using electronic weighing balance in the laboratory

3.4 PREPARATION OF COMPOST

Date palm waste was chopped into smaller pieces of less than 5cm, weighed and packed in composting cells of the Date Palm Substation, Dutse. The components were mixed with poultry manure at a ratio of 4:1 as source of nitrogen (Alkoaik *et al.,* 2015), turning and moistening of the heap was carried out weekly by transferring to another cell for the period of 12 weeks. The decomposed compost was then sieved to remove larger and non biodegradable materials using 2mm sieve. (Oviasogie *et al.,* 2013).

3.5 TREATMENTS AND EXPERIMENTAL DESIGN

The experiment consists of nine treatments and three varieties of date palm with three replications (9x3x3) making a total of 81 Pots arranged in Completely Randomized Design (CRD) that includes two level of NPK fertilizer (5g and 10g), two level of compost manure (50g and 100g), four level of their combination (5g N+50g C, 5g N+100gC, 10g N+50g C and 10gN+100g C) and control.

Management practices like weeding of internal rows and within the polybags and watering were carried out twice a day (early morning and late evening) for the period of six months

3.6 COMPOST SAMPLING AND ANALYSIS

Two hundred grams of compost was sampled for physical and chemical analysis. Compost properties such as pH, Moisture contents, Nitrogen, Phosphorus, Potassium, Magnesium, Electric Conductivity, Carbon: Nitrogen ratio of the compost manure were determined. The analysis was carried out in the Soil Science Laboratory of the Department of Soil Science, Bayero University, Kano. Following the standard procedure described by AOAC, (1995).

3.6.1 pH

The pH was determined using pH meter. The compost solution was prepared by adding distilled water in 1:10 ratio and the maximum salts were placed for 2 hours. The pH meter electrode was dipped in the compost solution and the readings was noted on the pH display when it was stabilized. The electrode was then washed with distilled water and clean with tissue paper. According to the procedure adopted by Monedero, *et al.*, (2001).

3.6.2 Moisture Contents

Moisture content was determined by drying moistened Date Palm Compost samples at 105°C for approximately 24 hours. Volatile solids were measured by combustion at 550°C in a muffle furnace for 8 hours (USCC, 2002) (United State Compost Committee)

3.6.3 Electric Conductivity

Electric conductivity determination of Date Palm waste compost. The solution of compost was prepared by adding distilled water at a ratio 1:5. The conductance cell was washed with distilled water and dipped into the solution, the readings was noted on EC meter display AOAC, (1995)

3.6.4 Carbon: Nitrogen Ratio (C: N)

Carbon to Nitrogen was determined in the laboratory. 0.5g of compost sample was collected and transferred in digestion tube. 1g of digestion mixture was added in the compost sample, then 10-12ml of sulphuric acid was also added. The digestion tube was placed in digestion block and heated for 2 hours at 400^{o}C. The contents changed colour from black to light green and the digested tube was allowed to cool down. (USSC, 2002)

3.6.5 Total nitrogen

The available Nitrogen was determined according to Micro Kjedahl Method. Fifty grams of compost sample was weighed into 500 ml kjeldahl flask and 1g of $CUSO_4$, 10g K_2SO_4 and 30ml of conc. H_2SO_4 were added, shaken and allowing to stand for 30 minutes with frequent shaking until complete solution was obtained digested until greenish colour appeared. A blank with the same quantities of reagent was set as the reagents sometimes contain impurities and the blank value was subtracted from the value of the soil digest.

Digestion was effected on the Kjeldahl digestion rack with low flame for the first 10 – 30 min until the frothing stops and gradually more strongly until the sample was completely charred. The heat was gradually raised until the acid reached approximately one third the way up the digestion flask. The flame was not allowed to touch the flask above the part occurred by the liquid. The contents were then cooled and diluted to 100 mL with distilled water. The flask was swirled for 2 minutes and transferred the fluid part to a 1000 mL distillation flask. The residues left in the Kjeldahl flask with 4 or 5 lots of 50 – 60 mL distilled water were washed and a few glass bead was added to prevent bumping. The flask with two neck joints was fitted to one neck dropping funnel was connected for adding 40 % NaOH while to the other neck Kjeldahl trap, which was used to trap the NaOH coming with the distillate. The trap was connected to the condenser with a delivery tube which dipped into 50 mL of 0.1 N HCl contained in a conical flask, with one or two drops of methyl red indicator. About 125 mL (or 100 ml if bumping is a problem) of 40 % NaOH solution was added until the contents were alkaline in reaction (about 5 times the volume of Con. H_2SO_4 used during the digestion). The ammonia formed to be absorbed in standard HCl were allowed. Washed down the end of the tube. 150 mL distilled water was added to the conical flask. When no more ammonia was received (test with a red litmus paper turning blue) stopped the distillation. The excess of the acid with 0.1 N NaOH solution were titrated until the pink colour changed to yellow. From the titre value the multi equivalence of the acid participating in the process of ammonia absorbing during digestion were calculated (AOAC, 1995)

3.6.6 Phosphorus

One gram of air dried compost was weighed (0.15mm) for ignited compost into a porcelain crucible.

The Porcelain crucible was placed in a cool muffle furnace, and the temperature was slowly raised to 55^0C over a period of 1 to 2 hours. The temperature was maintained at 55^0C for 1 hour, and the crucible were allowed to cool, and the ignited compost was transferred to 100ml polypropylene centrifuge tube. 1g air dried compost was weighed in a separate 100ml polypropylene centrifuge tube for unignited soil (0.15mm). 50 ml of 1N H_2SO_4 was added to both samples (ignited and unignited) and the tubes were placed on a shaker for 16 hours and the samples were centrifuged at 1500rpm for 15 minutes. 2 ml of clear filtrate was pipetted into 50ml flask, also 5 drops of 0.25% p-nitro phenol solution was added and neutralizes with 5N NaOH (Yellow). About 40ml was diluted with deionized water and 8ml of reagent B was also added, mixed well and made up the volume. Standard curve was prepared were 2 ml of each standard (2-10ppm) was pipetted and processed as for the samples. A blank with 2ml 1N H_2SO_4 solution was made and processed as the samples. The absorbance of blank was read standards and samples after 15 minutes on the spectrophotometer at 882-nm wavelength. Calibration curve for standards was prepared and absorbance was plotted against the respective p concentrations. The p concentrations in the unknown samples from the calibration curve was read (AOAC, 1995).

3.6.7 Exchangeable Bases

Extraction:

Two grams of air-dried fine compost (<2mm) was transferred into 50ml centrifuge tubes, two blanks were included and the sample weight was registered (resolution 0.001g)**.** 20 ml of 1M NH_4OAC was added and the screw cap was fastened and the tubes in the rotor shaker and extracts were placed for 2 hours

The samples were centrifuged for 10 minutes at 6000g or higher, the samples were cleared after centrifugation. The supernatant was transferred into 15 ml sampling tubes and samples for Ca, Mg, Na, and K were analyzed by ICP-OES. Standards and instrument blanks were prepared in 1 M NH_4OAc (AOAC, 1995).

3.7 SOIL SAMPLING AND ANALYSIS

Soil sample was collected and analysed at the Department of Soil Science Laboratory BUK for the test of Physico-chemical properties of the experimental soil such as pH, electric conductivity, organic carbon, total nitrogen, phosphorus, exchangeable acidity, exchangeable bases (Ca, Mg, K and Na), effective cation exchange capacity, textural class (sand, silt, clay etc.) AOAC, (1995)

3.7.1 Soil pH.

The Soil pH was determined using pH meter, the meter was calibrated using pH 7 buffer solution and adjusted with a known solution 4.0. Twenty grams of soil was weighed and transferred into 100ml beaker, 40ml distilled water was added and stirred with a glass rod and allowed to stand for 30 minutes with intermittent stirring. The electrode was immersed in the Soil:Water suspension and the pH values were determined from the automatic display (Eckert and Sims, 2011)

3.7.2 Total Nitrogen (Kjeldahl Method)

The available Nitrogen was determined according to Micro Kjedahl Method. Fifty grams of soil sample was weighed into 500 ml kjeldahl flask and 1g of $CUSO_4$, 10g K_2SO_4 and 30ml of conc. H_2SO_4 were added, shaken and allowing to stand for 30 minutes with frequent shaking until complete solution was obtained digested until greenish colour appeared. A blank with the same quantities of reagent was set as the reagents sometimes contain impurities and the blank value was subtracted from the value of the soil digest. Digestion was effected on the Kjeldahl digestion rack with low flame for the first 10 – 30 min until the frothing stops and gradually more strongly until the sample was completely charred.

The heat was gradually raised until the acid reached approximately one third the way up the digestion flask. The flame was not allowed to touch the flask above the part occurred by the liquid. The contents were then cooled and diluted to 100 mL with distilled water. The flask was swirled for 2 minutes and transferred the fluid part to a 1000 mL distillation flask. The residue left in the Kjeldahl flask with 4 or 5 lots of 50 – 60 mL distilled water were washed and a few glass bead was added to prevent bumping. The flask with two neck joints was fitted to one neck dropping funnel was connected for adding 40 % NaOH while to the other neck Kjeldahl trap, which was used to trap the NaOH coming with the distillate. The trap was connected to the condenser with a delivery tube which dipped into 50 mL of 0.1 N HCl contained in a conical flask, with one or two drops of methyl red indicator.

About 125 mL (or 100 ml if bumping is a problem) of 40 % NaOH solution was added until the contents were alkaline in reaction (about 5 times the volume of Con. H_2SO_4 used during the digestion). The ammonia formed to be absorbed in standard HCl were allowed. Washed down the end of the tube. 150 mL distilled water was added to the conical flask. When no more ammonia was received (test with a red litmus paper turning blue) stopped the distillation. The excess of the acid with 0.1 N NaOH solution were titrated until the pink colour changed to yellow. From the titre value the multi equivalence of the acid participating in the process of ammonia absorbing during digestion were calculated (AOAC, 1995).

3.7.3 Soil Electric Conductivity

Soil:water suspension was prepared at a ratio of 1:5 by weighing 10g air-dried soil (<2mm) into a bottle and 50ml of deionized water was added and mechanically shaken at 15 rpm for 1 hour to dissolve soluble salts. The conductivity meter was calibrated according to the manufacturers instruction using KCl reference solution to obtain the cell constant**.** The cell was then rinsed thoroughly and the electric conductivity of the 0.01M KCl was measured at the same temperatures as the soil suspensions**.** The conductivity cell was first rinsed with the soil suspension before been refilled without disturbing the settled soil. The values indicated on the conductivity meter were recorded and **f**inally, the conductivity cell was rinsed with deionized water between samples (AOAC, 1995).

3.7.4 Soil Organic Carbon (Walkley-Black chromic acid wet oxidation method)

The moisture of the air-dry soil has been grounded to pass 0.42mm sieve was determined and enough quantity of soil sample was accurately weighed containing 10 and 20mg of carbon into a dry tared 250ml conical flask between 0.5g and 1g for topsoil, 2 and 4g for subsoil**.** 10ml of 1N $K_2Cr_2O_7$ was accurately added and the flask was gently swirled to disperse the soil in the solution**,** 20ml of conc. H_2SO_4 was added into the suspension, the flask was immediately swirled until the soil and the reagents were mixed**.** 200^0C thermometer was inserted and heated while the swirling the flask and the contents on a hot plate until the temperature reached 135^0C**.** The suspension was then set aside to cool on an asbestos sheet in fume cupboard, two blanks were run into the same way to standardize $FeS0_4$. 200ml was diluted with deionized water after cooling for 20-30 minutes and processed with the $FeS0_4$ titration using the Ferron indicator or potentiometric with an expanding scale pH/mV meter. AOAC, (1995)

3.7.5 Cation Exchange Capacity (CEC) by Walkley-black oxidation method

The soil sample was grinded to pass through 0.5mm sieve, weighted sample was duplicated and transferred into 250ml Erlenmeyer flask. 10ml of 1N $K_2Cr_20_7$ solution was accurately pipetted into each of the flask and gently swirled to disperse the soil and 20ml conc. H_2SO_4 was added using automatic pipette. The flask was immediately swirled gently until the soil and reagents were mixed and more vigorously for one minute. The flask was then rotated and allowed to stand on a sheet of asbestos for 30 minutes. 100ml of distilled water was then added and stood for 30 minutes (AOAC, 1995).

3.7.6 Soil Phosphorus

One gram of air dried soil was weighed (0.15mm) for ignited soil into a porcelain crucible. The Porcelain crucible was placed in a cool muffle furnace, and the temperature was slowly raised to 55^0C over a period of 1 to 2 hours. The temperature was maintained at 55^0C for 1 hour, and the crucible were allowed to cool, and the ignited soil was transferred to 100ml polypropylene centrifuge tube. 1g air dried soil was weighed in a separate 100ml polypropylene centrifuge tube for unignited soil (0.15mm). 50 ml of 1N H_2SO_4 was added to both samples (ignited and unignited) and the tubes were placed on a shaker for 16 hours and the samples were centrifuged at 1500rpm for 15 minutes. 2 ml of clear filtrate was pipetted into 50ml flask, also 5 drops of 0.25% p-nitro phenol solution was added and neutralizes with 5N NaOH (Yellow). About 40ml was diluted with deionized water and 8ml of reagent B was also added, mixed well and made up the volume. Standard curve was prepared were 2 ml of each standard (2-10ppm) was pipetted and processed as for the samples. A blank with 2ml 1N H_2SO_4 solution was made and processed as the samples. The absorbance of blank was read standards and samples after 15 minutes on the spectrophotometer at 882-nm wavelength. Calibration curve for standards was prepared and absorbance was plotted against the respective p concentrations. The p concentrations in the unknown samples from the calibration curve was read (AOAC, 1995).

3.7.7 Soil Exchangeable Base

Extraction:

Two grams of air-dried fine soil (<2mm) was transferred into 50ml centrifuge tubes, two blanks were included and the sample weight was registered (resolution 0.001g)**.** 20 ml of 1M NH_4OAC was added and the screw cap was fastened and the tubes in the rotor shaker and extracts were placed for 2 hours

The samples were centrifuged for 10 minutes at 6000g or higher, the samples were cleared after centrifugation. The supernatant was transferred into 15 ml sampling tubes and samples for Ca, Mg, Na, and K were analyzed by ICP-OES. Standards and instrument blanks were prepared in 1 M NH_4OAc

3.7.8 Soil Texture Determination

The soil was sifted using a mesh sieve to remove any debris, rocks, and large organic matter (leaves, sticks, roots, etc.). The jar ⅓ was filled with the soil tested and the remainder of the jar was filled with clean water, but left some spaces at the top. One tablespoon of powdered dishwashing detergent was added and the jar was capped and shaken vigorously until the soil turns into a uniform slurry. Then a level surface was set and timed for one minute. A mark outside the jar was placed, showing the coarse sand layer settled at the bottom of the jar and was left in a level spot for 2 hours. The top of the next settled layer was marked with the permanent marker. That was the silt layer later the jar was left on a level spot for 48 hours. The top of the next settled layer was marked with the permanent marker. That was the clay layer that has settled on top of the silt layer. The height of each layer was measured and recorded using a ruler and the total height of all three layers. The soil texture analysis worksheet below was used and recorded the results (AOAC, 1995).

3.8 DATA COLLECTION

3.8.1 PHYSIOLOGICAL PARAMETERS

3.8.1.1 Chlorophyll contents (μmol)

This was measured using chlorophyll meter SPAD model Minolta 502 plus. The measurements of chlorophyll were taken by selecting well expanded and healthy green leaf from each pot and measured. The measurements were taken early in the morning at 30, 60, 90, 120, 150 and 180 days after treatment.

3.8.1.2 Photosynthetically Active Radiation

This was measured using Photosynthesis System Portable LI 6400 Infrared Gas Analyzer (Li COR Bioscience Inc. NE USA).

The measurement was carried out in the morning at (9:00 AM) were broadly expanded leaves were selected and measured at 30, 60, 90, 120, 150 and 180 days after treatment.

3.8.2 GROWTH PARAMETERS

3.8.2.1 Plant Height (cm)

This was determined from each pot using calibrated measuring tape from the ground level (stem base) to the tip of the longest leaf and recorded in centimeter. The measurements were repeated three times and the average was recorded at 30, 60, 90, 120, 150 and 180 days after treatment.

3.8.2.2 Stem girth (mm)

The stem Girth was taken using portable digital caliper by holding three positions i.e. ground level, center and upper side of each of the stem with the mouth part of the caliper, the readings appeared on the screen of the caliper in millimeter, and the average were recorded. The measurements were taken at 30, 60, 90, 120, 150 and 180 days after treatment.

3.8.2.3 Number of Leaves

Number of leaves was obtained by direct counting of the green and healthy leaves on each pot and recorded. The counting was done at 30, 60, 90, 120, 150 and 180 days after treatment application.

3.8.2.4 Leaf Area (cm^2)

The leaf area was measured using digital leaf area meter (L1-3100), repeated and the average means were recorded. The leaf area was taken at 30, 60, 90, 120, 150 and 180 days after treatments.

3.9 Statistical Analysis

Analysis of variance (ANOVA) was performed for all parameters with the statistical analysis system, SAS version 9.2 (SAS Institute, Inc., Cary, NC, USA). Differences between treatments were analysed using Duncan Multiple Range Test (DMRT) at $p<0.05$ probability

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

4.1 Physical and Chemical composition of date palm waste compost in Dutse Jigawa

The results of the analysis of date palm waste compost (Table 4.1) indicated that the prepared compost was rich in essential elements and other physical parameters. Nitrogen, Phosphorus, Potassium, Magnesium was higher in compost when compared with the experimental soil, and recorded the following values (4.20), (766.67), (843.88) and (2.48) respectively. The pH value (7.2) showed that the compost manure was alkaline. Other values obtained were Carbon: Nitrogen ratio (15.07), Electric Conductivity (0.095) and the moisture content was also higher (23.5). All the obtained values are within the desired range (See Appendix 2.)

Table 4.1 Physical and Chemical Composition of Date Palm Waste Compost in Dutse Jigawa State (2017)

S/No	Compost (Elements)	Values
1	N%	4.20
2	P (mg/kg)	766.67
3	K (mg/kg)	843.88
4	C:N	15.07
5	Mg (cmol/kg)	2.88
6	pH (H_2O)	7.2
7	Moisture content	45.8
8	EC(ds/m)	0.95

Keys: C:N= Carbon to Nitrogen Ratio, EC=Electric Conductivity, K=potassium, Mg=Magnesium, N=Nitrogen, P=Phosphorus

4.2 Physicochemical properties of the experimental soil from Dutse Jigawa State

The results of the pretreated Soil Analysis (Table 4.2) indicated that the soil was sandy loam with a composition of 85.44% sand, 12.0% clay and 2.56% silt, while the chemical properties indicated that the nursery soil is moderately acidic with pH 5.19. It was also indicated that the values of the following elements i.e. Phosphorus (6.333mg/kg), Total Nitrogen (0.070%), Organic Matter (0.485%) and Potassium (0.227cmol/kg) contents were below required range and thus, needs amendments. (See Appendix 2.) Other properties determined include; Electric Conductivity, Cation Exchange Capacity, Exchangeable Acidity and Bases and the following values were obtained; (0.071), (6.418) and (0.668) respectively.

Table 4.2 Physicochemical Properties of the Experimental Soil from Dutse Jigawa State (2017)

S/No	Physicochemical properties determined	Values
1	pH (H_2O)	5.19
2	pH ($CaCl_2$)	4.5
3	EC (ds/m)	0.071
4	OC (%)	0.485
5	TN (%)	0.070
6	P (mg/kg)	6.333
7	EA (cmol/kg)	0.668
8	Ca (cmol/kg)	4.552
9	Mg (cmol/kg)	0.877
10	K (cmol/kg)	0.227
11	Na (cmol/kg)	0.094
12	CEC (cmol/kg)	6.418
13	% Sand	85.44
14	% Silt	12.0
15	% Clay	2.56
16	Textural class	Sandy loam

Keys: CEC=Cation Exchange Capacity, Ca=Calcium, EA=Exchangeable Acidity, EC=Electric Conductivity, K=Potassium, Mg=Magnesium, Na=Sodium, P=phosphorus, OC=Organic Carbon, TN=Total Nitrogen

4.3 Effects of date palm waste compost and NPK fertilizer on the chlorophyll of some varieties of *p. dactylifera* seedlings

The result of the effects of NPK (Nitrogen Phosphorus and Potassium) and Compost manure on Chlorophyll contents of selected varieties of Date Palm Seedlings were presented (Table 4.3).

The statistical analysis showed that there was significant difference ($P<0.05$) within the varieties across the number of days and no significant difference was observed ($p>0.05$) in the treatments.

There were no significant differences ($P>0.05$) in all the varieties at 30, 60, 90, and 120 days after treatment with respect to Chlorophyll but only at 180 days were Deglet variety recorded as the highest with (112.13µg/m^2) followed by SSM with (94.41µg/m^2) and the lowest was Tirgal variety (74.45µg/m^2).

At 30 days after treatment, the highest chlorophyll content was obtained in the application of 10 and 100 grams of NPK and compost (21.27 µg/m^2) followed by the combination of 10 and 50 grams (10N+50) (18.98 µg/m^2) whereas control (no treatments) recorded as the lowest (11.27 µg/m^2).

At 60 days after treatment, the highest chlorophyll obtained was 10 and 100 grams of NPK and compost (45.08 µg/m^2) followed by the combination of 10 and 50 grams (10N+50) (38.12 µg/m^2) and the lowest was obtained in control (no treatment) (17.07 µg/m^2).

At 90 days after treatment, the highest chlorophyll obtained was 10 and 100 grams of NPK and compost (57.94 µg/m^2) followed by the combination of 10 and 50 grams (10N+50) (51.46 µg/m^2) and the lowest was obtained in control (no treatment) of (30.67 µg/m^2).

At 120 days after treatments the highest chlorophyll was obtained in 5N+50C (5 and 50 grams of NPK and compost) of (78.31 µg/m^2) followed by the combination of 10 and 50 grams (10N+50) (77.84 µg/m^2) and the lowest was obtained in control (44.07 µg/m^2)

At 150 days after treatment the highest chlorophyll was obtained in 10N+100C (10 and 100 grams of NPK and compost manure) (88.56 µg/m^2) followed by the combination of 10 and 50 grams (10N+50) (85.47 µg/m^2) and the lowest was obtained in control (no treatment) (65.90 µg/m^2)

At 180 days after treatment the highest chlorophyll was obtained in 10N+100C (10 and 100 grams of NPK and compost manure) (105.96 µg/m^2) followed by 10+50 combinations (97.44 µg/m^2) and the lowest was obtained in control (no treatments) (70.83 µg/m^2)

Table 4.3: Effects of different application rate of NPK and Compost manure on the Chlorophyll (μg/m^2) of selected varieties of Date Palm seedlings in Jigawa State, Nigeria

Varieties	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Deglet	12.21^{a}	24.19^{ab}	42.73^{bc}	64.24^{de}	95.38^{g}	112.13^{h}
SSM	14.82^{a}	26.62^{ab}	46.04^{d}	63.21^{de}	76.49^{ef}	94.41^{g}
Tirgal	11.63^{a}	23.72^{b}	41.89^{c}	61.41^{e}	74.45^{f}	93.44^{g}
Treatments						
Control	11.27^{a}	17.07^{c}	30.67^{de}	44.07^{def}	65.90^{fg}	70.83^{h}
5N	14.22^{a}	24.40^{d}	36.20^{de}	49.17^{ef}	71.42^{h}	88.78^{i}
10N	15.06^{b}	29.57^{e}	51.46^{ef}	71.08^{h}	85.47^{i}	93.33^{j}
50C	12.03^{a}	24.84^{d}	41.34^{f}	58.39^{g}	71.07^{h}	85.88^{a}
100C	15.12^{ab}	27.93^{cd}	44.24^{def}	65.37^{fg}	77.56^{h}	90.67^{ij}
5N+50C	15.14^{ab}	27.77^{cd}	44.23^{def}	74.54^{h}	76.86^{gh}	90.86^{ij}
5N+100C	17.72^{c}	32.49^{de}	45.02^{def}	75.29^{h}	79.53^{gh}	95.47^{ij}
10N+50C	18.98^{c}	38.12^{de}	48.00^{ef}	77.84^{h}	81.48^{gh}	97.44^{ij}
10N+100C	21.27^{d}	45.08^{ef}	57.94^{g}	78.31^{gh}	88.56^{gh}	105.96^{k}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. DAT= Days After Treatment

4.4: Interaction effects of variety x treatment on the chlorophyll contents (µg/m^2) of some varieties of *p. dactylifera* seedlings

The effects of variety by treatments interactions on Chlorophyll (Table 4.4), the results indicated that there were significant interactions between the varieties and the treatments across the number of days. Chlorophyll was significantly interacted ($p \leq 0.05$) at 30, 60, 90, 120, 150 and 180 days of treatments application.

Deglet variety treated with 5+100 grams of combinations of NPK and compost manure showed significant interactions (122.50 µg/m^2), followed by 10 grams of NPK (116.23 µg/m^2) and the least significant interactions was obtained in control (70.83 µg/m^2)

Tirgal variety treated with 5+50 grams of combinations showed significant interactions (117.53 µg/m^2), followed by 5 grams of NPK (103.10 µg/m^2) and the least was 5+100 grams of combinations (76.23 µg/m^2)

Similarly, Substation materials (SSM) variety treated with 50 grams of compost interacts positively (110.07 µg/m^2), followed by the one treated with 10+100 grams of combinations (107.83 µg/m^2) and the lower significant interactions was obtained in 5 grams NPK (70.57 µg/m^2)

Table 4.4: Interactions effects of variety x treatment on the Chlorophyll (μg/m^2) contents of some date palm varieties

Var.	Trt.	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
DEGLET	Control	13.07±0.22^{defg}	17.07±0.67^{ij}	30.67±2.73^{ijk}	44.07±2.83^{j}	65.90±11.82^{ghi}	70.83±6.27^{fgh}
	5N	12.33±3.13^{defgh}	15.13±2.63^{j}	28.53±0.93^{k}	62.53±7.33^{def}	74.27±9.47^{def}	92.67±3.97^{def}
	10N	21.80±1.59^{a}	39.60±1.09^{a}	61.13±3.07^{a}	87.17±4.43^{a}	94.90±2.87^{ab}	116.23±8.63^{ab}
	50C	11.57±2.23^{efghi}	21.87±0.73^{hi}	40.90±8.08^{hi}	51.93±6.27^{ghi}	57.27±16.24^{hij}	83.60±13.12^{efg}
	100C	19.10±0.00^{ab}	31.20±0.00^{bc}	56.30±0.00^{ab}	74.80±0.00^{d}	86.00±0.00^{abc}	107.80±0.00^{abcd}
	5N+50C	13.57±1.63^{defg}	21.03±0.27^{hij}	42.80±0.69^{h}	66.30±3.59^{cde}	83.13±7.73^{cde}	86.50±8.00^{efg}
	5N+100C	12.80±0.00^{defgh}	20.00±0.00^{ij}	44.20±0.00^{efg}	75.50±0.00^{abc}	98.50±0.00^{a}	122.50±0.00^{a}
	10N+50C	12.73±0.87^{j}	26.93±0.93^{cde}	35.67±2.07^{hij}	53.93±1.57^{efg}	60.20±2.30^{i}	72.30±2.90^{efgh}
	10N+100C	11.40±0.00^{efghi}	28.93±1.48^{efg}	44.37±1.23^{efg}	61.90±6.05^{def}	88.97±3.43^{c}	106.00±6.40^{abc}
	Control	13.23±1.37^{defg}	25.40±1.00^{def}	40.90±0.83^{hi}	52.87±2.19^{gh}	69.63±4.00^{efgh}	80.93±0.98^{def}
SSM	5N	15.57±3.33^{cd}	25.87±6.63^{def}	33.33±2.67^{ij}	41.90±3.09^{i}	56.03±6.7^{j}	70.57±5.03^{efg}
	10N	15.70±1.82^{cd}	26.43±31.89^{def}	52.57±7.76^{c}	71.47±13.46^{cd}	83.07±13.47^{cde}	99.23±11.28^{bcd}
	50C	15.23±2.37^{cd}	30.40±6.80^{bcd}	50.40±7.50^{c}	69.87±7.23^{e}	85.73±7.97^{bcd}	110.07±10.23^{abc}
	100C	13.50±1.69^{defg}	22.50±6.10^{ghi}	38.47±10.87^{ghi}	62.47±12.27^{def}	74.93±13.43^{def}	95.37±13.77^{cde}
	5N+50C	17.77±0.83^{bc}	27.67±0.37^{cde}	55.77±0.57^{bcd}	75.43±1.43^{abc}	85.50±0.09^{abcd}	101.53±0.87^{abcd}
	5N+100C	11.20±0.00^{fghi}	18.90±0.00^{cde}	31.20±0.00^{ijk}	44.60±0.00^{ij}	61.20±0.00^{ghi}	81.67±9.23^{def}
	10N+50C	19.30±5.50^{ab}	32.60±9.90^{bcd}	53.80±12.10^{cd}	75.93±19.17^{abc}	83.70±20.60^{cde}	102.50±18.10^{abc}
	10N+100C	11.87±0.93^{efghi}	29.80±0.69^{cde}	57.97±0.37^{ab}	74.37±2.17^{cd}	88.63±0.67^{bc}	107.83±6.37^{abc}
	Control	11.27±0.52^{fghi}	21.73±5.51^{hi}	41.10±8.72^{efg}	54.80±12.18^{efg}	66.27±12.16^{ghi}	86.17±13.48^{efg}
TIRGAL	5N	14.77±3.01^{cde}	32.20±2.90^{bcd}	46.73±3.13^{def}	73.07±4.64^{bcd}	83.97±3.87^{cde}	103.10±11.99^{abc}
	10N	13.67±1.1 3^{defg}	22.63±2.17^{h}	40.67±5.09^{efg}	54.60±8.58^{efg}	63.43±10.89^{hij}	76.53±10.77^{efgh}
	50C	9.30±4.40^{hi}	22.27±3.26^{h}	32.73±11.28^{j}	53.37±15.62^{ghi}	70.20±16.33^{efgh}	93.97±14.42^{cde}
	100C	12.77±1.13^{defgh}	21.10±2.71^{hi}	37.97±4.22^{hij}	58.83±8.25^{efg}	71.73±8.93^{efg}	92.83±11.52^{cdef}
	5N+50C	14.10±2.85^{def}	28.60±6.50^{cd}	46.13±10.03^{de}	81.90±2.52^{ab}	94.93±1.33^{abc}	117.53±6.06^{ab}
	5N+100C	8.17±2.23^{i}	19.57±2.53^{cde}	47.67±2.43^{d}	54.77±0.47^{efg}	63.90±0.29^{hij}	76.23±1.13^{efgh}
	10N+50C	10.37±3.41^{ghi}	24.83±1.05^{efg}	42.53±2.73^{def}	55.67±6.41^{efg}	76.53±8.96^{cde}	99.53±12.81^{bcd}
	10N+100C	10.30±0.15^{ghi}	20.50±1.90^{hi}	41.50±2.90^{def}	65.67±6.83^{cde}	79.07±9.33^{cde}	95.03±3.07^{cde}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different, **NB. Mean ± SE**

4.5 Effects of date palm waste compost and NPK fertilizer on the photosynthetically active radiation (μmol/m^2/s) (par) of some varieties of *p. dactylifera* seedlings

The result of the effects of NPK and compost manure on Photosynthetically Active Radiation (PAR) of selected varieties of Date Palm Seedlings were analyzed (Table 4.5).

The statistical analysis showed that there was significant difference ($P<0.05$) within the varieties across number of months and no significant difference recorded ($p>0.05$) in the treatments.

There were no significant differences ($P>0.05$) in all the varieties at 30, 60, 90, and 120 days after treatment with respect to Photosynthetically Active Radiation, but only at 150 days were Deglet variety recorded as the highest with (218.52 μmol/m^2/s) followed by SSM (211.11 μmol/m^2/s) and the lowest was Tirgal variety (225.29 μmol/m^2/s).

At 30 days after treatment, the highest Photosynthetically Active Radiation (PAR) was obtained in the application of combination of 10N+100C (10 and 100 grams of NPK and compost manure) (48.67 μmol/m^2/s) followed by the 10 and 50 grams (10N+50C) (45.33 μmol/m^2/s), whereas control (no treatments) was the lowest (21.33 μmol/m^2/s).

At 60 days after treatment, the highest Photosynthetically Active Radiation was obtained in 10N+100C (10 and 100 grams of NPK and compost) (68.33 μmol/m^2/s) followed by 10+50 combinations (64.31 μmol/m^2/s) and the lowest was control (no treatment) (45.00 μmol/m^2/s).

At 90 days after treatment, the highest Photosynthetically Active Radiation was obtained in 10N+100C (combination of 10 and 100 grams of NPK and compost) (138.78 μmol/m^2/s) followed by 10+50 combinations (125.00 μmol/m^2/s) and the lowest was obtained in control (no treatments) (97.67 μmol/m^2/s).
At 120 days after treatments the highest Photosynthetically Active Radiation was obtained in 10N+100C (10 and 100 grams of NPK and compost) (205.44 μmol/m^2/s) followed by

10+50 combination (200.22 µmol/m^2/s) and the lowest was obtained in control (no treatments) (160.33 µmol/m^2/s)

At 150 days after treatment the highest Photosynthetically Active Radiation was obtained in 10N+100C (10 and 100 grams NPK and compost) (256.56 µmol/m^2/s) followed by 10+50 combinations (247.11 µmol/m^2/s) and the lowest was obtained in control (no treatment) (193.00 µmol/m^2/s)

At 180 days after treatment the highest Photosynthetically Active Radiation was obtained in 10N+100C (10 and 100 grams of NPK and compost manure) (335.67 µmol/m^2/s) followed by 10+50 combinations (305.22 µmol/m^2/s) and the lowest was obtained in control (no treatments) (241.33 µmol/m^2/s)

Table 4.5: Effects of different application rate of NPK and compost manure on the Photosynthetically Active Radiation (µmol/m^2/s) of selected varieties of Date Palm seedlings in Jigawa State Nigeria

Varieties	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Deglet	26.00^{a}	66.48^{ab}	125.82^{d}	187.07^{de}	218.52^{ef}	264.12^{g}
SSM	24.00^{a}	52.22^{b}	110.59^{c}	180.74^{e}	211.11^{f}	268.41^{fg}
Tirgal	27.70^{a}	65.37^{ab}	120.41^{d}	181.70^{de}	225.29^{ef}	264.89^{fg}
Treatments						
Control	21.33^{a}	45.00^{cd}	97.67^{g}	160.33^{k}	193.00^{jk}	241.33^{c}
5N	23.67^{a}	49.78^{e}	107.44^{h}	168.78^{k}	200.00^{l}	260.67^{m}
10N	30.22^{b}	54.44^{e}	112.22^{i}	172.67^{ijk}	200.00^{l}	275.44^{m}
50C	33.33^{ab}	55.22^{e}	112.56^{i}	179.78^{jk}	218.44^{jkl}	279.22^{m}
100C	36.67^{c}	60.22^{f}	119.22^{i}	181.44^{jk}	223.11^{jkl}	284.56^{jkl}
5N+50C	30.56^{b}	58.00^{e}	120.44^{hi}	183.33^{jk}	239.33^{m}	291.00^{jkl}
5N+100C	43.00^{d}	62.56^{ef}	122.56^{hi}	191.78^{jk}	242.22^{jkl}	297.00^{jkl}
10N+50C	45.33^{cd}	64.31^{ef}	125.00^{hi}	200.22^{l}	247.11^{jkl}	305^{ijkl}
10N+100C	48.67^{d}	68.33^{ef}	138.78^{j}	205.44^{jkl}	256.56^{kl}	335.67^{ijkl}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. DAT= Days After Treatment

4.6: Interaction Effects of variety x treatment on the photosynthetically active radiation (par) (μmol/m^2/s) of some varieties of *p. dactylifera* seedlings

The effects of variety by treatments interactions on Photosynthetically Active Radiation (Table 4.6), the results indicated that there were significant interactions between the varieties and the treatments across the number of months. PAR was significantly interacted ($p \leq 0.05$) at 30, 60, 90, 120, 150 and 180 days of treatments application.

Substation materials (SSM) variety treated with 10 grams of NPK interacts positively (294.00 μmol/m^2/s), followed by the one treated with 50 grams of compost (291.00 μmol/m^2/s) and the lower significant interactions was obtained in 5+50 grams of combination of NPK and compost (226.67 μmol/m^2/s).

Tirgal variety treated with 5+100 grams of combinations showed significant interactions (294.00 μmol/m^2/s), followed by 10+100 grams of combinations of NPK and compost (287.00 μmol/m^2/s) and the least was obtained in 5 grams of NPK (221.67 μmol/m^2/s)

Similarly, Deglet variety treated with 5+50 grams of combinations of NPK and compost manure showed significant interactions (289.33 μmol/m^2/s), followed by 10+100 combinations (278.00 μmol/m^2/s) and the least significant interactions was obtained in 10+50 grams of combinations of NPK and compost manure (216.67 μmol/m^2/s)

Table 4.6: Interaction effects of variety x treatment on the Photosynthetically Active Radiation ($\mu mol/m^2/s$) of some Date palm seedlings

Var.	Trt.	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
DEGLET	Control	26.33±7.75^{abc}	70.33±1.67^{abc}	107.00±19.14^{fgh}	174.33±17.94^{efg}	209.00±12.01^{bcd}	241.33±7.67^{def}
	5N	25.33±1.33^{abc}	56.33±2.33^{def}	111.33±2.67^{cde}	187.00±4.00^{cdef}	213.00±6.00^{bcd}	278.00±3.00^{abc}
	10N	32.67±2.33^{ab}	64.00±0.00^{bcd}	129.67±2.67^{b}	196.00±7.00^{bcd}	223.33±10.71^{abcd}	272.33±13.72^{bcd}
	50C	27.00±1.00^{c}	52.67±0.67^{def}	119.00±28.09^{cde}	168.67±2.33^{efg}	206.33±13.33^{bcd}	271.67±10.17^{bcd}
	100C	27.00±0.00^{c}	48.00±0.00^{g}	128.00±0.00^{ab}	189.00±0.00^{def}	212.00±0.00^{bcd}	255.00±0.00^{cde}
	5N+50C	34.67±6.67^{a}	92.33±1.67^{a}	161.67±13.33^{a}	228.33±6.67^{a}	269.00±12.00^{a}	289.33±19.09^{ab}
	5N+100C	25.00±0.00^{abcd}	82.00±0.00^{b}	154.00±0.00^{ab}	211.00±0.00^{ab}	230.00±0.00^{abcd}	275.00±0.00^{abcd}
	10N+50C	24.00±2.00^{abcd}	75.33±17.67^{ab}	91.33±1.33^{efg}	140.00±4.00^{ghi}	163.00±4.00^{def}	216.67±2.67^{efg}
	10N+100C	22.00±0.00^{bcd}	57.33±5.67^{def}	130.33±1.67^{abc}	189.33±5.67^{cdef}	241.00±0.00^{abc}	278.00±6.00^{abc}
SSM	Control	23.33±2.73^{bcd}	55.67±16.17^{def}	97.67±12.03^{def}	170.33±19.34^{efg}	205.00±10.02^{abcd}	271.33±2.96^{bcd}
	5N	21.33±0.33^{cde}	52.67±14.67^{efg}	106.67±8.67^{cde}	158.33±11.33^{ghi}	200.33±5.33^{bcd}	282.33±8.67^{abc}
	10N	32.67±3.28^{ab}	64.00±2.31^{def}	129.67±4.91^{ab}	189.00±3.51^{cde}	227.00±13.87^{abcd}	294.00±18.59^{a}
	50C	23.67±1.67^{abcd}	53.00±1.00^{cde}	119.33±9.67^{cde}	181.67±12.33^{efg}	222.00±20.00^{abcd}	291.00±2.00^{a}
	100C	24.67±1.67^{abcd}	60.00±2.00^{cde}	115.00±4.00^{cde}	189.33±3.33^{def}	215.67±9.67^{bcd}	239.33±17.33^{def}
	5N+50C	20.67±4.67^{cde}	35.67±4.67^{efg}	97.33±0.33^{def}	151.67±9.33^{ghi}	177.00±0.00^{cde}	226.67±15.67^{efg}
	5N+100C	21.00±0.00^{cde}	25.00±0.00^{h}	87.00±0.00^{g}	198.00±0.00^{bcd}	215.00±0.00^{bcd}	268.00±10.00^{cde}
	10N+50C	27.33±1.67^{de}	52.00±0.00^{def}	127.67±3.33^{bcd}	197.67±1.33^{bcd}	218.33±1.33^{bcd}	272.00±9.00^{bcd}
	10N+100C	31.33±4.67^{abc}	72.00±6.00^{abc}	115.00±7.00^{cde}	190.67±8.33^{cde}	219.67±0.33^{bcd}	271.00±3.00^{bcd}
TIRGAL	Control	27.33±1.20^{abc}	55.00±6.35^{def}	122.00±1.00^{bcd}	198.67±2.73^{bcd}	226.33±4.91^{bcd}	251.00±9.45^{cde}
	5N	18.33±4.06^{def}	73.33±6.17^{abc}	104.33±8.69^{cde}	161.00±3.06^{fgh}	186.67±5.93^{def}	221.67±8.84^{efg}
	10N	25.33±3.93^{abcd}	59.33±7.69^{cde}	108.33±12.55^{cde}	163.00±21.39^{fgh}	220.33±16.29^{abcd}	260.00±15.95^{cde}
	50C	34.33±5.81^{ab}	75.00±12.58^{ab}	126.33±14.44^{bcd}	189.00±11.59^{cde}	227.00±9.45^{abcd}	275.00±15.05^{bcd}
	100C	28.33±5.67^{abc}	57.67±12.84^{def}	123.67±20.17^{bcd}	196.00±6.51^{cdef}	241.67±2.40^{abc}	278.33±4.33^{abc}
	5N+50C	36.33±2.85^{a}	64.00±4.00^{bcd}	126.33±4.09^{abcd}	170.00±22.73^{def}	212.00±7.00^{bcd}	255.00±2.31^{cde}
	5N+100C	33.00±5.00^{abc}	68.67±7.33^{abcd}	135.67±9.33^{abc}	193.33±19.67^{cde}	251.67±3.33^{ab}	294.00±3.00^{a}
	10N+50C	28.67±6.17^{abc}	59.67±4.41^{cde}	108.00±7.02^{cde}	158.00±10.21^{fgh}	225.00±14.84^{bcd}	262.00±17.21^{cde}
	10N+100C	35.67±3.33^{a}	75.67±1.33^{ab}	129.00±3.00^{abc}	206.33±4.67^{abc}	237.00±13.00^{abcd}	287.00±8.00^{ab}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. DAT=Days after treatments, N= NPK, C=Date palm waste compost, **NB**. **Mean ± SE**

4.7 Effects of date palm waste compost and NPK fertilizer on the plant height (cm) of some varieties of *p. dactylifera* seedlings

The result of the effects of NPK (Nitrogen Phosphorus and Potassium) and Date palm waste compost on Plant Height of selected varieties of Date Palm Seedlings were presented (Table 4.7)

In this study, it was observed that there were significant differences at ($P<0.05$) in the varieties across the number of days and no significant differences were observed ($P>0.05$) in the treatments.

There were no significant differences ($P>0.05$) in all the varieties at 30, 60, 90, and 120 Days after treatment with respect to Plant Height, but only at 180 days were SSM variety recorded as the highest with (58.48cm) followed by Tirgal with (58.44cm) and the lowest was Deglet variety (57.82cm).

At 30 days after treatment, the highest Plant Height was obtained in the application of combination of 10N+100C grams of NPK and compost manure (38.96cm) followed by 10+50 combinations (36.42cm) whereas control (no treatments) was the lowest (24.20cm).

At 60 days after treatment, the highest Plant Height was obtained in 10+100 (10 and 100 grams of NPK and compost) (40.70cm) followed by 10+50 combinations (39.88cm) and the lowest was control (no treatments) (30.90cm).

At 90 days after treatment, the highest Plant Height was obtained in 10N+100C (combination of 10 and 100 grams of NPK and compost) (49.48cm) followed by 10+50 combinations (43.64cm) and the lowest was control (no treatment) of (33.43cm).

At 120 days after treatments it was observed that the highest Plant Height was obtained in the application of 10N+100C (10 and 100 grams of NPK and compost manure respectively)

(56.50cm) followed by 10+50 combinations (50.09cm) and the lowest was control (no treatments) (35.90cm)

At 150 days after treatment, it was found that the highest Plant Height was obtained in the application of 10N+100C (62.08cm) followed by 10+50 combinations (56.82cm) and the lowest was control (39.73cm)

At 180 days after treatment the highest Plant Height was obtained in 10N+100C (10 and 100 grams of NPK and compost manure) (79.42cm) followed by 10+50 combinations (73.10cm) and the lowest was control (no treatments) (47.00cm)

Table 4.7: Effects of different application rate of NPK and compost manure on the Plant Height (cm) of selected varieties of Date Palm seedlings in Jigawa State, Nigeria

Varieties	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Deglet	22.46^{a}	31.08^{b}	36.84^{ab}	42.49^{bc}	49.38^{cd}	57.82^{de}
SSM	25.34^{a}	34.63^{ab}	39.68^{c}	46.28^{d}	50.49^{cd}	58.48^{de}
Tirgal	27.00^{a}	35.22^{ab}	41.82^{bc}	46.20^{d}	52.07^{e}	58.44^{de}
Treatments						
Control	24.20^{a}	30.90^{a}	33.43^{ab}	35.90^{ab}	39.73^{ab}	47.00^{bc}
5N	27.51^{a}	35.08^{ab}	35.70^{ab}	37.50^{ab}	40.43^{bc}	52.73^{cd}
10N	31.81^{b}	35.32^{ab}	36.28^{ab}	39.52^{ab}	44.59^{bc}	56.97^{d}
50C	32.83^{ab}	35.30^{ab}	36.18^{ab}	40.36^{c}	45.39^{bc}	57.83^{d}
100C	34.88^{ab}	35.41^{ab}	36.95^{ab}	42.88^{bc}	47.34^{abc}	60.91^{e}
5N+50C	34.29^{ab}	36.27^{ab}	38.48^{ab}	45.69^{bc}	51.11^{cd}	64.49^{de}
5N+100C	35.86^{ab}	38.37^{ab}	40.03^{c}	47.91^{bc}	55.24^{cd}	67.76^{de}
10N+50C	36.42^{ab}	39.88^{ab}	43.64^{bc}	50.09^{d}	50.82^{cd}	73.10^{f}
10N+100C	38.96^{ab}	40.74^{c}	49.48^{d}	56.50^{d}	62.08^{de}	79.42^{ef}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. DAT= Days After Treatment

4.8: Interaction effects of variety x treatment on plant height (cm) of some varieties of *p. dactylifera* seedlings

The effects of variety by treatments interactions on Plant Height (Table 4.8), the results indicated that there were significant interactions between the varieties and the treatments. Plant height was significant ($p \leq 0.05$) at 30, 60, 90, 120, 150 and 180 days of treatments application.

Deglet variety treated with (10+100) grams combinations of NPK and compost manure showed significant interactions (74.73cm), followed by (10+50) combinations and the least significant interactions was obtained in untreated (control) (44.90cm)

Substation materials (SSM) variety treated with (5+100) grams of combinations interacts positively (66.83cm), followed by the one treated with 50 grams of compost manure (65.73cm) and the lower significant interactions was obtained in control (untreated) (55.93cm).

Similarly, Tirgal variety treated with 100 grams of compost showed significant interactions (65.83cm), followed by 50 grams of compost (65.00cm) and the least was control (52.17cm)

Table 4.8: Interactions effects of variety x treatment on the plant height of some date palm seedlings

Var.	Trt.	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
DEGLET	Control	25.80±1.06^{cde}	34.50±0.29^{cde}	37.60±0.70^{f}	38.13±0.53^{f}	39.73±2.38^{efg}	44.90±1.30^{def}
	5N	26.10±6.00^{cde}	37.00±6.60^{bcd}	40.53±1.93^{cde}	43.70±0.29^{cde}	45.10±2.70^{def}	48.40±2.59^{def}
	10N	28.63±5.23^{cde}	38.97±1.13^{bcd}	41.17±2.97^{cde}	44.77±3.17^{cde}	51.57±3.29^{cde}	55.00±1.30^{cde}
	50C	32.07±9.57^{abc}	42.47±8.87^{abc}	44.20±4.59^{cde}	45.27±5.17^{cde}	55.53±0.03^{bcd}	60.00±5.76^{bcd}
	100C	34.10±0.00^{abc}	46.30±0.00^{ab}	50.20±0.00^{abc}	56.40±0.00^{abc}	60.60±0.00^{ab}	64.60±0.00^{abc}
	5N+50C	41.27±1.93^{ab}	49.08±1.17^{ab}	54.87±1.67^{ab}	58.40±6.20^{abc}	63.90±8.70^{ab}	66.20±7.50^{ab}
	5N+100C	43.40±0.00^{ab}	52.40±0.00^{a}	56.90±0.00^{a}	61.40±0.00^{ab}	65.60±0.00^{a}	68.30±0.00^{ab}
	10N+50C	45.53±3.43^{a}	53.90±1.80^{a}	58.80±1.19^{a}	64.07±0.67^{a}	68.07±0.17^{a}	71.27±0.97^{a}
	10N+100C	49.20±0.00^{a}	54.10±2.00^{a}	57.27±0.57^{a}	65.33±1.71^{a}	67.33±2.37^{a}	74.73±3.17^{a}
SSM	Control	24.20±1.13^{def}	34.90±3.47^{cde}	37.43±4.66^{g}	41.90±5.45^{cde}	46.93±5.36^{cde}	55.93±4.16^{cde}
	5N	29.57±0.47^{bcd}	45.40±0.29^{ab}	52.17±0.33^{abc}	59.43±0.67^{ab}	65.57±1.4^{a}	65.80±1.69^{abc}
	10N	29.97±3.26^{bcd}	32.80±4.01^{cde}	54.83±3.52^{ab}	54.53±1.96^{abc}	55.17±2.91^{bcd}	58.30±4.85^{bcd}
	50C	24.43±4.33^{def}	26.17±4.27^{efgh}	28.37±4.37^{efg}	49.17±0.27^{bcd}	54.83±0.73^{bcd}	65.73±0.23^{abc}
	100C	24.83±1.63^{def}	29.37±4.23^{efg}	34.37±0.93^{efg}	41.30±1.50^{def}	41.30±1.50^{def}	54.13±0.87^{cde}
	5N+50C	27.53±4.43^{cde}	36.23±2.73^{bcd}	47.00±1.90^{abc}	52.50±0.19^{c}	57.70±0.29^{abc}	63.43±1.95^{abc}
	5N+100C	22.10±0.00^{efg}	39.50±0.00^{bcd}	42.50±0.00^{cde}	51.10±0.00^{bcd}	56.30±0.00^{bcd}	66.83±0.47^{ab}
	10N+50C	30.17±0.67^{bcd}	38.57±2.53^{bcd}	42.27±3.03^{cde}	52.80±4.50^{bcd}	53.93±3.37^{bcd}	61.53±4.97^{bcd}
	10N+100C	25.23±2.17^{def}	31.77±1.83^{cde}	38.17±0.23^{def}	44.67±0.27^{cde}	44.67±0.27^{def}	58.57±0.53^{bcd}
TIRGAL	Control	24.47±3.52^{def}	31.73±1.18^{cde}	35.63±2.07^{efg}	38.97±0.22^{cde}	44.73±0.46^{def}	52.17±2.48^{cde}
	5N	26.87±10.27^{cde}	37.83±6.89^{bcd}	47.40±3.09^{abc}	51.37±3.27^{ab}	51.63±2.29^{cde}	58.00±1.48^{bcd}
	10N	27.83±8.13^{cde}	37.20±4.98^{bcd}	42.83±3.95^{cde}	49.27±2.01^{abc}	54.03±1.12^{bcd}	61.60±2.17^{bcd}
	50C	32.00±1.55^{abc}	36.27±2.28^{cde}	41.77±1.86^{cde}	44.63±0.83^{cde}	49.80±1.72^{cde}	56.77±1.00^{bcd}
	100C	22.70±5.91^{efg}	32.57±7.87^{cde}	42.57±3.82^{cde}	50.93±4.52^{bcd}	59.13±0.49^{abc}	65.00±1.42^{abc}
	5N+50C	30.07±2.59^{bcd}	37.50±2.31^{bcd}	42.57±4.94^{cde}	51.17±4.33^{bcd}	59.73±6.42^{abc}	65.83±5.84^{abc}
	5N+100C	32.06±7.23^{abc}	41.77±3.83^{abc}	46.70±4.09^{bcd}	50.23±1.67^{bcd}	57.83±3.67^{abc}	55.13±2.97^{cde}
	10N+50C	19.57±0.64^{fgh}	26.73±0.83^{def}	33.86±1.69^{efg}	39.37±0.35^{cde}	43.47±1.27^{def}	59.50±0.72^{bcd}
	10N+100C	27.43±2.33^{cde}	35.37±1.47^{cde}	43.00±0.29^{cde}	49.50±5.70^{bcd}	58.27±4.23^{abc}	61.97±4.73^{bcd}

Means followed by the same letters (superscript) are not significantly different according to DMRT at 5% level of significance. DAT= days after treatment, N=NPK, C= Date palm waste compost, **NB**. **Mean ± SE**

4.9: Effects of date palm waste compost and NPK fertilizer on the stem girth of some varieties of *P. dactylifera* seedlings

The result of the effects of NPK (Nitrogen Phosphorus and Potassium) and Date Palm waste compost on Stem girth of selected varieties of Date Palm Seedlings were analysed (Table 4.9)

In this study, it was observed that there were significant differences at ($P<0.05$) in the varieties across the number of months and no significant differences were observed at ($P>0.05$) in the treatments.

There were no significant differences ($P>0.05$) in SSM varieties except Deglet and Tirgal at 30 and 90 Days after treatment with respect to Stem Girth (2.40mm) and (5.85mm)

At 30 days after treatment, the highest Stem Girth recorded was obtained in the application of 10N (10 grams of NPK) (3.59mm) followed by 10+100 combinations (3.26mm) whereas Control (no treatments) was the lowest (1.78mm).

At 60 days after treatment, the highest Stem Girth obtained was in 10N (10 grams of NPK) (6.95mm) followed by 10+100 combinations (6.17mm) and the lowest was control (no treatments) (3.92mm).

At 90 days after treatment, the highest Stem Girth was obtained in 10N (10 grams of NPK) (9.37mm) followed by 10+100 combinations (8.71mm) and the lowest was control (no treatments) (4.71mm).

At 120 days after treatments the highest Stem Girth was obtained in 10N (10 grams of NPK) (12.70mm) followed by 10+100 combinations (11.70mm) and the lowest was control (7.08mm)

At 150 days after treatment the highest Stem Girth was obtained in 10N (10 grams of NPK) (16.21mm) followed by 10+100 combinations (15.36mm) and the lowest was control (10.97mm)

At 180 days after treatment the highest Stem Girth was obtained in 10N+100C (10 and 100 grams of NPK and compost manure) (21.81mm) followed by 10+50 combinations (19.44mm) and the lowest was control (no treatments) (13.50mm)

Table 4.9: Effects of different application rate of NPK and compost manure on the Stem girth of selected varieties of Date Palm seedlings in Jigawa State, Nigeria

Varieties	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Deglet	2.12^{a}	4.36^{b}	5.85^{b}	9.33^{bc}	12.11^{cd}	16.76^{de}
SSM	2.44^{a}	5.59^{b}	7.66^{c}	9.98^{bc}	12.30^{cd}	17.39^{de}
Tirgal	2.40^{a}	4.68^{ab}	6.04^{ab}	8.62^{bc}	10.79^{d}	16.01^{e}
Treatments						
Control	1.78^{a}	3.92^{ab}	4.77^{c}	7.08^{cd}	10.97^{de}	13.50^{ef}
5N	1.98^{a}	4.95^{c}	5.21^{bc}	10.17^{de}	12.79^{f}	15.34^{ef}
10N	3.26^{b}	6.17^{bc}	8.71^{d}	11.70^{f}	15.36^{ef}	19.44^{h}
50C	2.01^{a}	5.41^{bc}	5.40^{bc}	9.06^{de}	12.22^{ef}	16.36^{ef}
100C	2.18^{a}	5.22^{bc}	5.81^{bc}	9.14^{de}	12.69^{ef}	15.32^{ef}
5N+50C	2.40^{a}	5.78^{bc}	7.26^{d}	10.15^{de}	13.48^{ef}	16.76^{ef}
5N+100C	2.35^{a}	5.85^{bc}	7.52^{cd}	10.20^{de}	15.11^{ef}	$17.96f^{g}$
10N+50C	2.57^{a}	5.88^{bc}	7.26^{cd}	10.23^{de}	15.16^{ef}	17.58^{g}
10N+100C	3.59^{ab}	6.95^{bc}	9.37^{e}	12.70^{f}	16.21^{ef}	21.81^{gh}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. DAT= Days After Treatment

4.10: Interaction effects of variety x treatment on the stem girth (mm) of some varieties of *P. dactylifera* seedlings

The effects of variety by treatments interactions on Stem Girth (Table 4.10), the results indicated that there were significant interactions between the varieties and the treatments across the number of months. Stem girth was significantly interacted ($p \leq 0.05$) at 30, 60, 90, 120, 150 and 180 days of treatments application.

Deglet variety treated with (5+50mm) grams combinations of NPK and compost manure showed significant interactions (20.43mm), followed by (10+100) combinations (20.07mm) and the least significant interactions was obtained in 100 grams of compost (12.13mm)

Substation materials (SSM) variety treated with 10+50 grams of combinations interacts positively (19.20mm), followed by the one treated with 5+100 grams of combinations (19.17mm) and the lower significant interactions was obtained in control (untreated) (15.60mm).

Similarly, Tirgal variety treated with 5+100 grams of combinations showed significant interactions (18.90mm), followed by 5+50 grams of combinations (17.43mm) and the least was 10 grams of NPK (12.47mm)

Table 4.10: Interaction effects of variety x treatments on the Stem Girth (mm) of some Date palm seedlings

Var.	Trt.	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
DEGLET	Control	2.08±0.49^{cde}	3.92±0.21^{def}	6.17±0.4^{bcd}	10.90±2.59^{bc}	11.64±2.12^{bcd}	15.50±1.72^{abc}
	5N	1.27±0.95^{efg}	4.20±0.45^{cde}	4.71±1.49^{def}	10.50±1.69^{bc}	13.67±1.47^{abc}	14.50±2.00^{bcd}
	10N	2.31±0.43^{bcd}	4.50±0.68^{cde}	5.88±0.77^{cde}	9.65±0.05^{bcd}	13.20±1.70^{abc}	17.90±0.55^{abc}
	50C	2.49±0.50^{bcd}	4.45±0.13^{cde}	5.65±0.29^{cde}	8.21±0.04^{cde}	12.40±0.50^{abc}	18.00±1.23^{ab}
	100C	0.93±0.00^{h}	3.54±0.00^{def}	3.11±0.00^{efg}	5.33±0.00^{def}	8.44±0.00^{bcd}	12.13±0.00^{def}
	5N+50C	2.04±0.05^{cde}	5.06±0.12^{bcd}	7.21±0.02^{abc}	13.70±0.20^{a}	16.13±0.83^{a}	20.43±0.97^{a}
	5N+100C	4.08±0.33^{a}	5.04±0.00^{bcd}	6.60±0.00^{bcd}	8.05±0.00^{cde}	10.50±0.00^{cde}	15.80±0.00^{bcd}
	10N+50C	2.02±0.04^{cde}	4.00±0.09^{def}	6.46±0.19^{bcd}	8.75±0.42^{cde}	10.50±0.29^{cde}	16.53±0.17^{abc}
	10N+100C	1.86±0.00^{def}	4.49±0.19^{cde}	6.83±0.32^{bcd}	8.87±0.27^{cde}	12.43±1.13^{bcd}	20.07±2.43^{a}
SSM	Control	2.32±0.61^{bcd}	4.47±0.53^{cde}	6.82±0.65^{bcd}	9.08±0.67^{bcd}	10.97±0.92^{cde}	15.60±0.47^{abc}
	5N	2.71±0.74^{abc}	6.38±1.34^{ab}	7.65±1.51^{abc}	11.03±2.47^{ab}	13.17±2.03^{abc}	15.87±0.53^{abc}
	10N	1.74±0.78^{def}	4.93±0.93^{cde}	6.99±0.58^{bcd}	8.90±0.67^{bcd}	10.58±1.06^{cde}	15.97±1.68^{abc}
	50C	1.57±0.88^{def}	4.89±1.45^{cde}	7.91±0.61^{abc}	10.39±0.86^{abc}	13.97±0.57^{abc}	16.57±2.37^{ab}
	100C	2.29±0.04^{bcd}	5.17±0.33^{bcd}	6.50±0.00^{bcd}	8.27±0.12^{cde}	10.17±0.03^{cde}	17.67±0.37^{ab}
	5N+50C	2.35±0.25^{bcd}	5.87±0.27^{abc}	8.33±0.43^{ab}	10.24±0.74^{abc}	12.67±0.27^{bcd}	18.40±0.09^{b}
	5N+100C	2.45±0.00^{bcd}	6.82±0.00^{a}	8.70±0.00^{b}	11.80±0.00^{a}	14.10±0.00^{ab}	19.17±0.57^{a}
	10N+50C	3.79±0.35^{ab}	6.35±0.95^{ab}	9.40±1.50^{a}	11.27±1.97^{ab}	14.30±1.50^{ab}	19.20±0.09^{a}
	10N+100C	2.74±0.18^{abc}	5.49±0.15^{bcd}	6.68±0.01^{bcd}	8.86±0.05^{cde}	10.80±0.19^{cde}	18.13±0.27^{ab}
TIRGAL	Control	2.16±0.27^{cde}	4.60±0.56^{cde}	6.44±0.53^{bcd}	9.12±0.83^{bcd}	11.30±0.64^{bcd}	16.70±0.81^{ab}
	5N	1.95±0.73^{def}	4.26±0.85^{cde}	6.27±0.80^{bcd}	8.96±1.62^{cde}	11.54±1.91^{bcd}	15.67±1.67^{abc}
	10N	2.71±0.29^{abc}	4.86±1.04^{cde}	5.34±0.48^{cde}	7.55±0.67^{def}	9.25±0.65^{def}	12.47±0.61^{bcd}
	50C	2.11±0.28^{cde}	3.90±0.29^{def}	5.65±0.91^{cde}	8.58±0.47^{cde}	10.28±0.43^{cde}	14.50±1.14^{bcd}
	100C	2.12±0.26^{cde}	3.95±0.26^{def}	5.62±0.31^{cde}	7.82±0.59^{def}	10.48±0.74^{cde}	16.17±1.39^{ab}
	5N+50C	2.83±0.59^{ab}	5.82±0.49^{abc}	6.23±1.45^{cde}	9.50±2.04^{bcd}	11.65±1.75^{bcd}	17.43±1.01^{ab}
	5N+100C	2.91±0.35^{b}	5.39±0.37^{bcd}	7.25±0.17^{abc}	9.92±0.18^{bcd}	11.73±0.03^{bcd}	18.90±1.19^{ab}
	10N+50C	1.89±0.32^{def}	4.76±0.39^{cde}	5.92±0.40^{bcd}	7.68±0.29^{def}	11.07±0.88^{bcd}	17.00±1.32^{ab}
	10N+100	2.93±0.27^{ab}	4.53±0.46^{cde}	5.59±0.19^{cde}	8.46±0.14^{cde}	9.80±0.34^{def}	15.23±0.37^{abc}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. DAT=Days after treatment, N=NPK, C= Date palm waste compost, **NB**. **Mean ± SE**

4.11 Effects of date palm waste compost and NPK fertilizer on the number of leaves of some varieties of *P. dactylifera* seedlings

The result of the effects of NPK (Nitrogen, Phosphorus and Potassium) and Date Palm waste compost on Number of Leaves of selected variety of Date Palm Seedlings were analyzed (Table 4.11).

The statistical analysis showed that there was significant difference ($P<0.05$) within the varieties across the number of months and no significant difference was observed ($p>0.05$) in the treatments.

There were no significant differences ($P>0.05$) observed in all the varieties except Deglet at 90 Days after treatment with respect to number of leaves (4.15)

At 30 days after treatment, the highest number of leaves was obtained in the application of combination of 10N+100C grams of NPK and compost manure (3.57) followed by 10+50 combinations (3.49) whereas control (100 grams of compost manure) was the lowest (2.01).

At 60 days after treatment, the highest number of leaves was obtained in 10N+100C (10 and 100 grams of NPK and compost) (4.18) followed by 10+50 combinations (3.99) and the lowest was control (no treatments) (3.00).

At 90 days after treatment, the highest number of leaves obtained was 10N+100C (combination of 10 and 100 grams of NPK and compost) (7.67) followed by 10+50 combinations (6.71) and the lowest was control (no treatment) (4.00).

At 120 days after treatments the highest number of leaves was obtained in 10N+100C (10 and 100 grams of NPK and compost) of (8.27) followed by 10+50 combinations (6.80) and the lowest was control (4.67)

At 150 days after treatment the highest number of leaves was obtained in 10N+100C (11.67) followed by 10+50 combinations (7.11) and the lowest was control (6.00)

At 180 days after treatment the highest number of leaves was obtained in 10N+100C (10 and 100 grams of NPK and compost manure) (14.37) followed by 10+50 combinations (10.22) and the lowest was control (no treatments) (6.67)

Table 4.11: Effects of different application rate of NPK and compost manure on the Number of Leaves of selected varieties of Date Palm seedlings in Jigawa State, Nigeria

Varieties	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Deglet	2.37^{a}	3.04^{b}	4.15^{c}	5.11^{d}	6.11^{e}	7.07^{f}
SSM	2.89^{a}	3.89^{b}	4.67^{c}	5.89^{d}	6.78^{e}	7.85^{ef}
Tirgal	2.63^{a}	3.63^{b}	4.48^{c}	5.48^{d}	6.48^{e}	7.48^{ef}
Treatments						
Control	2.01^{a}	3.00^{c}	4.00^{bc}	4.67^{bc}	6.00^{cd}	6.67^{cd}
5N	2.67^{a}	3.67^{bc}	4.30^{bc}	5.00^{bc}	6.00^{cd}	7.00^{e}
10N	2.71	3.70^{bc}	4.33^{bc}	5.33^{bc}	6.25^{cd}	7.00^{e}
50C	2.78^{a}	3.76^{bc}	4.44^{bc}	5.44^{bc}	6.44^{cd}	7.44^{de}
100C	2.44^{ab}	3.80^{bc}	4.50^{bc}	5.50^{bc}	6.54^{cd}	7.00^{e}
5N+50C	3.00^{c}	3.82^{bc}	5.24^{d}	5.67^{bc}	6.67^{cd}	7.67^{de}
5N+100C	3.46^{bc}	3.86^{bc}	6.00^{cd}	6.44^{cd}	7.00^{e}	8.11^{f}
10N+50C	3.49^{bc}	3.99^{bc}	6.71^{cd}	6.80^{cd}	7.11^{de}	10.22^{g}
10N+100C	3.57^{bc}	4.18^{bc}	7.67^{de}	8.27^{ef}	11.67^{fg}	14.37^{h}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. DAT= Days After Treatment

4.12: Interaction effects of variety x treatment on the number of leaves of some varieties of *P. dactylifera* seedlings

The effects of variety by treatments interactions on number of leaves (4.12), the results indicated that there were significant interactions between the varieties and the treatments. Stem girth was significantly interacted ($p \leq 0.05$) at 30, 60, 90, 120, 150 and 180 days of treatments application.

Substation materials (SSM) variety treated with (10+50) grams of combinations interacts positively (9.00), followed by the one treated with 5+100 grams of combinations (8.67) and the lower significant interactions was obtained in 10 grams NPK (7.00).

Deglet variety treated with (10+50) grams combinations of NPK and compost manure showed significant interactions (8.00), followed by (5+100) combinations (8.00) and the least significant interactions was obtained in 5 grams NPK (6.00)

Similarly, Tirgal variety treated with 5+100 grams of combinations showed significant interactions (8.00), followed by 50 grams of compost (8.00) and the least was control (7.00)

4.12: Interaction effects of variety x treatment on the number of leaves of some Date palm seedlings

Var.	Trt.	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
DEGLET	Control	2.67±0.33^{b}	3.00±0.00^{b}	4.00±0.58^{bcd}	4.67±0.33^{ab}	6.00±0.58^{abc}	6.67±0.03^{def}
	5N	2.00±0.00^{ab}	3.00±0.00^{b}	3.00±0.00^{cde}	4.00±0.00^{abc}	5.00±0.00^{bcd}	6.00±0.00^{efg}
	10N	2.00±0.00 ^{ab}	3.00±0.00^{b}	4.00±0.00^{bcd}	5.00±0.00^{ab}	5.67±0.33^{bcd}	6.67±0.33^{def}
	50C	3.00±0.00^{a}	3.33±0.33^{b}	4.33±0.33^{abc}	5.33±0.33^{abc}	6.33±0.33^{abcd}	7.33±0.33^{bcd}
	100C	2.33±0.67^{b}	2.00±0.00^{bc}	3.00±0.00^{cde}	4.00±0.00^{abc}	5.00±0.00^{bcd}	6.00±0.00^{efg}
	5N+50C	2.67±0.33^{b}	3.00±0.00^{b}	4.67±0.33^{abc}	5.67±0.33^{ab}	6.67±0.33^{abc}	7.67±0.33^{bcd}
	5N+100C	2.00±0.00^{ab}	3.00±0.00^{b}	5.00±0.00^{b}	6.00±0.00^{b}	7.00±0.00^{b}	8.00±0.00^{abc}
	10N+50C	2.67±0.33^{b}	3.67±0.33^{b}	5.00±0.00^{b}	6.00±0.00^{b}	7.00±0.00^{b}	8.00±0.00^{abc}
	10N+100C	2.00±0.00^{ab}	3.33±0.33^{b}	4.33±0.67^{abc}	5.33±0.67^{ab}	6.33±0.67^{abcd}	7.33±0.67^{bcd}
SSM	Control	2.33±0.33^{b}	3.67±0.33^{b}	4.67±0.33^{abc}	6.00±0.58^{b}	6.67±0.33^{abc}	7.67±0.33^{bcd}
	5N	3.67±0.33^{a}	4.67±0.33^{a}	5.00±1.00^{b}	6.00±1.00^{b}	7.00±1.00^{b}	8.00±1.00^{abc}
	10N	2.00±0.00^{ab}	2.67±0.33^{bc}	4.67±0.33^{abc}	5.67±0.33^{ab}	6.00±0.58^{abc}	7.00±0.58^{cde}
	50C	2.67±0.33^{b}	3.67±0.67^{b}	4.00±1.00^{bcd}	5.00a±1.00^{b}	6.00±0.33^{abc}	7.00±1.00^{cde}
	100C	2.67±0.33^{b}	3.67±0.33^{b}	4.67±0.33^{abc}	5.67±0.33^{ab}	6.67±0.67^{abc}	7.67±0.33^{bcd}
	5N+50C	3.33±0.33^{a}	4.33±0.33^{a}	4.67±0.67^{abc}	5.67±0.67^{ab}	6.67±0.00^{abc}	7.67±0.58^{bcd}
	5N+100C	3.00±0.33^{b}	4.00±0.00^{a}	3.33±1.67^{bcd}	6.00±0.00^{b}	7.00±0.00^{b}	8.67±0.33^{ab}
	10N+50C	3.33±0.33^{a}	4.33±0.33^{a}	6.00±0.00^{a}	7.00±0.00^{a}	8.00±0.00^{a}	9.00±0.00^{a}
	10N+100C	3.00±0.33^{a}	4.00±0.00^{a}	5.00±0.00^{b}	6.00±0.00^{b}	7.00±0.00^{b}	8.00±0.00^{abc}
TIRGAL	Control	2.67±0.33^{b}	3.67±0.33^{b}	4.00±0.58^{b}	5.00±0.58^{ab}	6.00±0.58^{abc}	7.00±0.58^{cde}
	5N	2.33±0.33^{b}	3.33±0.33^{b}	4.00±0.58^{b}	5.00±0.58^{ab}	6.00±0.58^{abc}	7.00±0.58^{cde}
	10N	2.33±0.33^{b}	3.33±0.33^{b}	4.33±0.67^{ab}	5.33±0.67^{abc}	6.33±0.67^{abcd}	7.33±0.67^{bcd}
	50C	2.67±0.33^{b}	3.67±0.33^{b}	5.00±0.00^{b}	6.00±0.00^{b}	7.00±0.00^{b}	8.00±0.00^{abc}
	100C	2.33±0.33^{b}	3.33±0.33^{b}	4.33±0.33^{ab}	5.33±0.33^{abc}	6.33±0.33^{abcd}	7.33±0.33^{bcd}
	5N+50C	3.00±0.00^{a}	4.00±0.00^{a}	4.67±0.33^{abc}	5.67±0.33^{ab}	6.67±0.33^{abc}	7.67±0.33^{bcd}
	5N+100C	2.67±0.33^{b}	3.67±0.33^{b}	5.00±0.00^{b}	6.00±0.00^{b}	7.00±0.00^{b}	8.00±0.00^{abc}
	10N+50C	2.67±0.33^{b}	3.67±0.33^{b}	4.33±0.33^{ab}	5.33±0.33^{abc}	6.33±0.33^{abcd}	7.33±0.33^{bcd}
	10N+100C	3.00±0.00^{a}	4.00±0.00^{a}	4.67±0.33^{abc}	5.67±0.33^{ab}	6.67±0.33^{abc}	7.67±0.33^{bcd}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. DAT= Days after treatment, N= NPK, C= Date palm waste compost, **NB**. **Mean ± SE**

4.13: Effects of date palm waste compost and NPK fertilizer on the leaf area (cm^2) of some varieties of *P. dactylifera* seedlings

The result of the effects of NPK and compost manure on Leaf Area of selected varieties of Date Palm Seedlings were analyzed (Table 4.13).

The statistical analysis showed that there was significant difference ($P<0.05$) within the varieties across the number of months and no significant difference recorded in the treatments.

There were significant differences ($P>0.05$) in all the varieties at 30, 60, 90, 120 and 150 Days after treatment with respect to Leaf Area but only at 180 days were Tirgal variety recorded as the highest (511.53cm^2) followed by SSM (509.50cm^2) and the lowest was Deglet variety (470.69cm^2).

At 30 days after treatment, the highest Leaf Area recorded was obtained in the application of combination of 10N+100C grams of NPK and compost manure (208.89 cm^2) followed by 10+50 combinations (191.36 cm^2) whereas control (no treatments) was the lowest (102.97 cm^2).

At 60 days after treatment, the highest Leaf Area obtained was 10N+100C (10 and 100 grams of NPK and compost) (385.46 cm^2) followed by 10+50 combinations (373.52 cm^2) and the lowest was control (no treatments) (255.80 cm^2).

At 90 days after treatment, the highest Leaf Area obtained was 10N+100C (combination of 10 and 100 grams of NPK and compost) (477.56 cm^2) followed by 10+50 combinations (428.76 cm^2) and the lowest was control (no treatment) of (319.33 cm^2).

At 120 days after treatments the highest Leaf Area was obtained in 10N+100C (10 and 100 grams of NPK and compost) of (513.82 cm^2) followed by 10+50 combinations (494.48 cm^2) and the lowest was control (no treatments) (366.23 cm^2)

At 150 days after treatment the highest Leaf Area was obtained in 10N+100C (10 and 100 grams of NPK and compost manure) (587.78 cm^2) followed by 10+50 combinations (565.91 cm^2) and the lowest was control (no treatments) (379.67 cm^2)

At 180 days after treatment the highest Leaf Area was obtained in 10N+100C (10 and 100 grams of NPK and compost manure) (595.01 cm^2) followed by 10+50 combinations (571.53 cm^2) and the lowest was control (no treatments) (408.73 cm^2)

Table 4.13: Effects of different application rate of NPK and compost manure on the Leaf Area (cm^2) of selected varieties of Date Palm seedlings in Jigawa State, Nigeria

Varieties	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
Deglet	153.92^{a}	265.34^{b}	328.91^{d}	393.61^{cd}	447.55^{de}	470.69^{f}
SSM	177.40^{a}	308.44^{bc}	382.23^{cd}	446.78^{de}	492.83^{ef}	509.50^{g}
Tirgal	157.72^{a}	302.10^{c}	376.41^{cd}	435.24^{e}	474.82^{f}	511.53^{g}
Treatments						
Control	102.97^{a}	255.80^{d}	319.33^{e}	366.23^{de}	379.67^{f}	408.73^{ef}
5N	151.70^{b}	267.21^{cd}	336.38^{c}	404.58^{ef}	381.79^{f}	466.68^{fg}
10N	156.97^{b}	288.90^{cd}	341.98^{de}	414.51^{ef}	415.55^{ef}	483.86^{fg}
50C	160.73^{b}	296.94^{cd}	360.14^{de}	430.47^{ef}	459.30^{g}	518.92^{fg}
100C	167.28^{ab}	310.52^{e}	387.91^{f}	439.78^{ef}	489.01^{fg}	534.18^{fg}
5N+50C	181.40^{c}	336.77^{de}	390.46^{ef}	431.16^{ef}	494.26^{fg}	540.38^{fg}
5N+100C	188.11^{c}	351.71^{de}	406.91^{ef}	481.21^{g}	511.00^{fg}	553.54^{fg}
10N+50C	191.36^{bc}	373.52^{de}	428.76^{ef}	494.48^{g}	565.91^{fg}	571.53^{fg}
10N+100C	208.89^{bc}	385.46^{de}	477.56^{fg}	513.82^{fg}	587.78^{h}	595.01^{h}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. DAT= Days After Treatment

4.14: Interaction effects of variety x treatment on leaf area (cm^2) of some varieties of *P. dactylifera* seedlings

The effects of variety by treatments interactions on the leaf area (Table 4.14), the results indicated that there were no significant interactions between the varieties and the treatments across the number of months. Leaf area was significantly interacted ($p \leq 0.05$) at 30, 60, 90, 120, 150 and 180 days of treatments application.

Substation materials (SSM) variety treated with 5+100 grams of combinations interacts positively (578.97 cm^2), followed by the one treated with 10+100 grams of combinations (558.93 cm^2) and the lower significant interactions was obtained in 5+50 grams of combinations (444.50 cm^2).

Tirgal variety treated with 10+100 grams of combinations showed significant interactions (572.97 cm^2), followed by 10+50 grams of combinations (530.63 cm^2) and the least was control (478.73 cm^2)

Similarly, Deglet variety treated with 50 grams of compost manure showed significant interactions (524.97 cm^2), followed by (10+100) combinations (503.13 cm^2) and the least significant interactions was obtained in 100 grams of compost (414.50 cm^2)

Table 4.14: Interaction effects of variety x treatment on the leaf area (cm^2) of some Date palm seedlings

Var.	Trt.	30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT
DEGLET	Control	118.40±33.30^{i}	261.60±31.20^{g}	330.83±16.27^{efg}	406.27±12.33^{def}	477.37±40.45^{def}	481.37±12.33^{cde}
	5N	148.43±20.93^{fgh}	235.23±7.43^{fgh}	320.93±28.13^{fgh}	383.23±16.43^{efg}	407.30±7.60^{i}	441.30±15.40^{cde}
	10N	152.43±18.87^{efg}	259.33±9.23^{efg}	315.87±15.47^{fgh}	392.37±11.67^{g}	425.53±7.40^{fgh}	465.23±7.02^{cde}
	50C	152.30±16.40^{efg}	289.27±45.28^{def}	365.30±35.27^{def}	406.50±41.50^{def}	509.93±3.63^{abc}	524.97±26.92^{bcd}
	100C	204.80±0.00^{b}	201.50±0.00^{fgh}	289.60±0.00^{i}	351.20±0.00^{efg}	388.70±0.00^{ghi}	414.50±0.00^{def}
	5N+50C	166.10±10.59^{def}	232.20±4.20^{h}	325.40±26.90^{efg}	378.97±23.57^{efg}	411.37±32.97^{fgh}	426.77±5.83^{def}
	5N+100C	141.70±0.00^{fgh}	259.90±0.00^{efg}	366.20±0.00^{def}	413.80±0.00^{def}	492.10±0.00^{bcd}	499.30±0.00^{bcd}
	10N+50C	120.33±19.53^{ghi}	390.00±3.40^{ab}	302.60±54.70^{fgh}	416.17±27.77^{def}	438.93±30.73^{efg}	479.60±35.30^{cde}
	10N+100C	180.60±0.00^{bcd}	259.07±3.57^{efg}	343.47±10.83^{efg}	393.97±12.36^{efg}	476.73±13.77^{def}	503.13±17.47^{bcd}
SSM	Control	122.67±7.48^{ghi}	255.80±25.12^{efg}	319.33±8.17^{fgh}	366.23±9.59^{efg}	472.10±36.86^{def}	492.10±28.66^{def}
	5N	160.20±19.90^{def}	259.23±36.97^{efg}	311.97±44.43^{h}	385.33±22.07^{efg}	418.83±28.97^{fgh}	455.37±30.13^{efg}
	10N	166.07±24.89^{cde}	283.20±38.39^{def}	375.40±32.99^{def}	438.23±29.06^{bcd}	460.20±29.63^{def}	485.63±36.88^{def}
	50C	182.37±30.03^{bcd}	343.40±7.90^{abc}	414.03±5.83^{def}	465.27±14.07^{abc}	498.00±12.30^{bcd}	540.27±19.87^{bcd}
	100C	136.33±15.13^{fgh}	274.17±51.37^{def}	343.63±31.33^{abc}	432.97±21.17^{bcd}	510.70±1.00^{abc}	535.40±10.10^{bcd}
	5N+50C	189.80±10.30^{bc}	274.87±18.17^{def}	327.07±26.67^{efg}	403.27±33.57^{cde}	421.97±36.27^{h}	444.50±40.40^{def}
	5N+100C	250.50±0.00^{a}	406.30±0.00^{a}	543.60±0.00^{a}	608.50±0.00^{a}	652.40±0.00^{ab}	678.97±53.67^{a}
	10N+50C	184.60±0.59^{bcd}	314.63±3.27^{bcd}	372.17def3.77^{a}	432.17±11.17^{bcd}	468.07±3.77^{def}	494.37±2.57^{cde}
	10N+100C	204.07±2.13^{b}	364.33±25.47^{abc}	432.87±22.4 3^{ab}	489.03±23.87^{ab}	533.20±22.70^{ab}	558.93±29.27^{ab}
TIRGAL	Control	102.97±2.13^{j}	318.47±46.79^{bcd}	407.50±32.50^{bcd}	418.13±11.58^{def}	460.67±19.39^{efg}	478.73±21.92^{def}
	5N	164.47±40.4 1^{cde}	367.17±15.66^{abc}	406.23±5.54^{bcd}	445.17±17.41^{abc}	469.23±10.81^{def}	503.37±8.89^{bcd}
	10N	152.27±13.35^{efg}	264.17±15.88^{def}	334.67±6.24^{efg}	412.93±8.44^{cde}	444.80±6.16^{efg}	500.70±13.22^{def}
	50C	147.53±27.49^{fgh}	288.17±38.04^{def}	361.10±37.92^{def}	419.63±42.29^{cde}	453.97±37.75^{efg}	491.53±46.78^{def}
	100C	160.70±24.61^{def}	305.90±58.04^{bcd}	380.50±48.45^{def}	445.17±37.35^{abc}	477.63±36.21^{efg}	502.63±30.56^{bcd}
	5N+50C	188.30±16.91^{bc}	293.23±13.98^{def}	368.90±22.74^{def}	421.23±20.73^{cde}	469.43±17.95^{efg}	509.87±5.24^{bcd}
	5N+100C	172.13±18.03^{cde}	268.93±24.73^{def}	370.93±6.63^{def}	421.33±1.67^{cde}	481.50±3.40^{bcd}	513.37±8.93^{bcd}
	10N+50C	179.13±16.70^{cde}	325.93±25.41^{bcd}	401.50±27.45^{bcd}	455.10±29.91^{abc}	490.73±24.58^{abc}	530.63±21.79^{def}
	10N+100C	152.00±0.40^{efg}	286.97±10.83^{def}	356.33±20.52^{efg}	478.47±6.37^{ab}	525.40±3.59^{ab}	572.97±3.33^{ghi}

Means followed by the same letters in column (superscript) according to DMRT at 5% level of significance are not significantly different. Days After Treatments, N= NPK, C=Compost, **Mean ± SE**

4.2 DISCUSSION

4.2.1 Compost and Soil Compositions

The analysis of Date palm waste compost as shown in Table (4.1) indicated that the prepared compost is rich in major essential elements Such as Nitrogen, Phosphorus, Potassium, Magnesium at higher quantity which could be an indication of its potential to improve vegetative growth and physiological functions of date palm seedlings. This is in line with the findings of Gray *et al.* (1997) who stated that compost manure contains all the essential, micro and macro elements the plant required to grow. Compost manure also play significant role in stabilizing soil structure and nutrients amendments to be favorable for plant generation. This also conforms with the findings of Mohamed *et al.* (2018) who stated that the application of Date palm waste compost at 30 t ha^{-1} increased significantly the principal soil properties (organic matter and water retention capacity) and decreased their electric conductivity.

The Soil Analysis Table (4.2) indicated the soil was sandy loam with a composition of sand, clay and silt. It was also indicated that Electric Conductivity was higher and Cation Exchange Capacity, Exchangeable Acidity and Bases were moderate. The results showed that; Phosphorus, Total Nitrogen, Organic Matter, Potassium were low and thus, needs amendments as described by Mohamed *et al.* (2018). Also primary elements below desired ranges must be amended for efficient plants growth.

4.2.2 Physiological Parameters

4.2.2.1 Chlorophyll

The chlorophyll contents of date palm seedlings were significantly enhanced by the application of combination of compost manure and NPK fertilizer at 10 and 100 grams respectively followed by 10 and 50 grams of the combinations. This is probably due to the high quantity of Nitrogen in both treatments and Magnesium in the Compost which play significant role in chlorophyll production and protein synthesis as described in the findings of Uwumarongie-Ilori *et al.* (2012). Similar findings were reported by Rosenani *et al.* (2016) who reported on Oil palm seedlings growth and physiology improved with the application of compost which show similar growth patterns

4.2.2.2 Photosynthetically Active Radiation

Photosynthetically active radiation (PAR) also showed a greater response at 10 and 100 grams of compost and NPK respectively, followed by 10 and 50 grams of the combinations. This could be due to the fact that the values obtained were within the normal spectral range of solar radiation (400-700) nanometers that photosynthetic organisms are able to use in the process of photosynthesis. Also corresponds with the same reason obtained for chlorophyll as they are closely related in functions (Uwumarongie-Ilori *et al.* 2012)

4.2.3 Growth Parameters

4.2.3.1 Plant Height

The Plant height showed that the there were significant increase in height of different varieties of date palm especially the one treated with application of combination of compost manure and NPK fertilizer at 10 and 100 grams. This was followed by 10 and 50 grams of the combinations. This may be as a result of high nitrogen in both the compost manure and inorganic fertilizer. This agrees with the finding of Hamdan *et al.* (1998), Verma, (2011) who stated that plant growth is associated with availability of nutrients such as Nitrogen, Phosphorus, Potassium and Magnesium etc.

4.2.3.2 Stem Girth

Stem girth responds positively to the application of inorganic fertilizer (NPK) at 10 grams. Probably due to the fact that Nitrogen requirement in large quantity is a physiological component which is directly related to genetic potential of a crop and its growth as reported by Uwumarongie-Ilori, (2012). Phosphorus is also a vital component of adenosine triphosphate ATP which supplies the energy for many physiological processes, this is also in conformity with Aisueni *et al.* (2014).

4.2.3.3 Number of Leaves

Number of leaves significantly increased via the application of 10 and 100 grams of NPK and compost manure, followed by 10 and 50 grams, this could be attributed to the presence of other secondary and trace elements in the compost plus the high quantity of nitrogen contained in inorganic fertilizer (NPK). This was similar to the findings reported by Aisueni *et al.* (2014).

4.2.3.4 Leaf Area

Leaf Area showed significant response through the application of 10 and 100 grams of NPK and compost manure, followed by 10 and 50 grams. It is probably linked to the higher quantity of primary element (Nitrogen, Phosphorus and Potassium) contained in the inorganic fertilizer and the other useful elements found in the compost required by the plant. This report agrees with the findings of Oviasogie *et al.* (2013).

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The research was conducted to evaluate the effects of Date palm waste compost and NPK fertilizer on growth and physiology of Date palm (*Phoenix dactylifera* L.) seedlings. It was carried out at Botanic garden of Bayero University Kano to seedlings. The study showed that there was significant increase in plant height (79.42), stem girth (21.81), number of leaves (14.37), leaf area (595.01), chlorophyll (105.96) and PAR (335.67) parameters after 180 days, were combinations of NPK and Compost at 10 and 100 grams gave the best result. Similarly, the interaction between the varieties and treatments shows that Deglet at higher level of combinations (NPK + Compost) had significant response with respect to Plant Height and Chlorophyll contents.

However, Substation material showed similar response on Stem Girth, Number of Leaves and Leaf Area. Tirgal variety also had higher significant interaction on Photosynthetically Active Radiation only. The results suggested that date palm waste enhances date palm seedling growth in the nursery and could serve as alternative soil fertility treatment to inorganic fertilizer. However, combination of NPK and compost manure may be needed to enhance seedlings physiology and vegetative growth.

5.2 CONCLUSION

Conclusively, it was found from the research that Date Palm Waste Compost when applied in adequate quantity (≥100g) would enhance growth and physiological performance of Date Palm seedlings. However, chemically fertilized date palm seedlings show significant response with respect to vegetative growth parameters and similar effects on physiology.

The study also reveals that significant increase was observed in both growth and physiological measurements when seedlings were treated with combinations of NPK and Date palm waste compost.

5.3 RECOMMENDATIONS

1- It could be recommended that Date palm waste should be composted, utilized and used for nursery seedlings fertilization especially at 100 grams, and the combinations of compost and inorganic fertilizer as well.

2- For efficient production of Date palm seedlings, the use of chemical fertilizers should be minimized according to the recommendations of the United State Department of Agriculture (USDA) that young nursery seedlings raised under organically processed manure perform better when transplanted

3- Further research should be carried out to determine the sex of Date palm at seedlings stage using Karyotype analysis, as it was the second part of the research that was not accomplished.

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APPENDICES

Appendix 1. Nutritive value of different parts of date palm biomass

S/No	Samples	P%	Ca%	Mg%	K%	Na%	N%
A	DTPBS	0.058	0.275	0.160	0.969	0.047	0.228
B	DTPB	0.032	0.281	0.190	0.958	0.043	0.082
C	DTSB	0.043	0.257	0.112	0.922	0.045	0.179
D	DTFB	0.088	0.160	0.065	0.935	0.030	0.077

A= Date palm bunch stem, B=date palm bunch spikes, C= Date palm bunch sticks, D= Date palm flowers. Source: Aisueni *et al.*, Date palm task execution project report, NIFOR (2009)

Appendix 2. Desired Ranges of Some Important Parameters of Compost from Plant origin

S/No	Parameters	Values
1	Electric Conductivity	<2.5
2	pH	6-7.5
3	Moisture Contents	40-50
4	Organic matter	50-70
5	C:N ratio	<25

Adapted for Organic materials 1995 (Michael Leaond): California Integrated Waste Management Board