FECT OF TOPSOIL AND CATTLE DUNG MANURE POTTING MIXTURE ON THE GROWTH OF PAWPAW SEEDLINGS (*Carica papaya* L.)

BY

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UNIVERSITY OF BENIN
BENIN CITY

NOVEMBER, 2025

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A PROJECT SUBMITTED TO THE DEPARTMENT OF CROP SCIENCE, FACULTY OF AGRICULTURE, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA IN PARTIAL FULFILLMENT OF THE AWARD OF THE DEGREE OF BACHELOR OF AGRICULTURE (B. AGRIC.) DEGREE IN CROP SCIENCE, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA.

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CERTIFICATION

This is to certify that this project was carried out by **Abdulkareem MOHAMMED LAWAL (AGR2004347)** under the guidance of the project supervisors and approved by the Department of Crop Science, Faculty of Agriculture, University of Benin, Benin City, Nigeria.

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Prof. K.E. Law-Ogbomo Project Supervisor	Date
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Prof. A.U. Osaigbovo Co- Supervisor	Date
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Prof. S.U Ewansiha Head of Department	Date

DEDICATION

This work is dedicated to Allah (Subhanahu Wa Ta'ala). From whom all knowledge and success originate. Alhamdulillah for the strength to begin, the patience to continue, and the blessing of completion.

To my beloved parents, for their unending support, sacrifice, and love, which paved the way for this accomplishment.

And to the Muslim Ummah, may this humble contribution be of benefit, however small, to our community and to the pursuit of knowledge. I pray it serves as a stepping stone for future progress and understanding.

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ABSTRACT

A study was carried out in the cropping season of 2025 at the screen house of the Department of Crop Science, Faculty of Agriculture, University of Benin, Ugbowo Campus, Benin City to evaluate the effect of topsoil and cattle dung potting mixture on the growth of pawpaw (*Carica papaya* Linn) seedlings. The trial involved five potting media (topsoil (TS), cattle dung (CD), TS+ CD 1:1, TS+ CD 1:2 And TS+ CD 2:1) laid out in a completely randomized design (CRD) and replicated three times. Data were collected on the physical and chemical properties, growth parameters (stem height, stem girth, number of leaves and leaf area) and dry matter indices (total dry weight, shoot dry weight, root dry weight and root:shoot ratio) of all potting media. Results of the study show that seedlings grown in mixtures of topsoil and cattle dung (TS + CD) consistently showed superior growth in terms of plant height and stem girth compared to those in topsoil and cattle dung alone. At 8 WAS, the TS + CD 1:1 potting medium produced seedlings with the largest leaf area, longest root length, highest shoot dry weight, root dry weight and total dry weight. Based on the superior performance in the key growth parameters, the use of a 1:1 mixture of topsoil to cattle dung is recommended for growing pawpaw seedlings in the nursery.

CHAPTER ONE

INTRODUCTION

The pawpaw (*Carica papaya* L.) is a member of the family Caricaceae and order Brassicales (Angiosperm Phylogeny Group, 2016). It is a fast-growing, large herbaceous plant known for its succulent fruit and economic importance in tropical agriculture. Manshardt (1992) traced the origin of pawpaw to the Caribbean coast of Central America, Argentina, Chile and Southern Mexico. Research suggests that the domestication of pawpaw emerged from natural hybridization between *Carica peltata* and other wild species (Manshardt, 1992).

It typically has a single, straight trunk and can reach heights of 5 to 10 meters. The stem is succulent, hollow, cylindrical, and becomes woody only at the base with age. The exterior is marked by prominent, shield-shaped leaf scars arranged in a tight spiral, indicating where leaves were once attached. The leaves are large (50-70 cm in diameter), palmately-lobed with 7-11 deep lobes, and arranged spirally at the apex of the trunk. The petioles (leaf stalks) are long (40-100 cm), succulent, and hollow (Nakasone and Paull, 1998). The fruit is a large berry, with shape, size, flesh colour (yellow, orange, or red), and flavour varying significantly among cultivars. The plant has a shallow and relatively weak root system, consisting of a main taproot with extensive lateral surface roots. This morphology makes it highly susceptible to damage from waterlogging, drought, and strong winds (Evans and Ballen, 2012).

The optimal temperature range for pawpaw cultivation is between 21°C and 33°C. Growth is greatly inhibited below 12°C, while exposure to frost is often lethal (Crane, 2005). Conversely, temperatures exceeding 35°C can lead to flower drop and reduced fruit production. Pawpaw requires substantial rainfall of 1000 mm to 2000 mm annually and evenly distributed. Although the plant needs a lot of water, it cannot tolerate waterlogged conditions. Consistent irrigation is vital for good fruit development during dry spells (Singh and Singh, 2019).

Pawpaw can be used as a food, a cooking aid, and in medicine. It is considered as a low calorie nutrient dense fruit (Ali *et al*., 2012) and may be eaten fresh, juiced, or incorporated into salads, smoothies, and desserts. A significant industrial application of pawpaw is the extraction of a complex mixture of proteolytic enzymes from its latex, of which papain is the most prominent. In clinical settings purified papain is used in wound care preparations for enzymatic debridement, effectively removing dead or necrotic tissue from burns, ulcers, and wounds to promote healing (Gurung and Skalko-Basnet, 2009). Pawpaw leaf extract has been extensively investigated and is widely used in many tropical countries to manage thrombocytopenia (low platelet count) associated with dengue fever, with studies suggesting it can significantly boost platelet levels (Subenthiran *et al*., 2013). The seeds of the pawpaw have demonstrated significant anthelmintic properties in scientific studies, validating their traditional use in expelling intestinal parasitic worms in both humans and livestock (Okeniyi *et al*., 2007).

The successful raising of pawpaw seedlings for planting out in the field is significantly hampered by suboptimal growing media, particularly with soils deficient in organic matter. Yet, many farmed lands globally, especially those under continuous cultivation experience degradation, frequently showing low levels of organic matter, resulting in poor fertility with low nutrient base. Low organic matter directly impairs crucial soil properties for pawpaw which include water holding capacity, nutrient retention, aeration, and microbial activity, all of which are essential for the plant's vigorous growth and productivity (Abad *et al*., 2002; CABI, 2019). Consequently, insufficient organic matter can lead to stunted growth, reduced fruit set, decreased fruit quality, and increased susceptibility to stress conditions like drought and nutrient imbalances, thereby limiting the overall yield and economic viability of pawpaw cultivation. Therefore, there is a critical need to investigate effective and sustainable strategies for enhancing soil organic matter content in pawpaw growing media. This necessitates exploring the use of various organic amendments such as cattle dung and their combinations to alleviate the problem of low organic matter, thereby improving soil health, and ultimately optimize the growth of pawpaw seedlings. Therefore, this study was conducted to assess the impact of topsoil and cattle dung in different ratios in potting media on the seedling growth of pawpaw (*Carica papaya* L.).

CHAPTER TWO

LITERATURE REVIEW

2.1 Economic importance of pawpaw

2.1.1 Food and Beverage:

Carica papaya is mainly grown for its edible fruit, valued for its high nutrient content. The mature fruit provides considerable quantities of vitamins such as A, C, and E, along with essential minerals such as potassium and magnesium. It also has a considerable amount of dietary fiber, which is beneficial for digestion (Krishna *et al*., 2008). Due to its abundant antioxidants such as β-carotene and lycopene, pawpaw is often regarded as a nutraceutical fruit that contributes to disease prevention beyond basic nourishment (Milind and Gurditta, 2011). It plays an essential role in the production of jams, jellies, marmalades, fruit juices, nectars, concentrates, and other processed food items. In many Asian cuisines, particularly in Southeast Asia, the firm texture of unripe papaya makes it a popular ingredient in dishes such as salads, pickles and curries (FAO, 2002).

2.1.2 Medicinal and Pharmacological Applications:

In addition to its nutritional benefits, every part of the pawpaw plant including the fruit, leaves, seeds, and roots, has recognized medicinal qualities. The latex of pawpaw contains papain, a proteolytic enzyme found in the plant's milky latex. Papain is recognized for its strong, digestive and anti-inflammatory properties that are widely utilized in traditional medicine (Mali and Mehta, 2008). Moreover, studies indicate that pawpaw leaf extract exhibits antiviral activity and can increase platelet counts in dengue-infected individuals, suggesting potential for supportive therapy (Saran and Chaudhary, 2014). The plant's abundant phytochemical content, which includes flavonoids and alkaloids, also adds to its antibacterial, antifungal, and anticancer properties, making it a focus of extensive research for innovative pharmaceutical advancements (Anaga and Onehi, 2010).

2.1.3 Industrial Uses:

The economic impact of pawpaw reaches various industries, primarily revolving around the enzyme papain. Papain is an enzyme of significant commercial value, utilized as a meat tenderizer in the food sector. Its protein-digesting properties are also utilized in the brewing industry to reduce "chill haze" and in textile and leather sectors for processing and tanning (Krishna *et al*., 2008). The seeds from the pawpaw fruit, often considered a waste product, can be dried and used as a black pepper substitute due to their spicy taste and antibacterial features (Heuzé and Tran, 2015).

2.1.4 Export Potential:

Pawpaw presents considerable export possibilities due to the growing global demand for healthy, nutrient-dense, and exotic tropical fruits. It is a critical cash crop for developing countries, where export revenues support the livelihoods of thousands of farmers. Key exporters include Mexico, Brazil, and Guatemala, with significant markets located in North America and Europe. Prominent export varieties, like the small, pear-shaped 'Solo' papaya, are favored in international markets for their practicality and quality consistency (FAO, 2002).

2.2 Potting media

Potting media (also called growing media or substrates) are materials specifically formulated for growing plants in containers. They are used instead of natural garden soil, which is generally unsuitable for pots because it is too dense, inconsistent, and can harbor pathogens. The purpose of potting media is to provide an optimal environment for root growth within the limited space of a pot (Landis, 1990). The composition and characteristics of these media are paramount to the success of nursery operations, horticulture, and home gardening, directly influencing plant health, vigour, and yield.

The basic functions of a potting medium are; four in total, first it must provide the plant with physical support and anchorage through having the roots well held inside it. Secondly, it must be a water reservoir and be able to hold sufficient water to meet the requirements of the plant for the duration between irrigation. Thirdly, it must be a reservoir of nutrients because it can either have them stored in the components or because it is able to retain additional fertilizers. Finally, and most critically, it should allow efficient gas exchange, supplying oxygen to roots to be utilized in respiration and allowing carbon dioxide to diffuse away. (Bilderback *et al*., 2005).

Potting media are typically composed of a blend of organic and inorganic components, each contributing specific properties to the final mix. Traditionally, sphagnum peat moss has served as the primary organic base in most potting mixtures because of its water-holding capacity, aeration properties and slightly acidic pH. However, environmental concerns over the sustainability of peat harvesting have driven a significant shift towards alternatives (Abad *et al*., 2001). Coconut coir, a byproduct of the coconut industry readily available in tropical regions like Nigeria, has emerged as a leading substitute, valued for its excellent water retention, re-wettability, and durability. Other common organic components include composted pine bark, which improves aeration and drainage, composted green waste, and agricultural byproducts like rice hulls, which enhance drainage and reduce bulk density (Handreck and Black, 2002).

Inorganic components are added to modify the physical properties of the mix. Perlite, a heat-expanded volcanic glass, is a lightweight, sterile material used to increase aeration and drainage without adding significant weight. Vermiculite, a heat-expanded mica mineral, is porous and has a high cation exchange capacity (CEC), allowing it to retain both water and nutrients effectively. Coarse sand can also be used to increase drainage and add weight for stability in larger pots, although it significantly increases the bulk density of the medium (Landis, 1990).

An ideal potting medium, therefore, is not a single recipe but rather a concept characterized by several desirable traits. Physically, it should be lightweight and easy to manage, with a low bulk density while still providing enough stability. It needs to have high overall porosity, featuring a balanced mix of small pores that retain water (container capacity) and large pores that facilitate air movement (air-filled porosity), typically targeting 10-20% air-filled porosity right after watering (Bilderback *et al*., 2005). Chemically, a perfect medium should maintain a pH level between 5.5 and 6.5 in order to ensure optimal nutrient accessibility for most plant species. It should also possess an adequate cation exchange capacity (CEC) to hold onto vital mineral nutrients while maintaining low initial levels of soluble salts to avoid harming young roots (Handreck and Black, 2002). Biologically, the medium needs to be either sterile or pasteurized so that it is free from pathogens, insect pests, and weed seeds. Lastly, the ideal mix must be consistent, reproducible, and cost-effective, utilizing materials that are readily available locally to promote sustainability (Oyekale and Adebayo, 2019).

2.3 Cattle dung

Cattle dung, also referred to as cow manure, has long been recognized as one of the earliest and most widely utilized organic inputs in farming due to its role in nutrient supply and soil improvement. It is a complex mixture composed of both digested and undigested feed, metabolic by-products, and microorganisms from the animal's digestive system.

The composition of cattle manure, which is abundant in essential nutrients for plants and organic substances, can differ greatly based on factors like the animal's feed, age, the type of bedding used, and the methods of manure collection and storage (Chadwick *et al*., 2000). The solid component is especially rich in macronutrients, mainly nitrogen (N), phosphorus (P), and potassium (K). A notable portion of nitrogen exists in the form of ammonia, which may escape into the air if not managed properly. Furthermore, manure supplies secondary nutrients such as calcium, magnesium, and sulfur, in addition to micronutrients including zinc and copper (Eghball and Power, 1998).

One of the key benefits of cattle dung is the addition of organic matter, which is crucial for soil health and serves as a slow-release nutrient source during the decomposition process. The use of cattle manure provides advantages that go beyond simply acting as a fertilizer. The organic matter helps bind soil particles into aggregates, which improves soil structure (tilth), increases pore space, and enhances water infiltration and retention. This contributes to a reduction in runoff, increases resilience to drought, decreases bulk density, and aids root penetration (Haynes and Naidu, 1998). Additionally, manure guarantees a steady nutrient supply through microbial decomposition, minimizes the risk of nutrient leaching compared to synthetic fertilizers, boosts the soil's cation exchange capacity (CEC), and releases organic acids that can assist in stabilizing soil pH (Eghball and Power, 1998).

Prior to its application, manure is frequently treated, with composting being among the most efficient methods. This regulated aerobic process stabilizes organic materials, diminishes both bulk and moisture levels, removes a majority of pathogens and weed seeds, and transforms volatile nitrogen into more stable varieties. The resulting compost is a dark, nutrient-dense substance that is safer to manage and apply. (Nicholson *et al*., 2005).

In Nigeria, particularly in the northern savanna regions where cattle production is prominent, sun-drying manure into cakes is a traditional practice to lower moisture content and facilitate transport. However, composting is increasingly encouraged as it helps conserve nutrients and improve hygiene (Adebisi and Ojo, 2021). Properly managed cattle manure is especially important for smallholder farmers in sustaining the fertility of soils that are often deficient in organic matter.

2.4 Inclusion of cattle dung in potting media

The main benefit of adding cattle dung to a potting mix is its ability to improve the fertility of the substrate. It acts as both a source and a storage of vital macronutrients for plants, such as nitrogen (N), phosphorus (P), and potassium (K), while also providing a wide range of micronutrients, including zinc and manganese (Eghball and Power, 1998). In contrast to highly soluble synthetic fertilizers that may result in nutrient loss due to leaching, the nutrients found in manure are organically bound. Their release is regulated by the gradual process of microbial mineralization, which involves soil organisms breaking down the organic material and ensuring a consistent nutrient supply throughout the plant's growth period. This slow-release nature is particularly beneficial in the limited root zone of a container, as it guarantees a long-lasting nutrient supply and minimizes the need for frequent fertilizer applications.

Beyond its chemical properties, the structure of a potting medium is vital for plant health, necessitating a balance between moisture retention and aeration for the roots. Well-decomposed cattle manure contributes stable organic matter, or humus, which greatly enhances a substrate's ability to hold water, functioning like a sponge to lessen the frequency of irrigation. As noted by Handreck and Black (2002), a suitable medium must also have a high level of air-filled porosity to allow for gas exchange necessary for root respiration. Here lies the crucial difference: while properly composted manure aids in forming stable aggregates that preserve this porosity, the utilization of raw, untreated manure is harmful. Its fine particles obstruct air-filled pores, resulting in compaction, increased bulk density, and ultimately, saturated, anaerobic conditions that encourage root rot. Thus, the physical advantages of manure rely entirely on its prior decomposition.

The effective incorporation of cattle dung into potting mixes relies on its processing through a curing procedure, which is a critical pre-treatment that reduces various inherent risks. Fresh manure is not appropriate for container gardening due to its potentially high levels of soluble salts and ammonia, both of which can be toxic to plants and lead to serious root injury. Additionally, it typically contains a substantial number of pathogens and viable weed seeds. The curing process, involving the drying and aging of the manure, successfully stabilizes the organic materials, guaranteeing that the end product is safe, consistent, and advantageous for plant growth.

Given these properties, cattle dung should not be viewed as a stand-alone potting medium but rather as a valuable component within a larger formulation. It is typically blended with materials that provide structural integrity and enhance aeration, such as composted bark, coconut coir, sand, or perlite. Scientific research, like the experimental trials conducted by Adebisi and Ojo (2021), helps determine optimal inclusion rates by testing various volumetric ratios and measuring plant responses. Such studies consistently show that inclusion rates between 10 and 30% by volume are often effective. This range provides significant nutritional benefits without compromising the physical structure of the medium. Exceeding this limit may result in a mix that is too dense and retains too much water, potentially harming root health and the general vitality of the plants. In conclusion, cattle dung manure is a highly effective and sustainable additive for enhancing potting media. Nonetheless, it is advised to use it only after it has been adequately and properly processed.

CHAPTER 3
MATERIALS AND METHODS

3.1. Experimental site

The study was conducted in the screen house of the Department of Crop Science, University of Benin, Ugbowo Campus, Benin City, Nigeria. The area lies within the tropical rainforest zone between Latitude 6° 23′ 37″ and 6° 24′ 26″ North and Longitude 5° 36′ 25″ and 5° 38′ 09″ East at 162m above sea level. The tropical climate is characterized by high humidity, a mean annual rainfall of 1761.90 mm with a brief dry season, and average daily temperatures between 25 and 30°C.

3.2. Collection and preparation of materials

The topsoil used in this study was sourced from the experimental research farm of the Faculty of Agriculture, University of Benin, Benin City. The cattle dung used was obtained from a cattle market along Federal Government Girl's College Road, Benin City and cured under shade for a period of six weeks before usage. Dry and viable packaged pawpaw seeds from Maradona F1 variety were purchased from Farmers Shopping Complex, First East Circular Road, Benin City. A total of 150 polythene bags, also referred to as polybags were used and were purchased from a certified supplier.

3.3. Experimental design

The study comprised five potting media (topsoil (TS) only (3 kg), cattle dung (CD) only (3 kg), TS + CD (1:1, 1.5 kg each), TS + CD (1:2, 1 kg TS and 2 kg CD), and TS and CD (2:1, 2 kg TS and 1 kg CD) laid out in completely randomized design (CRD) with three replications. Each treatment had ten polybags per replicate giving rise to 50 polybags per replication and 150 polybags in all.

3.4. Soil and media analysis

Tests were conducted at the department of Soil and Land Management laboratory, Faculty of Agriculture, University of Benin, to analyze the physical and chemical properties of each potting medium before sowing. The tests measured pH, electrical conductivity (EC), organic carbon, organic matter, total nitrogen, exchangeable acidity (Al^{3+} and H^{+}), and exchangeable bases (sodium, potassium, calcium, and magnesium). Additionally, the effective cation exchange capacity (ECEC), particle size, bulk density and porosity were also determined.

3.5 Management practices

Each polybag was filled with the appropriate potting media as per treatment, perforated, randomized and was irrigated with 100ml of water daily for a week. One pawpaw seed was sown per polybag. Seedlings emerged after one week, after which irrigation was reduced to 100 ml every three days, and weeds were removed by hand.

3.6. Data collection

Plant growth was assessed by measuring seedling height, stem girth, number of leaves and leaf area at two-week intervals, starting two weeks after sowing (WAS) on three randomly selected seedlings.

3.6.1 Seedling height: This was measured from the base of the stem to the tip of the youngest leaf using a meter rule on the three randomly selected seedlings, summed up and average determined to obtain the seedling height.

3.6.2 Stem girth: This was measured at the base of the stem using a flexible measuring tape on the three randomly selected seedlings and mean estimated to obtain the stem girth.

3.6.3 Number of leaves: This was determined by a direct count of all fully emerged leaves on each of the three randomly selected seedlings and the average calculated to arrive at the number of leaves per plant.

3.6.4 Leaf length and width of some leaves of the three randomly selected seedlings were taken and mean estimated. The resultant leaf length and width were used to estimate the leaf area and thus:

Leaf Area= (Average Length×Average Width) × Total Number of Leaves × 0.65

Where 0.65 is a standard correction factor (Schrader *et al.*, 2021)

3.7 Dry matter determination

At 8 WAS, the three randomly selected seedlings from each treatment were uprooted. The roots were carefully washed to remove soil, and the total fresh weight of each plant was taken and recorded. Each seedling was then separated into its root and shoot components. These parts were weighed separately, placed in separate, labeled aluminum foil envelopes and oven-dried at 60°C to a constant weight. After drying, the dry weight of the roots and shoots was taken and recorded separately to compute the total dry weight (TDW), root to shoot ratio and dry root length.

3.8 Data analysis

All collected data were subjected to an Analysis of Variance (ANOVA). When significant differences were found among treatments, the means were compared using the Least Significant Difference (LSD) test at a 5 % probability level ($p \leq 0.05$).

CHAPTER 4

RESULTS

4.1 Properties of the potting media

The physical and chemical properties of the different potting media before sowing is presented in Table 1. The pH value was highest in cattle dung only and TS + CD 1:1 potting media with similar values produced in TS + CD 2:1 potting media. Cattle dung recorded the highest values for electrical conductivity EC, organic C, organic matter and key nutrients including total N, available P, K, Ca, Mg and Na with similar values recorded for TS + CD 1:1 potting medium and lowest values in topsoil only potting medium. Physically, the topsoil only medium had the highest bulk density and was similar to TS + CD 1:2 potting media while also being the least porous. As the proportion of cattle dung in the mixes increased, the bulk density decreased while porosity increased, with cattle dung being the least dense and most porous. Al^{+} and H^{+} content was highest in the topsoil only medium and reduced with increasing cattle dung content.

4.2 Effect of topsoil and cattle dung potting media on seedling growth of pawpaw

4.2.1 Seedling height

The influence of the potting mixtures on pawpaw seedling height at 3 - 8 weeks after sowing (WAS) is presented in Table 2. The seedlings grown in TS + CD 1:1, TS + CD 2:1, and TS + CD 1:2 potting media were significantly taller than those in either topsoil or cattle dung alone at 3 and 4 WAS. At 4 WAS, the cattle dung (CD) medium produced taller seedlings than the topsoil (TS) medium. All potting media produced seedlings of similar height at 6 WAS. At 8 WAS, the TS + CD 1:2 potting medium produced the tallest seedlings which was on par with those grown in TS + CD 1:1 potting medium.

Table 1: Properties of potting media

Potting medium	pH	EC (µS/cm)	Org.C (g/kg^{-1})	Org.M (g/kg^{-1})	T.N (g/kg^{-1})	Al^{+}	H	Na	K (Cmol/kg)	Ca	Mg	ECEC	Bulk Density g/cm^3	Porosity (%)	Avg. P (mg/kg)	Clay	Silt (%)	Sand	Textural class
Topsoil (TS)	4.30	402	0.56	0.96	0.051	1.1	0.7	0.15	0.55	0.48	0.27	3.25	1.6	36	0.18	9.3	0.6	90.1	Sand
Cattle Dung (CD)	5.00	4948	22.40	38.5	2.000	NA	NA	1.04	7.15	5.01	2.88	NA	1.0	62	18.6	NA	NA	NA	NA
TS+CD 1:1	5.00	4122	18.70	32.2	1.700	0.5	0.3	0.76	5.35	3.01	1.48	11.4	1.2	54	15.1	16.6	1.1	82.3	Sandy Loam
TS+CD 2:1	4.80	2693	11.30	19.4	1.000	0.7	0.5	0.38	2.45	1.42	0.88	6.33	1.3	51	13.7	13.2	0.8	86.0	Loamy Sand
TS+CD 1:2	4.60	1796	8.60	14.8	0.800	0.8	0.5	0.32	1.23	0.85	0.66	4.36	1.5	44	13	12.1	0.8	87.1	Loamy Sand
$LSD_{0.05}$	0.203	810.3	6.919	11.90	0.619	0.33	ns	0.292	2.263	1.503	0.821	2.632	0.19	8.0	ns	ns	ns	ns	

Table 2: Height (cm) of pawpaw seedlings as influenced by potting mixture

Potting medium	Weeks after sowing			
	3	4	6	8
Topsoil (TS)	5.18^{b}	6.81^{a}	21.9	33.4^{ab}
Cattle dung (CD)	4.53^{a}	9.27^{b}	20.0	26.6^{a}
TS + CD 1:1	7.02^{c}	16.16^{c}	34.3	55.2^{b}
TS + CD 2:1	6.86^{c}	15.93^{c}	38.3	57.9^{b}
TS +CD 1:2	6.94^{c}	15.80^{c}	37.7	51.4^{ab}
$LSD_{0.05}$	0.271	0.536	ns	27.11

Means with the same letters in the same column are not significantly different at 0.05 level of probability.

ns - not significant at 0.05 level of probability.

4.2.2 Stem girth

The influence of the potting mixtures on the stem girth of the pawpaw seedlings is presented in Table 3. From the 4th WAS onwards, all TS + CD mixtures consistently produced seedlings with a significantly larger stem girth than the topsoil and cattle dung only treatments except at 8 WAS, when the stem girth of seedlings grown in cattle dung only was at par with those grown in TS + CD potting mixture. At 8 WAS, the TS + CD 1:1 and 2:1 potting media recorded the highest values for stem girth but was comparable with those grown in cattle dung only and TS+ CD 1:2.

4.2.3 Number of leaves

The influence of the potting mixtures on the number of leaves per pawpaw seedling is shown in Table 4. At 3 weeks after sowing, the TS + CD 1:1 and 2:1 potting media produced seedlings with the highest number of leaves. This trend continued through weeks 4 and 6 WAS where seedlings in all TS + CD mixtures produced significantly more leaves than those in the topsoil and cattle dung only media. By 8th WAS, all potting media produced seedlings with a similar number of leaves.

Table 3: Stem girth (cm) of pawpaw seedlings as influenced by potting mixture

Potting medium	Weeks after sowing			
	3	**4**	**6**	**8**
Topsoil (TS)	0.44^{ab}	0.60^{a}	1.48^{a}	1.92^{a}
Cattle dung (CD)	0.43^{a}	0.72^{b}	2.15^{b}	2.44^{ab}
TS + CD 1:1	0.46^{ab}	0.97^{c}	2.74^{c}	3.30^{b}
TS + CD 2:1	0.47^{b}	1.01^{c}	2.81^{c}	3.31^{b}
TS +CD 1:2	0.46^{ab}	0.96^{c}	2.68^{c}	2.91^{ab}
$LSD_{0.05}$	ns	0.089	0.430	0.946

Means with the same letters in the same column are not significantly different at 0.05 level of probability.

ns - not significant at 0.05 level of probability.

Table 4: Number of leaves of pawpaw seedlings as influenced by potting mixture

Potting medium	Weeks after sowing			
	3	4	6	8
Topsoil (TS)	4.00[a]	6.31[a]	10.01[a]	10.00
Cattle dung (CD)	4.00[a]	8.01[b]	11.66[b]	12.44
TS + CD 1:1	4.77[b]	9.10[c]	14.46[c]	13.00
TS + CD 2:1	4.77[b]	8.99[c]	14.23[c]	11.00
TS +CD 1:2	4.23[a]	9.00[c]	14.00[c]	9.00
$LSD_{0.05}$	0.407	0.948	1.532	ns

Means with the same letters in the same column are not significantly different at 0.05 level of probability.

ns - not significant at 0.05 level of probability.

4.2.4 Leaf area

The results for leaf area as influenced by the potting mixtures are presented in Table 5. The TS + CD mixtures began to show a significant effect at 3 WAS, with the TS + CD 1:1 and 2:1 potting media ratios producing a larger leaf area than the other treatments. At 4 - 6 WAS, seedlings grown in all TS + CD mixtures had a significantly larger leaf area than those in topsoil and cattle dung only. At the 8 WAS, the TS + CD 1:1 potting medium produced seedlings with the largest leaf area while topsoil only produced seedlings with the smallest leaf area which was at par with cow dung only and TS + CD 1:2.

4.3 Dry matter production of pawpaw seedlings

The dry matter production of pawpaw seedlings as influenced by different potting mixtures is shown in Table 6. The longest root length was observed in seedlings produced from TS + CD 1:1 potting media which was comparable with the root length of seedlings produced from TS + CD 1:2. The highest shoot dry weight, root dry weight and total dry weight were produced from seedlings raised in TS + CD 1:1. However, root:shoot ratio was similar among seedlings produced in all potting mixtures.

Table 5: Leaf area (cm²) of pawpaw seedlings as influenced by potting mixture

Potting medium	Weeks after sowing 3	4	6	8
Topsoil (TS)	9.14^{a}	53.0^{a}	659^{a}	1150^{a}
Cattle dung (CD)	11.67^{a}	129.6^{b}	1114^{a}	1566^{a}
TS + CD 1:1	21.31^{b}	418.4^{a}	3181^{b}	4317^{c}
TS + CD 2:1	18.59^{b}	354.2^{c}	3038^{b}	3219^{b}
TS +CD 1:2	10.08^{a}	331.4^{c}	2574^{b}	1995^{a}
$LSD_{0.05}$	2.729	59.47	1264.1	1003.6

Means with the same letters in the same column are not significantly different at 0.05 level of probability.

ns - not significant at 0.05 level of probability.

Table 6: Dry matter production of pawpaw seedlings as influenced by potting mixture

Potting medium	Root length (cm)	Shoot dry weight (g)	Root dry weight (g)	Total dry weight (g)	Root:Shoot ratio
Topsoil (TS)	5.30^{a}	1.7^{a}	0.24^{a}	3.1^{a}	0.11
Cattle dung (CD)	6.00^{a}	2.8^{b}	0.34^{a}	2.0^{a}	0.12
TS + CD 1:1	11.17^{c}	10.4^{e}	2.02^{c}	12.4^{d}	0.16
TS + CD 2:1	8.30^{b}	9.7^{d}	1.07^{b}	10.8^{c}	0.11
TS +CD 1:2	9.67^{bc}	8.6^{e}	0.81^{b}	9.4^{b}	0.09
$LSD_{0.05}$	2.260	0.33	0.44	1.13	ns

Means with the same letters in the same column are not significantly different at 0.05 level of probability.

ns - not significant at 0.05 level of probability.

CHAPTER FIVE

DISCUSSION

5.1 Discussion

This study clearly demonstrated that the combination of topsoil and cattle dung as a potting medium significantly influenced the vegetative growth and dry matter production of pawpaw seedlings. Throughout the early and middle stages of the experiment (3 - 6 WAS), the TS + CD mixtures consistently produced seedlings that were taller, had thicker stems, more leaves, and larger leaf areas than either topsoil or cattle dung potting media alone. Notably, while there were significant numerical differences in dry matter production, the TS + CD 1:1 potting medium yielded the highest total dry weight.

The improved performance of the seedlings grown from the topsoil and cattle dung (TS + CD) mixtures, particularly those containing the 1:1 ratio, is attributed to the complementary effect of combining the two materials. The cattle dung provided a rich source of organic matter and essential plant nutrients such as nitrogen, phosphorus, and potassium, which were deficient in the topsoil only medium. Furthermore, the addition of cattle dung improved the physical condition of the soil by decreasing the bulk density and increasing the porosity, which likely enhanced root penetration, water retention, and aeration.

Conversely, the poor performance of the seedlings in the topsoil only potting medium could be due to the deficiencies characterized in the medium such as high bulk density, low porosity, low nutrient content, and high acidity (Al^{3+} and H^{+}), all of which are known to inhibit vigorous plant growth as reported in studies by Landis (1990) and Bilderback *et al*. (2005). While the cattle dung only medium was nutrient-rich, its performance was suboptimal, suggesting that high concentrations may lead to nutrient imbalances or phytotoxic effects, as indicated by its very high electrical conductivity (EC) value. This is corroborated by findings from research by Nicholson *et al*. (2005) and Chadwick *et al*. (2000). It could also be attributed to excessive organic matter leading to increased microbial activity, which may have caused temporary nitrogen immobilization or altered soil aeration, negatively affecting plant growth.

The results were consistent with earlier studies showing that organic amendment improve soil fertility and pawpaw seedlings productivity (Haynes and Naidu, 1998; Gautam *et al*., 2019; Sarkaka *et al*., 2023; Sinha *et al*., 2018). A significant positive correlation was found between total dry weight and growth factors, including plant height, stem girth, and leaf area. These relationships suggest that enhancements in vegetative growth directly led to greater biomass accumulation indicating that vigorous vegetative growth is essential for enhanced dry matter production.

5.2 Conclusion

This study demonstrated that amending topsoil with cattle dung enhanced the overall vegetative growth and dry matter production of pawpaw seedlings. The mixtures consistently outperformed the use of cattle dung alone across nearly all growth metrics, including seedling height, stem girth, leaf area, root length, shoot and root dry weight and total dry weight. Among the treatments, the TS + CD 1:1 potting medium proved to be the most effective, producing the best overall performance, particularly in leaf area at 8 WAS, and showing the highest trend towards increased dry matter accumulation.

5.3 Recommendations

Based on the findings of this study, it is recommended that nursery operators and farmers use a mixture of topsoil and cattle dung for the propagation of pawpaw seedlings. Specifically, the use of a 1:1 ratio of topsoil to cattle dung (TS + CD 1:1) is suggested as the optimal potting medium to achieve vigorous vegetative growth and support healthy seedling development.

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