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***Research Article***

# Effects of Five Different Leaf Mulches on Seedling Growth of Avocado Pear (*Persea americana*) in Abraka, Delta State, Nigeria

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**ABSTRACT**

The present study was carried out in 2022 and repeated in 2023 to investigate the effects of five different types of leaf mulch on seedling growth of Avocado pear in Abraka, Delta State, Nigeria. The mulches were: Zero mulch (Control), *Terminalia catappa* leaves, *Pennisetum purpureum* leaves, *Panicum maximum* leaves and *Mangifera indica* leaves. The growth parameters assessed to achieve the objectives of the study were; initial physico-chemical properties of the soil used for the study, the nitrogen, phosphorus and potassium contents of the leaf mulches, percentage germination, plant height, number of leaves/plant, leaf area and collar diameter of Avocado pear seedlings. The experiment was laid out in a randomized complete block design with three replications. The results of the study showed that plants grown in poly pots containing *P. purpureum* leaf mulch were superior to their counterparts for all the seedling growth parameters of Avocado pear investigated, including percentage emergence of 92% in 2022 and 98% in 2023, plant height of 62cm in both 2022 and 2023. A similar trend was also observed in the 24th and 32nd week after planting where *P. americana* grown in poly pots containing *P. purpureum* had outstanding heights of 152cm in 2022 and 160cm in 2023 respectively as well as 338cm in 2022 and 342cm in 2023 respectively at 32 weeks after planting. Based on the study's findings, it was recommended that farmers adopt the application of *P. purpureum* leaf mulch in the study area for increased growth and yield *P. americana*.

**Keywords:** Leaf mulches; seedling growth; Avocado pear; Abraka; Nigeria

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## INTRODUCTION

Avocado pear (*Persea americana*) is an evergreen tree that belongs to the family Lauraceae (Wegier, 2017). It is believed to have been domesticated in *Mesoamerica* more than 5,000 years ago where it was highly prized for its large oily fruit (3). The fruit is a berry containing a single large seed (Storey, 1973). They are presently cultivated in tropical and Mediterranean climates of many countries (Morton, 1987). As a self-pollinating plant, avocado pear is often propagated through grafting to maintain consistent fruit yield (Rendon – Anaya *et al*., 2019). Mexico the world's leading avocado pear producer supplying nearly 30% of the global harvest in 2020 (Dreher and Davenport, 2013).

Tremendous nutritional, health and economic benefits are associated with avocado pear. This fruit tree is described as a powerhouse super food containing healthy fats, anti-aging, and disease fighting antioxidants, and nearly 20 vitamins and minerals (Wegier, 2017). They reduced the risk of developing cardiovascular function and digestion health (*Maksimova*). Eating healthy fats obtained from avocado helps to slow down stomach emptying, which keeps you full longer than usual and delays the return of hunger (Chen *et al.*, 2008). Regular consumption of avocado helps to maintain a healthy body weight and increase your soluble and insoluble fibre intake which

slows down digestion and absorption of ingested fats and carbohydrates (Storey, 1973). Avocados are an excellent source of potassium – a micronutrient that helps to reduce blood pressure (Sommaruga and Eldridge, 2020). Consumption of avocado pear over time may reduce belly fat which cushions the organs in your abdominal region that is associated with high risk of type 2 diabetes (Storey, W.B (1973) pairing avocado with tomato sauce and carrots boost the absorption of Vitamin A, which is a crucial nutrient for healthy skin vision and immunity (Wegier, 2017).

The fruits are also rich in a phytochemical called lutein – a pigment related to beta carotene and vitamin A (Gruiter, *et al.*, 2022). Lutein is one of the two major carotenoids found in the eye, which gives it the ability to fine-tune your vision (Dreher and Davenport, 2013). Avocados are rich in antioxidants known to have cancer-fighting properties – they stop the growth of prostate cancer cells (Wegier, 2017). One whole avocado – without the skin and seed provides 322 calories, 4g protein, 17g carbohydrates, 163 micrograms folate, 42 micrograms vitamin K, 20mn vitamin C, 4g Vitamin E, 975mg Potassium and 58mg Magnesium (Dreher and Davenport, 2013). Retrieved from: https://www.health.com/nutrient/avocado-health-benefits

Ogunwusi and Ibrahim (2016) posited that avocado pear is of great importance in the cosmetic industry with respect to its photosterol content, and the array of vitamins contained in it such as Vitamins A, B and C help to prevent skin wrinkling, while the fruit can also be used in the production of snacks.

The numerous uses and economic potentials of avocado pear notwithstanding, there is a dearth of information on the necessity and suitability of the appropriate type of leaf mulch needed for enhancement of growth parameters in the early life of this fruit tree to achieving eventually increased fruit yield. Leaf mulches are various organic and inorganic materials needed to spread on the surface of the soil to reduce loss of moisture and weed population to promote crop yield (Igbal *et al*., 2020). Through the shading effects of mulches, they check erosion, reduce evapotranspiration, and increase infiltration capacity (Rathore *et al*, 1998). Mulching helps to conserve soil moisture (Harris *et al*, 2004), reduce irrigation requirement of crop plants (Ahmad *et al.*, 2015) and prevent soil compaction which limits rots growth and development of plants (Igbal *et al*., 2019). Application of mulches also help in maintaining soil temperature needed for proper growth of the plant (Long *et al*., 2001). Igbal *et al.* (2019) reported other benefits of mulches to include increasing nutrient status of soil, improving soil health, improving water holding capacity and increasing crop yield. The present study was therefore carried out to assess the effects for different leaf mulches on seedling growth of Avocado pear in Abraka, Delta State, Nigeria to identify the most appropriate type for enhanced growth and yield of the crop in the study area.

## MATERIALS AND METHODS

### Description of Experimental Site

The research was conducted at the experimental site of Delta State University Abraka in 2022 and repeated in 2023. Abraka is located between Latitude $60^0$ E and Latitude $54^0$N where the wet season starts in April and terminates in October, while the dry season is from November to March. The rainfall is between 2000mm and 3000mm, while the temperature ranges from $25^0$ to $31^0$C (Efe and Aruegodore, 2003)

### Initial Analysis of Soil Samples

Soil samples were obtained from those in poly pots and air-dried at $27^0$C for three days. They were crushed and filtered using 2mm sieve. Particle size fractions were indicated using Gee and Bauder (1986) hydrometer method, while a pH meter (Pye Unican Model $MK^2$) was used to ascertain the pH in the 1:2.5 soil/water suspension ratio. The Walkley-Black wet-oxidation method recommendation by Nelson and Sommers (1987) was used to know the organic carbon, and the micro-kjedahl distillation technique of Bremirier and Malvaney (1982) was used to ascertain the total nitrogen. Available phosphorus was obtained following the procedure of Bray No 1 suggested IITA (1979), while the exchangeable potassium was determined using a flame photometer. The cation exchange capacity (CEC) was known using the ammonium acetate saturation method posited by Roades (1982).

### Analysis of the Leaf Mulch Samples

Samples of the leaf mulches were collected and air-dried at $27^0$C for three days. They were ground and filtered in a 2mm sieve, and assessed for major nutrients needed for growth including N, P and K following the soil and plants analysis method of IITA (1979)

### Seed Procurement and Planting

Ripe fruits of *P. americana* were bought from nearby Obiaruku market and the seeds were extracted carefully for planting. Fifteen poly pots, each measuring 45cm x 50cm with perforation at their bottom were filled with loamy soil, and one healthy seed was planted at the centre of the soil filled polypot arranged at spacing of 6m x 6m. The experiment was laid out in a randomized complete block design with three replications.

### Application of Leaf Mulches

The ground leaf mulches were applied on top of the soil in the poly pots according to the treatments.

**Weeding**

The experiment was kept weed-free throughout the period of the study.

**Data Collection**

Data collected at 8 weeks intervals starting from the 8th week after planting, including percentage (%) emergence on the 16th day after planting , plant height (cm), number of leaves, leaf area ($cm^2$), number of branches and collar diameter (cm) at 3cm above soil level. Percentage emergence was obtained by counting the number of seedlings that emerged in the 8th week after planting, dividing by the number of seeds planted per treatment and multiplying by 100 according to the procedure of Agbogidi *et al*., (2007), Enujeke (2013), Oroka and Ureigho (2019). Plant height was ascertained using a measuring tape drawn from the top of the soil to the terminal bud. By counting, each parameter the number of leaves/plants, and branches/plant were obtained. The leaf area was determined by measuring the length and breadth of the leaf and multiplying by a correction factor as suggested by Agbogidi *et al*., (2007). The collar diameter at 3cm above soil level was measured using a veneer caliper.

**Statistical Analysis**

Data collected were subjected to analysis of variance and significant means were separated using the Duncan Multiple Range Test (DMRT) using SAS (2000).

**RESULTS AND DISCUSSION**

**Initial Soil Properties**

The initial physico-chemical properties of the study site is shown in table 1. The particle size fractions indicate that the soil is sandy loam with low fertility status based on the low organic matter content ($15.2gkg^{-1}$) and total nitrogen ($0.88gkg^{-1}$). Its pH value of 5.4 show that the soil was strongly acidic. Given that the available phosphorus (P) and water solubility potassium (K) were $5.30mgkg^{-1}$ and $0.18cmolgkg^{-1}$ indicates that the values were lower than the rates prescribed by FMANR (1996) for the agro-ecological zone. The low fertility status of the soil is typical of ultisols of humid areas where heavy rainfall and erosion have leached away the low activity clay mineralogy.

**N, P and K Content of the Five Different Mulches Used for the Study**

The N, P and K contents of the five different mulches are shown in Table 2. Significant differences were observed between them. However, poly pots containing *P. purpureum* had the highest levels of N, P and K, while poly pots in control had the lowest N, P and K levels. The observed levels are appropriate for plant growth based on the ratings of soil and plant analysis recommended by IITA (1979).

**Effects of Five Different Types of Leaf Mulch on Germination Percentage (%) of Avocado Pear at 8th Weeks after Planting**

The germination percentage of avocado pear as affected by five different types of leaf is shown in Table 3. Poly pots containing ground *P. purpureum* leaves had the highest percentage emergencies 92% in 2022 and 98% in 2023, followed by seeds grown in poly pots containing ground *P. maximum* leaves which had 87% in 2022 and 93% in 2023. Seeds grown in poly pots containing zero mulch (control) had the lowest percentage emergence of 73% in 2022 and 79% in 2023. The outstanding percentage emergence of seeds sown in poly pots containing ground *T. purpureum* could be attributed to the preponderance of nutrient elements contained in poly pots for N, P and K levels over their counterparts (Table 2). Similar reports have been made by Enujeke (2013), Mehedi *et al*., (2011) and Iputu *et al*., (2019) that the highest rates of applied fertilizer gave the corresponding highest growth parameters in benefiting crops.

**The Effects of Five Different Types of Leaf Mulch on Growth Parameter of Avocado Pear**

**Plant Height**

The response of plant height of Avocado pear to five different types of leaf mulch is shown in Table 4. Significant differences were observed in plant height of *P. americana* throughout the weeks of the evaluation. At the 16th week after planting, *P. americana* seedlings grown in poly pots containing ground *P. purpureum* leaves had the highest plant height of 62cm in both 2022 and 2023, followed by plants grown in poly pots containing *P. maximum* which had 54cm in 2022 and 58cm in 2923. Plants grown in the control poly pots containing Zero mulch had the lowest plant height (48cm). A similar trend was also observed in the 24th and 32nd week after planting where *P. americana* grown in poly pots containing *P. purpureum* had outstanding heights of 152cm in 2022 and 160cm in 2023 respectively as well as 338cm in 2022 and 342cm in 2023 respectively at 32 weeks after planting. Plants grown on poly pots containing zero mulch had the lowest height of 220cm in 2022 and 230cm in 2023 at 32 weeks after planting.

**Other Growth Parameters – Number of Leaves, Leaf Area and Collar Diameter**

Similar trend was observed in other growth parameters of *P. americana*, including number of leaves (Table 5), leaf area (Table 6) and collar diameter (Table 7) where plants grown poly pots containing *P. purpureum* leaf mulch were superior to their counterparts grown in poly pots containing other types of leaf mulches.

The superiority in growth parameter of plants grown in poly pots containing *P. purpureum* leaf mulch over other

plants could be attributed to the presence and release of higher level of major plant nutrient element (N, P, and K) to benefiting plants. The higher proportion of these major nutrient elements might have rapidly enhanced the growth parameters of *P. americana* of the benefiting crops more than their counterparts grown with other types of the mulch. Similar findings have been made by Igbal *et al*, (2019) who reported that some mulches increase nutrient status of soil, improve soil health and water holding capacity, all of which help to increase crop growth and yield. The higher nutrient status of poly pots containing *P. purpureum* must have lowered and maintained ambient temperature necessary for improvement of activities of bio-degrading organisms whose works enhance soil porosity and fertility, as well as water infiltration, leading to increased plant growth and productivity. This is consistent with the report of Rathore *et al.*, (1998), Long *et al.* (2001), Eifediya and Remison (2010), Enujeke and Egbucha (2021). It is also synonymous to the findings of Anwuli-Okoh and Enujeke (2023) who attributed the superiority in growth parameter of benefitting plants to increased nutrient supply, better utilization of carbon and synthesis of assimilates.

**Table 1: Initial Physico-Chemical Properties of Soil Used for the Study**

| **Parameters measured** | **Values obtained** |
|---|---|
| Particle size fractions (%) | |
| Sand | 87.0 |
| Silt | 9.4 |
| Clay | 3.6 |
| Textural class | Sandy loam |
| pH ($H_2O$) | 5.4 |
| Organic matter ($gkg^{-1}$) | 15.2 |
| Total nitrogen ($gkg^{-1}$) | 0.88 |
| Available P ($mgkg^{-1}$) | 5.30 |
| Exchangeable K ($cmolkg^{-1}$) | 0.18 |
| CEC ($cmolkg^{-1}$) | 10.10 |

**Table 2: N, P and K Content of the Five Different Mulches Used for the Study**

| | **N ($gkg^{-1}$)** | **P ($mgkg^{-1}$)** | **K ($cmolkg^{-1}$)** | **Mean** |
|---|---|---|---|---|
| Type of Mulch | | | | |
| Zero mulch (control) | $0.88_a$ | $5.30_a$ | $0.18_a$ | **2.12** |
| *T. catappa* leaves | $1.10_a$ | $5.36_a$ | $0.20_a$ | **2.22** |
| *P. purpureum* leaves | $1.32_a$ | $5.80_a$ | $0.34_a$ | **2.49** |
| *P. maximum* leaves | $1.20_a$ | $5.50_a$ | $0.28_a$ | **2.33** |
| *M. indica* leaves | $1.12_a$ | $5.40_a$ | $0.24_a$ | **2.25** |
| **Mean** | **1.12** | **5.47** | **0.25** | |

Means with the same alphabets under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT)

**Table 3: Effects of Five Different Types of Leaf Mulch on Germination Percentage (%) of Avocado Pear at 8th Weeks after Planting**

| | **Percentage emergence (%)** | | |
|---|---|---|---|
| | **2022** | **2023** | **Mean** |
| Types of Mulch | | | |
| Zero mulch (control) | $73_e$ | $79_e$ | 76 |
| *T. catappa* leaves | $80_d$ | $84_d$ | 82 |
| *P. purpureum* leaves | $92_a$ | $98_a$ | 95 |
| *P. maximum* leaves | $87_b$ | $93_b$ | 90 |
| *M. indica* leaves | $83_c$ | $87_c$ | 85 |

Means with similar letters under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT)

**Table 4: Effects of Five Different Type of Leaf Mulch on Plant Height (cm) of Avocado Pear**

| | Weeks after planting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **16** | | | **24** | | | **32** | | |
| | 2022 | 2023 | Mean | 2022 | 2023 | Mean | 2022 | 2023 | Mean |
| **Types of Mulch** | | | | | | | | | |
| Zero mulch (control) | $44_e$ | $48_e$ | **46** | $100_e$ | $110_e$ | **105** | $220_a$ | $230_e$ | **225** |
| *T. catappa* leaves | $48_d$ | $52_d$ | **50** | 108 | $122_d$ | **115** | $250_d$ | $254_d$ | **252** |
| *P. purpureum* leaves | $62_a$ | $62_a$ | **62** | 152 | $160_a$ | **156** | $338_a$ | $342_a$ | **340** |
| *P. maximum* leaves | $54_b$ | $58_b$ | **56** | $138_b$ | $142_b$ | **140** | $280_b$ | $290_b$ | **285** |
| *M. indica* leaves | $50_c$ | $54_c$ | **52** | $120_c$ | $130_c$ | **125** | $266_c$ | $272_c$ | **269** |
| **Mean** | **51.6** | **54.8** | **53.2** | **123.6** | **132.8** | **128.2** | **270.8** | **277.6** | |

Means with the same alphabets under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT)

**Table 5: Effects of Five Different Type of Leaf Mulch on Number of Leaves of Avocado Pear**

| | Weeks after planting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **16** | | | **24** | | | **32** | | |
| | 2022 | 2023 | Mean | 2022 | 2023 | Mean | 2022 | 2023 | Mean |
| **Types of Mulch** | | | | | | | | | |
| Zero mulch (control) | $9_a$ | $11_a$ | **10** | $17_a$ | $19_a$ | **18** | $27_a$ | $29_a$ | **28** |
| *T. catappa* leaves | $11_a$ | $13_a$ | **12** | $18_a$ | $21_a$ | **20** | $29_a$ | $31_a$ | **30** |
| *P. purpureum* leaves | $15_a$ | $17_a$ | **16** | $25_a$ | $27_a$ | **26** | $37_a$ | $39_a$ | **38** |
| *P. maximum* leaves | $13_a$ | $15_a$ | **14** | $23_a$ | $25_a$ | **24** | $35_a$ | $37_a$ | **36** |
| *M. indica* leaves | $11_a$ | $13_a$ | **12** | $21_a$ | $23_a$ | **22** | $33_a$ | $35_a$ | **34** |
| **Mean** | **11.8** | **13.8** | **12.8** | **21.0** | **23.0** | **22.0** | **32.2** | **34.2** | |

Means with similar letters under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT)

**Table 6: Effects of Five Different Type of Leaf Mulch on Leaf Area ($cm^2$) of Avocado Pear**

| | Weeks after planting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **16** | | | **24** | | | **32** | | |
| | 2022 | 2023 | Mean | 2022 | 2023 | Mean | 2022 | 2023 | Mean |
| **Types of Mulch** | | | | | | | | | |
| Zero mulch (control) | $26.0_e$ | $32.0_e$ | **29.0** | $43.0_e$ | $45.0_e$ | **44.0** | $57.0_e$ | $63.0_e$ | **60.0** |
| *T. catappa* leaves | $47.5_d$ | $52.5_d$ | **50.0** | $57.0_d$ | $63.0_d$ | **60.0** | $63.0_d$ | 77.0 | **70.0** |
| *P. purpureum* leaves | $80.0_a$ | $88.0_a$ | **84.0** | $90.0_a$ | $96.0_a$ | **93.0** | $100.0_a$ | $104.0_a$ | **102.0** |
| *P. maximum* leaves | $53.5_b$ | $59.5_b$ | **56.5** | $67.0_b$ | $70.0_b$ | **68.5** | $76.0_b$ | 84.00 | **80.0** |
| *M. indica* leaves | $52.0_c$ | $56.0_c$ | **54.0** | $61.5_c$ | $66.5_c$ | **64.0** | $72.5_c$ | 73.5 | **73.0** |
| **Mean** | **51.8** | **57.6** | **54.7** | **63.7** | **68.1** | **65.9** | **73.7** | **80.3** | |

Means with the same letters under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT)

**Table 7: Effects of Five Different Type of Leaf Mulch on Collar Diameter (cm) of Avocado Pear**

| | Weeks after planting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **16** | | | **24** | | | **32** | | |
| | 2022 | 2023 | Mean | 2022 | 2023 | Mean | 2022 | 2023 | Mean |
| **Types of Mulch** | | | | | | | | | |
| Zero mulch (control) | $2.0_a$ | $2.2_a$ | **2.1** | $3.2_a$ | $3.6_a$ | **3.4** | $4.2_a$ | $4.2_a$ | **4.4** |
| *T. catappa* leaves | $24._a$ | $2.6_a$ | **2.5** | $3.6_a$ | $4.0_a$ | **3.8** | $4.8_a$ | $4.8_a$ | **5.0** |
| *P. purpureum* leaves | $3.4_a$ | $3.8_a$ | **3.6** | $4.8_a$ | $5.2_a$ | **5.0** | $6.4_a$ | $6.4_a$ | **6.6** |
| *P. maximum* leaves | $3.0_a$ | $3.2_a$ | **3.1** | $4.2_a$ | $4.6_a$ | **4.4** | $5.6_a$ | $5.6_a$ | **5.8** |
| *M. indica* leaves | $2.8_a$ | $3.0_a$ | **2.9** | $3.8_a$ | $4.2_a$ | **4.0** | $5.2_a$ | $5.2_a$ | **5.4** |
| **Mean** | **2.72** | **2.96** | **2.84** | **3.92** | **4.32** | **4.12** | **5.24** | **5.64** | |

Means with the same alphabets under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT)

## CONCLUSION

The study confirmed that the application of leaf mulches significantly affects the growth parameters of *P. americana*. It has been established that *P. americana* leaf mulch gives outstanding results when applied for the improvement of the growth characteristics of Avocado pear. Therefore, it was recommended that farmers adopt the application of *P. purpureum*, leaf mulch for growth enhancement of Avocado pear seedlings in Abraka, Delta State, Nigeria.

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**Conflict of Interest**

The authors hereby affirm that there is no conflict of interest.

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