Effects of Different Organic Wastes at Varying Temperatures on Morphotypes of Nigerian *Corchorus olitorius* L

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Received: 16 January 2024; Revised: 23 June 2024; Accepted: 1 July 2024; Available online: 19 July 2024

Abstract

This study investigated the effects of different types of organic wastes (poultry manure and cow dung) at varying temperatures (25 30, and 35°C) on the germination, growth, and yield responses of three morphotypes of *Corchorus olitorius* (Agbadu, Yaya, and Eleti'eku). The study was carried out at the Osun State University Teaching and Research Farms using a Completely Randomized Design (CRD) design with three-factor levels namely: two organic media, three morphotypes of *C. olitorius* and three soil temperatures at three replications to make 2 × 3 × 3 × 3 design. There was a control with loam soil in all the soil temperatures. Data were collected on the number of leaves, plant height, stem girth, number of branches, leaf weight, and leaf area index. The analysis of variance showed that the interaction of organic media, temperature, and morphotypes had significant effects on most of the traits evaluated ($P<0.05$). Poultry manure treatment (15 t/ha) significantly improved the vegetative parameters, the Agbadu morphotype showed the highest seed germination rate across all temperatures, while the Eleti'eku morphotype showed the lowest. Furthermore, the study revealed that the Agbadu morphotype exhibited superior germination performance when subjected to a temperature of 35°C and treated with poultry manure. These findings are significant for the development of new cultivars of *C. olitorius* that are tolerant to abiotic stress and can maintain high biomass production while reducing input resources.

Keywords: Agbadu, Eleti'eku, growth parameters, Yaya, yield

Introduction

The increasing demand for natural fibres and the need to reduce input resources in agriculture instigates the pressing need for research that focuses on improving the productivity and sustainability of *C. olitorius* cultivation which is an important crop and natural fibre source that has been cultivated for centuries in tropical and subtropical regions around the world (Abad et al., 2002; Akinola et al., 2020; Dada et al., 2021; Afzal et al., 2022; Mudau et al., 2022). *C. olitorius*, also known as jute mallow or bush okra, is a plant cultivated globally that contributes significantly to many developing countries' economies and food security. It is widely grown in Nigeria and plays a significant role as a cash crop for smallholder farmers (Balogun et al., 2022; Kehinde & Kehinde, 2022). The leaves and young shoots of *C. olitorius are* highly nutritious, rich in vitamins, minerals, and antioxidants, and are used as a food source (Biswas et al., 2022; Ebabhi & Adebayo, 2022). Additionally, the plant is a significant source of natural fibre used in the production of various household and industrial products, including textiles, ropes, and twines (Zhang et al., 2019; Al Faruque et al., 2022). Furthermore, *C. olitorius* has medicinal properties and is used in traditional medicine to treat various ailments (Nakaziba et al., 2020). Despite the numerous benefits of *C. olitorius*, several challenges limit its production and sustainability including soil degradation, pests and diseases management, and the effects of climate change (Omotayo & Babalola, 2021; Fayose, 2022; Gwenzi et al., 2022; Akinola et al., 2020). Additionally, there is a growing need to develop cultivars which are tolerant to abiotic stress such as heat and drought while maintaining high yields and quality. Developing sustainable agricultural practices and using modern biotechnological tools to enhance crop productivity and resilience are essential to addressing these challenges (Imathiu, 2021; Omotayo & Babalola, 2021; Lamidi et al., 2018). Previous studies have investigated the effects of organic media and temperature on plant growth and development. Organic media such as manure and compost have been shown to enhance plant growth and yield by improving soil fertility, nutrient availability, and water retention (Lamidi & Dada, 2023; Lamidi et al., 2019; Sayara et al., 2020; Ullah et al., 2021; Caporale et al., 2023). A study by Luziatelli et al. (2019) found that the study also reported that the use of different organic media had a significant influence on the vegetative parameters of the different morphotypes. Temperature is also a critical environmental factor that influences plant growth and development (Ding et al., 2020; Khan et al., 2020). Studies have shown that different morphotypes of *C. olitorius* exhibit varying germination rates and biomass production under different environmental conditions (Kushwaha et al., 2020; Mwakha et al., 2020). However, there is limited research on the specific effects of organic media and temperature on the different morphotypes of *C. olitorius*. Furthermore, there is a need for more comprehensive research on the interactions between organic media, germinating and growing temperatures and morphotypes.

Therefore, the objective of this study was to investigate the effects of organic media and temperature of the germination, growth, and yield of three morphotypes of *C. olitorius*. Specifically, the study aimed to determine the single and interacting effects of varying temperatures (25°C, 30°C, and 35°C) and different types of organic manures (poultry manure and cow dung) on the vegetative parameters of the three morphotypes (Agbadu, Yaya, and Eleti'eku) of *C. olitorius*. The results from this study will contribute to the development of more sustainable and profitable agricultural practices in the long run.

Materials and Methods

The present study was conducted as a pot experiment at the Teaching and Research farms of Osun State University, College of Agriculture, located at latitude 7.8717′N and longitude 4.3067′E in Osun State, Nigeria. The climatic condition of the area is typically rainforest, consisting of two peaks (Bimodal Rainfall) which is between 926.33-1995.17mm per annum (Lamidi et al., 2021). The study was laid out in a Completely Randomized Design (CRD) with three factors: three morphotypes of *C. olitorius*, three different soil temperatures, and two types of organic wastes/media [poultry manure, (PM) and cow dung, (CW)], each replicated thrice to make 2 × 3 × 3 × 3 design. The seeds were stored in a cool, dark room before the start of the experiment. The seeds used in both samples were approximately 6 months old when the experiments were carried out. There was a control of 3 pots with loam soil for all the soil temperatures in the experiment, in all, 57 pots were used. To prepare them for rapid germination, the scarification process was carried out on the seeds at a temperature of 90-97°C for about five minutes. To ensure high germination rates, a cold-water viability test was carried out on the seeds. Approximately 100% of the Agbadu, Yaya, and Eleti'eku seeds had a high germination rate as none was found floating. The experimental pots were manually weeded, and insect pests were controlled using insecticide (Cypermethrin) at 10 ml to 1 L of water applied only once. Weekly observations were carried out on three randomly selected plants from each experimental pots.Each pot had a surface area of 2464 cm^2 (28 cm radius), and 50 seeds of *C. olitorius* were sown in each pot. Before the experiment, the physicochemical compositions of the loamy soil and the organic media were analyzed in the laboratory. The organic media used in the experiment were poultry manure and cow dung, which were air-dried, crushed, and uniformly incorporated into the soil at a rate of mixing which was 1 part of organic media to 3 parts of loam soil inside the pot, each pot was filled with 3 kg comprising 750 g of organic media and 2,250 g of loam soil (Adeyeye et al., 2016a). The control experiment comprised of three pots filled with loamy soil and sown with three morphotypes of *C. olitorius* at the ambient temperature of 27 °C, which has been the experimental area's local temperature over some time. Soil samples were collected at a 0-30cm depth using a zig-zag method and analyzed at the Agronomy Laboratory of Osun State University, College of Agriculture. The 0 - 30 cm depth was used because the roots of *C. olitorus* cannot penetrate soil for more than such depth. The same soil sample was used for all the 57 pots, this was to ensure the soil factor was not part of the experimental treatments. The samples were mixed to form a composite, they were air-dried and sieved using a 2 mm sieve. The soil's properties included pH, total nitrogen, organic carbon, available phosphorus, available potassium, exchangeable calcium, exchangeable magnesium, exchangeable sodium, cation-exchange capacity (CEC), and particle size analysis were determined (Lamidi & Babarinde, 2017). The physical and chemical properties of the soil samples at the initial stage, that is, before the organic media were added to soil samples and after the organic media had been added, are shown in Table 1. Chemical and physical characteristics and the exchangeable cations for the soil mixed with PM have good and beneficial values for the plants and could reflect on the parameters of growth or plants' yield. The control experiment possessed soil properties the same as the initial sample before mixing the soil with organic media (Table 1).

Table 1 Chemical and Physical properties of soil at the initial stage before organic media were added

Soil Characteristics	**Initial value before mixing with two organic media**	**Final chemical and physical characteristics of different pots after two organic media have been added**		
		Control Pots	**Cow dung (CD) pots**	**Poultry manure (PM) pots**
Chemical characteristics				
pH (H_20)	6.3	6.3	6.94	6.80
Total nitrogen (%)	0.12	0.12	0.90	0.97
Organic carbon (%)	3.20	3.20	3.20	3.50
Available P (ppm)	15.40	15.40	10.8	12.0
Exchangeable cations (cmol/kg):				
Cation exchange capacity (cmol/kg)	6.1	6.1	6.30	7.20
K (Cmol/kg)	1.03	1.03	1.48	1.50
Mg (Cmol/kg)	1.26	1.26	1.47	1.49
Ca (Cmol/kg)	0.57	0.57	0.67	0.69

Table 1 (Cont.)

Soil Characteristics	Initial value before mixing with two organic media	Final chemical and physical characteristics of different pots after two organic media have been added		
		Control Pots	Cow dung (CD) pots	Poultry manure (PM) pots
Physical characteristics				
Sand (%)	72.8	72.8	71.7	71.0
Silt (%)	8.28	8.28	8.38	8.51
Clay (%)	18.92	18.92	19.92	20.49
Textural class	Sandy loam	Sandy loam	Organic medium	Organic medium

Key: K= Potassium, Mg= Magnesium, Ca= Calcium (Murtadha et al., 2023; Lamidi & Babarinde, 2019)

The seeds of *C. olitorius* were purchased from the Nigerian Institute of Horticulture, NIHORT, Ibadan, Nigeria namely: Agbadu, Yaya or Oniyaya, and Eleti'eku, as the plants are depicted in Fig. 1. The germination temperatures were set at 25, 30, and 35°C respectively. Standard agronomic protocols were followed throughout the study, including regular watering, fertilization, and weed control. The seeds were sown at different soil temperatures of 25, 30, and 35°C, and were maintained throughout the experiment. The reason for these temperature values is that Nigeria is in the tropics and 30 °C is the room temperature, then 25 and 35 °C that are closer to 30 °C were selected, also, an earlier experiment got 35 °C in their experimental area (Mostsa et al., 2015). Thus, the necessity to experiment around 25-35 °C. Seven water baths were used. Each of the first three water baths was for each of the required 25, 30, and 35°C experiment temperatures for the poultry manure, and the second three water baths were for the cow dung experiment at 25, 30, and 35°C temperatures. The other water bath was used for the control and its replicates, the control water bath was maintained at 0°C to provide needed irrigable water to the control experiment. The water baths supplied an equal rate of water to their respective pots. The water baths were to reduce the water temperatures in hoses to the required degrees with digital thermometer (Th) monitoring at various hose lengths. Transparent hoses of 2.54 cm (1 inch) diameter that led to each pot were used. To have the desired temperature: each water bath was closely monitored for desired soil temperature according to the experimental procedures for the soil in the pots. High-sensitive digital glass thermometers made by Uniscope Nigeria Ltd and REOTEMP soil thermometers were used. The experiment was allowed on the field till the harvest time of three weeks. The heated water vapour was introduced into the pots through their sides, which served two purposes: (a) it provided the experimental desired temperature for the soil and seeds, and (b) it provided the necessary moisture content as the steam was converted back to water (for irrigation purpose) in the soil inside the pot through convection (conduction and advection) and latent heat of vaporization. This setup was maintained for the entire germination period and one week after germination (WAG).

(a) (b) (c)

Figure 1 Morphology of *C. olitorius* morphotypes (a) Agbadu morphotype, (b) Yaya morphotype, (c) Eleti'eku morphotype

Standard agronomic protocols were followed throughout the study, including regular watering and weed control (Lamidi & Adeyeye, 2015). The agronomic data collection included recording the germinating temperature, germination percentage (%) and mean number of days to germination. To ensure accuracy, germinating temperatures (soil temperatures beneath the seeds/seedlings were measured twice daily at 10:00 h and 14:00 h. The vegetative characters such as plant height, leaf length, stem girth (measured in cm using a tape ruler and graduated ruler), and the number of leaves were also recorded. Additionally, the Leaf Area Index (LAI) was measured using a portable leaf area meter (LI-COR LI-3000C, made in the USA). Data collection began a Week After Planting (WAP) and continued on a weekly basis until the end of the experiment. At 3 weeks, harvesting was done. After harvesting, the plants were weighed to obtain the fresh shoot yield which was recorded as fresh weight (kg) using a Camry 50 kg weighing scale (model CA277HL, made in Nigeria).

Statistical Analysis

The statistical analysis of the germination characteristics data involved descriptive statistics and ANOVA with a statistical programme, Minitab (Minitab Inc., College Park, PA). The ANOVA included three factors of classification, namely organic media, morphotypes, and soil temperature, with interactions to determine whether there was a significant ($p< 0.05$) difference between morphotypes and organic media treatment. Where a significant F-test was used and means comparison tests were carried out using Fisher's Least Significant Difference (F-LSD) at $p<0.05$.

Results and discussion

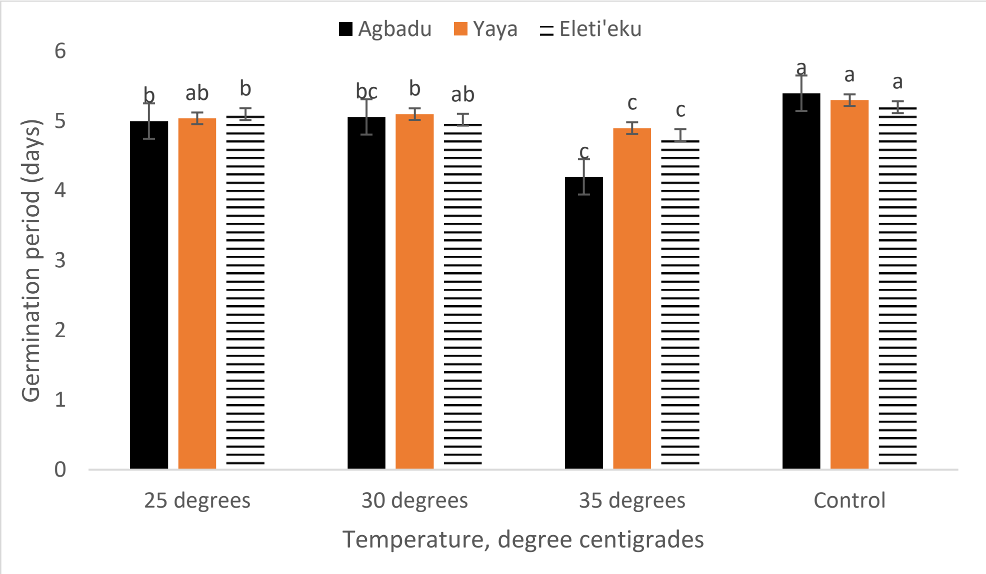
Effect of soil temperature and morphotypes on germination rates of *C. olitorius*

Table 2 indicates the interactive effect of morphotypes and temperatures on percent seeds' germination. The morphotypes behaved differently with temperature variability including control. Germination rates recorded at 25°C and 30°C were lower than the corresponding values recorded for each of the varieties at 35°C, indicating that 35°C resulted in a higher germination percentage than the other temperatures (Table 2). Germination rates were lower in the control experiment, where temperatures remained between 24°C and 27°C throughout the 12 days (5 days of germination and 7 days WAG), compared to the experimental temperatures of 25°C, 30°C, and 35°C. This is supported by Mostsa et al. (2015) findings which reported that a temperature of 35°C is the best and required for *C. olitorius* to germinate. This contrasts with Mguis et al. (2014) who revealed that the optimal germination temperature was 30°C. The results are consistent with the research by Nkomo and Kambizi (2009) that *C. olitorius* grows well mostly when day temperatures average 30°C and above. Thus, the enhanced germination under constant light, alternating light, dark, and under the constant temperature of 35°C and alternating temperatures of 21-35 °C is an appropriate response to simulated natural conditions considering the climate of the region where the plant grows (Lamidi & Babarinde, 2017; Okusanya et al., 1980). Fig. 3. illustrates the relationship between soil temperatures, *C. olitorius* morphotypes, and the number of days to germination. Seeds of the Agbadu morphotype had the lowest mean time to germination although, germination started from the fourth day at soil temperatures of 25 and 30°C, and the fifth day at 35°C. Statistical analysis (Table 2) revealed significant differences among the germination mean time of the three morphotypes, with decreasing period to germination as temperature increased from 25°C to 35°C. In summary, the germination period was reduced at a soil temperature of 35°C, while the germination time was extended at 25°C (Fig. 2). All the germination periods were statistically different implying that the varying soil temperatures were significantly different in the germination periods. Notably, the values for the control group were the lowest for all experimental conditions.

Table 2 Mean values (± SD) of percent seeds' germination during the mean time to germination and a week after germination of *C. olitorius* seed at varying temperatures

Morphotypes	Seed germination rate (%) at varying temperatures (°C)			
	25	**30**	**35**	**Control**
Agbadu	96.43^{a}±6.22	96.30^{a}±5.22	98.30^{a}±5.24	90.30^{a}±5.02
Yaya	89.48^{b}±4.02	89.82^{b}±4.42	90.80^{b}±6.02	84.31^{b}±4.32
Eleti'eku	82.42^{c}±7.22	86.12^{c}±6.02	86.62^{c}±3.76	81.22^{c}±3.72
LSD	0.88	2.57	1.28	1.89

[abc]Mean values with the same letter along the column are not significantly different $p \leq 0.05$.



abc- Means on the same shape filled with different letters are significantly different (P<0.05)

Figure 2 Mean times of germination for different varieties of *C olitorius*

The influence of organic media, morphotypes, and soil temperature on the vegetative parameters of *C. olitorius* during the germination and Week After Germination (WAG) stages

The results presented in Table 3 demonstrate that the vegetative parameters of *C. olitorius* were significantly influenced by organic media, morphotypes, and soil temperature during the germination and WAG stages. As reported by Baiyeri and Mbah (2006), the growing media act as a reservoir of moisture and plant nutrients, which can anchor or support the plant and enable oxygen diffusion to the roots and gaseous exchange between the roots and the atmosphere outside the root substrate. The study's findings are also consistent with the report by Okechukwu et al. (2021), which found significant differences in the number of leaves and plant height among four growing media. The interaction between organic media and soil temperature was not significant for the number of leaves and plant height but was significant for the number of branches and stem girth. The interaction between organic treatment and morphotypes was not significant for the number of leaves and branches, but it was significant for plant height and stem girth, this results from the high nitrogen, available potassium, and organic carbon contents which could have increased the number of branches and the overall plant heights (Table 1). Additionally, the interaction among organic treatment, morphotypes, and soil temperature was not significant for the number of branches, but it was significant for the number of leaves, plant height, and stem girth. These findings suggest that organic media and morphotypes have a significant effect on the vegetative parameters of *C. olitorius*, while soil temperature has a minimal effect. Therefore, the positive effects on the germination rate of the *C. olitorius* seeds is depicted in Table 2. The combination of these factors influenced the growth of *C. olitorius* differently due to the physiological processes that could have happened in the seed through the activeness of the membrane-bound proteins and some enzymes, and the membrane's permeability that could have been affected by the soil temperature variations (Lamidi & Afolabi, 2016). Furthermore, the differences in chemical constituents in the morphotypes' stems could be responsible for the significant differences observed among their performances with soil and organic wastes. The presence of different constitutive components in these different seeds, such as oleanolic acid, 2-hydroxyethyl benzoate, chlorophyll, phytyl fatty acid esters, β-sitosterol fatty acid esters, β-sitosterol, and stigmasterol, could contribute to these differences. These differences in the morphotypes and the possible effects of the soil constituents that have been changed through the organic media complements could have resulted in these significant differences. It is also worth noting that the control experiment showed a lesser mean time to germination, less germination percentage, and the lowest shoots' fresh yield than other treatments with organic wastes. This observation implies that the organic media influenced the meantime of germination of the seeds, indicating that the organic wastes might have provided the necessary nutrients and conditions for the seeds to germinate more efficiently.

Table 3 The vegetative parameter of *C. olitorius* as influenced by organic waste, morphotypes and temperatures of soil

Source of variation	DF	Number of leaves	Plants' heights (cm)	Number of Branches	Stem girth(cm)	LAI, (cm^{2})
Blocks	2					
Organic waste	1	0.04^{*}	0.04^{*}	3.87^{ns}	0.08^{ns}	13.68^{ns}
Morphotypes	2	0.02^{*}	0.05^{*}	3.17^{ns}	0.04^{*}	11.61^{ns}
Temperatures	2	10.03^{ns}	20.48^{ns}	4.53^{ns}	2.43^{ns}	3.84^{ns}
Organic waste × Morphotypes	2	3.14^{ns}	0.01^{**}	1.54^{ns}	0.05^{*}	8.13^{ns}
Morphotypes × Temperatures	4	0.01^{**}	5.53^{ns}	0.02^{*}	0.55^{ns}	60.03^{ns}
Organic waste × Temperatures	2	3.01^{ns}	0.77^{ns}	0.05^{*}	0.02^{*}	65.05^{ns}
Organic wastes × Morphotypes × Temperatures	4	0.01^{**}	0.03^{*}	4.87^{ns}	0.04^{**}	3.78^{ns}
Error	32	0.35	7.99	0.33	7.99	0.33
Total	53					
CV %		9.52	21.45	10.43	21.45	10.43

**- highly significant at 0.05%, NS- not significant, CV- Co-efficient of variation, SOV- Source of variation, DF- Degree of freedom.

The effect of organic media on yield components and morphotypes of *c. olitorius*

From the ANOVA result in Table 3, the interaction effect for three factors (organic wastes, temperatures and morphotypes) was significant ($p<0.05$) on number of leaves and number of branches but was not significant on the plant height and stem girth and LAI. Table 4 displays the mean values and statistical differences ($p<0.05$) of all yield components in *C. Olitorius as* influenced by the types of organic media used. The effect of morphotypes on the vegetative parameters of *C. olitorius* was also examined and presented in Table 4. Among the three morphotypes, no statistical differences ($p<0.05$) were found between the Yaya and Eleti'eku varieties regarding the number of leaves, stem girth, LAI, and plants' heights. Likewise, Agbadu and Yaya did not show any statistical differences of the number of branches for yield components. The Agbadu and Yaya varieties supplied with poultry manure organic medium had the highest values for all yield components studied, including number of leaves, plants' heights, stem girth, number of branches, and LAI. The least significant differences (LSD) were used to differentiate means that were close in values in Table 4.

The C. *olitorius* supplied with poultry manure had the highest mean plant height (14.925), mean number of leaves (7.315), and mean number of branches (5.925). The present study showed that seeds of three *C. olitorius* morphotypes germinated very well in the experimental temperatures (25, 30, and 35°C). This could have been so especially from the results of the mixing of the poultry manure (PM) with the soil sample as depicted in Table 1, the high nitrogen, potassium and organic carbon could have increased the number of leaves, branches, and the overall plant heights. However, *C. olitorius* seeds exhibited maximum germination percentage at 35°C for all organic media tested. The lowest performance of the control plants reflected soil nutrient deficit as no organic manure was added to the soil, and it may also be because the temperature was at normal soil temperature, which did not positively or negatively affect the seeds. This aligns with Okpara et al. (2007). The plant's height, number of leaves, and number of branches of *C. olitorius* applied with poultry manure was lower than the work done earlier by Aluko et al., (2014) could be because of the global climatic change and its attendant change in environmental parameters from the earlier date of their experiment to the date of this research. It could also be because of the soil constituent of the area where the experiment was carried out, even though the same loam sand was used, mineral compositions of soil from one spot to another spot may be different. In addition, it may also be a result of the embedded genetic materials that may be peculiar to each crop morphotype.

Table 4 Mean values (± SD) of vegetative components of *C. olitorius* showing organic media effects on the vegetative parameter of *C. olitorius*

Treatments/ Factors	Treatments/ Factors	Number of Leaves	Plant Height (cm)	Stem girth, (cm)	Number of Branches	LAI (cm^2)
Organic wastes	Poultry Manure	7.32^{a}±0.32	14.93^{ab}±0.22	3.64^{ab}±0.25	5.93^{a}±0.22	47.21^{c}±4.32
	Cow dung	6.04^{bc}±0.42	13.29^{b}±0.32	3.12^{bc}±0.32	5.78^{ab}±0.02	40.12^{c}±2.22
Morphotypes	Agbadu	6.39^{ab}±0.05	15.07^{a}±0.22	3.96^{a}±0.23	5.94^{a}±0.22	56.62^{a}±5.12
	Yaya	6.26^{c}±0.12	12.32^{ab}±0.24	3.21^{c}±0.22	5.68^{ab}±0.32	52.40^{b}±4.02
	Eleti'eku	5.92^{a}±0.20	12.13^{ab}±0.42	3.12^{bc}±0.32	4.81^{b}±0.14	52.20^{b}±2.22
Temperatures (°C)	25	6.29^{ab}±0.15	13.08^{b}±0.32	3.76^{a}±0.23	5.90^{a}±0.32	50.62^{ab}±5.02
	30	6.07^{bc}±0.17	12.22^{ab}±0.22	3.28^{c}±0.42	4.78^{b}±0.31	49.40^{ab}±4.12
	35	5.90^{d}±0.21	10.11^{c}±0.72	3.19^{c}±0.33	4.82^{b}±0.24	48.22^{ab}±2.20

[abc]Mean values with the same letter along the column are not significantly different $p \leq 0.05$ from each other

Fig. 3 illustrates the impact of organic media treatment on the vegetative yield of *Corchorus* as earlier observed by Adeyeye et al. (2016a, 2016b, 2017) that organic manure increases yield in melon, sweet potatoes, and onion. The shoot yield of *Corchorus* was significantly higher for poultry manure (36.54% increase) compared to cow dung. This demonstrates a significant increase in yield because of organic fertilizer treatment (Lamidi et al., 2022). Figure 4 shows that the shoot yield of *Corchorus* was highest in the Agbadu variety, with a 38.93% increase compared to the Eleti'eku variety, and a 39.42% increase compared to the Yaya variety. The shoot yields of the three *Corchorus* morphotypes that germinated and grew on different organic media have the same $R^2 = 0.99$ (Fig. 4) which depicted a high coefficient of determination (R^2) among the different organic media which means that a stronger linear relationship exists between shoot yields of *Corchorus* spp. and organic medium used.

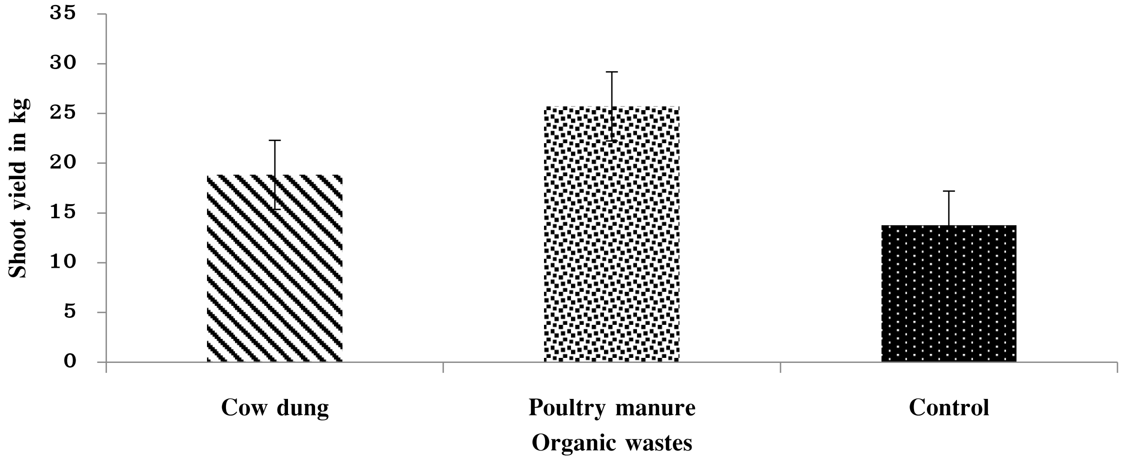


Figure 3 Mean values (±SD) of the fresh shoot (vegetative) yield of *C. olitorius* at different organic media treatments

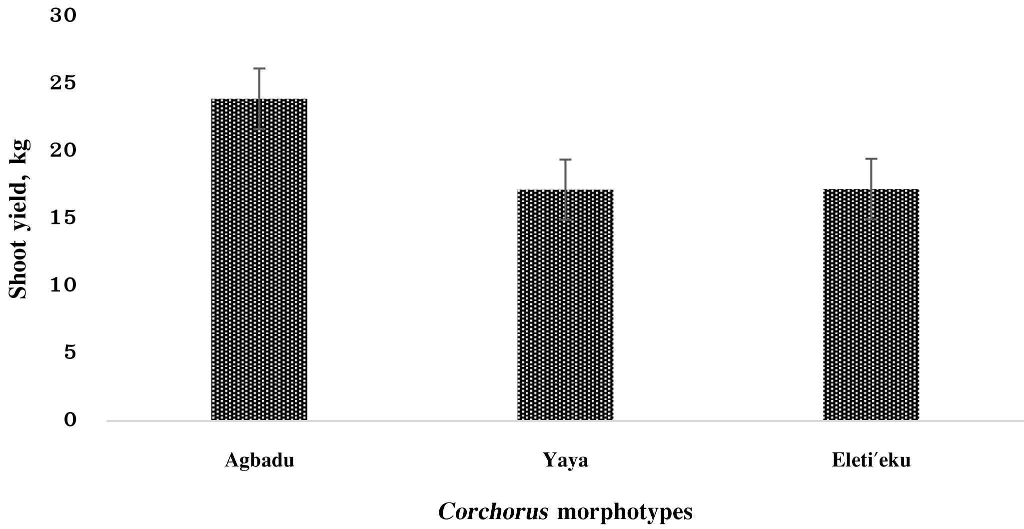


Figure 4 Mean values (±SD) of the fresh shoot (vegetative) yield of different varieties of *C. olitorius*

Conclusion and Suggestions

The study investigated the effect of soil temperature, organic media, and morphotypes on the germination and vegetative parameters of *Corchorus olitorius*. The results showed that a soil temperature of 35°C was optimal for seed germination. The study also revealed that organic media and morphotypes significantly influenced the vegetative parameters of the plant. The interaction among the organic media, soil temperature, and morphotypes showed significant effects on the number of leaves, plant height, and stem girth. The study recommends that for optimum yield of *C. olitorius*, a soil temperature of 35°C should be maintained during seed germination, and appropriate organic media should be used for planting to achieve the best vegetative parameters. Furthermore, different morphotypes of the plant should be considered when selecting seeds for planting, as they may exhibit differences in yield components.

Acknowledgement

The authors sincerely acknowledge the permission, enabling research site (Teaching and Research Farms) and laboratory facilities provided by the College of Agriculture, Osun State University during the research.

Author Contributions

Wasiu A. Lamidi: Conceptualization, Development or design of methodology, Provision of materials subjects or patients, Investigation, Collection of data, Data analysis and interpretation, Manuscript writing, Manuscript review and editing,

Abiola E. Ojeleye: Development or design of methodology, Provision of materials subjects or patients, Investigation and editing

Samson O. Abiola: Development or design of methodology, Provision of materials subjects or patients, Investigation and editing

Olayemi C. Ojeokun: Development or design of methodology, Provision of materials subjects or patients, Investigation and editing

Declaration of Conflicting Interests

No potential conflict of interest was declared by the author(s) concerning the research, authorship, and/or publication of this article.

Funding

The research was self-sponsored by the authors

References

Abad M., Noguera P., Puchades R., Maquieira A., & Noguera V., (2002). Physico-chemical and chemical properties of some coconut dusts for use as a peat substitute for containerized ornamental plants. *Bioresource Technology*, *82*(3), 241- 245.

Adeyeye, A. S., Akanbi, W. B., Sobola, O. O., Olalekan, K. K., & Lamidi, W. A. (2017). Comparative Effect of Organic and Inorganic Fertilizer Treatments on the Growth and Yield of Onion (*Allium cepa* L). *Research and Reviews: Journal of Botanical Sciences*, *6*(2), 1-5.

Adeyeye, A. S., Akanbi, W. B., Sobola, O. O., Lamidi, W. A., & Olalekan, K. K. (2016a). Comparative effect of organic and inorganic fertilizers treatment on the growth and tuber yield of sweet potato (*Ipomea Batata* L.) *International Journal of Sustainable Agricultural Research*, *3*(3), 54-57.

Adeyeye, A. S., Akanbi, W. B., Sobola, O. O., Lamidi, W. A., & Olalekan, K. K. (2016b). Growth and Fruit Yield of Water Melon (*Citrullus lanatus*) as influenced by compost and NPK fertilizer. *FUW Trends in Science & Technology Journal*, *1*(1), 80–83.

Afzal, M. Z., Mahmood, N., Moosa, M. M., Ibrahim, A. K., Chen, S., & Zhang, L. (2022). Comparative Genomics and Synteny Within *Corchorus* Species and Among Malvaceae Genomes. In: L. Zhang, H. Khan, & C. Kole, (eds) *The Jute Genome, Compendium of Plant Genomes*. (pp. 193-208). Springer, Cham. https://doi.org/10.1007/978-3-030-91163-8_13

Akinola, R., Pereira, L. M., Mabhaudhi, T., De Bruin, F. M., & Rusch, L. (2020). A review of indigenous food crops in Africa and the implications for more sustainable and healthy food systems. *Sustainability*, *12*(8), 3493.

Al Faruque, M. A., Salauddin, M., Raihan, M. M., Chowdhury, I. Z., Ahmed, F., & Shimo, S. S. (2022). Bast fiber reinforced green polymer composites: a review on their classification, properties, and applications. *Journal of Natural Fibers*, *19*(14), 8006-8021.

Aluko, O. A., Olanipekun, T. O., Olasoji, J. O., Abiola, I. O., Adeniyan, O. N., Olanipekun, S. O., Omenna, E. C., Kareem, K.O., & Douglas, A. I. (2014). Effect of organic and inorganic fertilizer on the yield and nutrient composition of jute mallow. *Global Journal of Agriculture Research*, *2*(3), 1-9.

Baiyeri, K. P., & Mbah, B. N. (2006). Effects of soilless and soil-based nursery media on seedling emergence, growth and response to water stress of African breadfruit (*Treculia africana* Decne). *African Journal of Biotechnology*, *5*(15), 1405-1410.

Balogun, O. L., Abasilim, C. F., & Ayantoye, K. (2022). Market participation behavior among urban okra producers in Ojo Local Government Area, Lagos State, Nigeria. *Agrosearch*, *21*(1-2), 46-56.

Biswas, A., Dey, S., Huang, S., Deng, Y., Birhanie, Z. M., Zhang, J., & Li, D. (2022). A comprehensive review of *C. capsularis and C. olitorius*: a source of nutrition, essential phytoconstituents and pharmacological activities. *Antioxidants*, *11*(7), 1358.

Caporale, A. G., Palladino, M., De Pascale, S., Duri, L. G., Rouphael, Y., & Adamo, P. (2023). How to make the Lunar and Martian soils suitable for food production-assessing the changes after manure addition and implications for plant growth. *Journal of Environmental Management*, *325*, 116455.

Dada, T. E., Otitoloju, K., Adjonu, R., Crockett, J., & Nwose, E. (2021). Nutritional and medicinal values of common green leafy vegetables consumed in Delta State, Nigeria: a review. *International Journal of Community Medicine and Public Health*, *8*(5), 2564.

Ding, Y., Shi, Y., & Yang, S. (2020). Molecular regulation of plant responses to environmental temperatures. *Molecular plant*, *13*(4), 544-564.

Ebabhi, A., & Adebayo, R. (2022). *Nutritional Values of Vegetables. In Vegetable Crops-Health Benefits and Cultivation.* IntechOpen.

Fayose, C. A. (2022). *Efficient Management of Environmental Resources through Sustainable Crop Production Intensification. In Sustainable Management of Natural Resources.* IntechOpen.

Gwenzi, J., Mafongoya, P. L., & Mashonjowa, E. (2022). Effects of Climate Change on Food Production in Semi-Arid Areas: A Case Study of Uzumba Maramba Pfungwe District, Zimbabwe. In Handbook of Climate Change Across the Food Supply Chain (pp. 451-465). Cham: Springer International Publishing.

Imathiu, S. (2021). Neglected and underutilized cultivated crops with respect to indigenous African leafy vegetables for food and nutrition security. *Journal of Food Security, 9*(3), 115-125.

Kehinde, A., & Kehinde, A. D. (2022). Assessing resource use efficiency and investment in small-scale okra production in Osun state, Nigeria. *Journal of Agribusiness and Rural Development, 65*(3), 219-227.

Khan, M. A., Asaf, S., Khan, A. L., Jan, R., Kang, S. M., Kim, K. M., & Lee, I. J. (2020). Thermotolerance effect of plant growth-promoting *Bacillus cereus* SA1 on soybean during heat stress. *BMC Microbiology, 20*(1), 1-14.

Kushwaha, P., Kashyap, P. L., Srivastava, A. K., & Tiwari, R. K. (2020). Plant growth promoting and antifungal activity in endophytic Bacillus strains from pearl millet (*Pennisetum glaucum*). *Brazilian Journal of Microbiology, 51*, 229-241.

Lamidi, W.A., & Dada, J.O. (2023). Effect of oil palm bio-organic wastes on macro-propagation of some permanent crops' seeds. *International Journal of Recycling Organic Waste in Agriculture, 12*(4), 643–654. https://doi.org/10.30486/ijrowa.2023.1968034.1541

Lamidi, W. A., Shittu, K. A., & Akinrinade, E. O. (2022). Effect of organic amendments on the vegetative development of okra (*Abelmoschus esculentus* L. Moench) at different wind's directions. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 22*(4), 359-366.

Lamidi, W. A., Murtadha, M. A, Afolabi, M. S., & Olawumi, A. E. (2021). Effect of Depths of Tillage on the Performances of Open-Pollinated Yellow Maize (Zea mays) Varieties. *Polish Journal of Natural Sciences, 36*(3), 215-228.

Lamidi, W. A., Akinrinade, E.O., & Murtadha, M. A. (2019). Growth and yield of pumpkin (*Telfairia occidentalis* L) as affected by different prevailing wind speeds', heights and directions under different organic media. *Uniosun Journal of Agriculture and Renewable Resources, 3*, 25-29.

Lamidi, W. A., Nwoke, O. C., & Shittu, K. A. (2018). Assessment of soil characteristics under four cropping and land management systems in south west Nigeria. *African Journal of Agricultural Research 13*(27), 1400-1406. https://doi.org/10.5897/AJAR2017.12227

Lamidi, W. A., & Babarinde, I. E. (2017). Environmental parameters and applied nutrients' influence on germination and growth of jute mallow (*Corchorus olitorus*) under rain-fed agriculture. *UNIOSUN Journal of Science, 2*(1), 45-53.

Lamidi, W. A., & Afolabi, M. S. (2016). Influence of Some Environmental Factors on Maize Productivity in Osun State, Nigeria. *Ethiopian Journal of Environmental Studies and Management, 9*(2), 1009-1021. https://doi.org/10.4314/ejesm.v9i2.7S

Luziatelli, F., Ficca, A. G., Colla, G., Baldassarre Švecová, E., & Ruzzi, M. (2019). Foliar application of vegetal-derived bioactive compounds stimulates the growth of beneficial bacteria and enhances microbiome biodiversity in lettuce. *Frontiers in plant science, 10*, 60.

Mathowa T., Hababa K, Mojeremane W., Mpofu C., & Legwaila, G. M. (2014c). Influence of different potting media on the growth of pod mahogany (Afzeliaquanzensis) seedlings. *International Journal of Advanced Research in Biological Sciences, 1*(7), 105-113.

Mguis, K., Albouchi, A., & Ben, B. N. (2014). Germination responses of *Corchorus olitorius* L. to salinity and temperature. *African Journal of Agricultural Research, 9*(1), 65-73.

Motsa, M.M., Slabbert, M.M., Van Averbeke, W., & Morey, L. (2015). Effect of light and temperature on seed germination of selected African leafy vegetables. *South African Journal of Botany, 99*, 29- 35. https://doi.org/10.1016/j.sajb.2015.03.185

Mudau, F. N., Chimonyo, V. G. P., Modi, A. T., & Mabhaudhi, T. (2022). Neglected and underutilised crops: A systematic review of their potential as food and herbal medicinal crops in South Africa. *Frontiers in Pharmacology, 12*, 4054.

Murtadha, M.A., Oyetunji, A.T., & Lamidi, W. A. (2023). Evaluation of okra shoot and root systems under stress and non-stress water conditions. *Nigerian Journal of Horticultural Science, 27*(1), 29-34.

Mwakha, F. A., Gichimu, B. M., Neondo, J. O., Kamau, P. K., Odari, E. O., Muli, J. K., & Budambula, N. L. (2020). Agro-Morphological Characterization of Kenyan Slender Leaf (*Crotalaria brevidens* and *C. ochroleuca*) Accessions. *International Journal of Agronomy, 4*, 1-10.

Nakaziba, R., Anyolitho, M. K., Amanya, S. B., Ogwal-Okeng, J., & Alele, P. E. (2020). *Traditional uses of Corchorus olitorius L in Oyam District.* A cross-sectional ethnobotanical survey.

Nkomo, M., & Kambizi, L. (2009). Length Research Paper Effects of pre-chilling and temperature on seed germination of *Corchorus olitorius* L.(Tiliaceae)(Jew's Mallow), a wild leafy vegetable. *African Journal of Biotechnology, 8*(6), 1078-1081.

Okechukwu, G. C. E., Ngwu, O. E., & Awere, S. U., (2021). Effect of potting media on the growth and leaf yield of lettuce (*Lactuca sativa*) in Agbani Nkanu south, Nigeria. *Journal of Agriculture and Ecosystem Management (JONAGES), 1*(2), 1-8.

Okpara, D. A., Muoneke, C. O., & Ojikpong, T. O. (2007) Effects of Nitrogen and phosphorus fertilizer rates on the growth and yield of sesame (*Sesamum indicum* L.) in the southeastern rain forest belt of Nigeria. *Nigeria Agricultural Journal, 38*, 1-11, https://doi.org/10.4314/naj.v38i1.3243

Okusanya, O. T. (1980). Germination and growth of *Celosia cristata* L., under various light and temperature regimes. *American Journal of Botany, 67*(6), 854-858.

Omotayo, O. P., & Babalola, O. O. (2021). Resident rhizosphere microbiome's ecological dynamics and conservation: Towards achieving the envisioned Sustainable Development Goals, a review. *International Soil and Water Conservation Research, 9*(1), 127-142.

Sayara, T., Basheer-Salimia, R., Hawamde, F., & Sánchez, A. (2020). Recycling of organic wastes through composting: Process performance and compost application in agriculture. *Agronomy, 10*(11), 1838.

Ullah, N., Ditta, A., Imtiaz, M., Li, X., Jan, A. U., Mehmood, S., & Rizwan, M. (2021). Appraisal for organic amendments and plant growth-promoting rhizobacteria to enhance crop productivity under drought stress: A review. *Journal of Agronomy and Crop Science*, 207(5), 783-802.

Zhang, L., Ibrahim, A. K., Niyitanga, S., Zhang, L., & Qi, J. (2019). Jute (*Corchorus* spp.) breeding. *Advances in Plant Breeding Strategies: Industrial and Food Crops*, *6*, 85-113.