**THE PERFORMANCE OF JUTE MALLOW (*Corchorus olitorius*) UNDER DIFFERENT INTRA-ROW SPACINGS AND ORGANIC MANURE TYPES FOR SUSTAINABLE PRODUCTIVITY AND ENHANCED MARKET-ECONOMIC POTENTIALS IN NIGERIA**

**ABSTRACT**

This study examined the effect of different intra-row spacing's and organic manure types on the growth, yield and fibre colour of jute mallow (*Corchorus olitorius*). The field experiment was conducted at the Teaching and Research Farm, Federal University, Wukari, Taraba State, Nigeria. Two intra-row spacing's (10 and 20cm) and three manures - poultry manure (5t ha-1), goat manure (10t ha-1), cow dung (10t ha-1) and control (0t ha-1) were laid in a 2 x 4 factorial experiment in a Randomized Complete Block Design (RCBD) with three replications. Data was collected on growth, yield, jute quality parameters and subjected to ANOVA and were means of treatments were significant at (p≤ 0.05) level of probability, they were separated using the Turkey-HSD. Results showed that at 4WAT, the survival rate (70 - 79%) of the plants in all treatments did not differ significantly. Meanwhile, the highest leaf fresh weight plant-1, highest stem girth, fiber yield at harvest, plant height, stem fresh weight plant-1, leaf area (LA), fiber length and width at harvest (10 WAT) were recorded from the jute crop sown at 20cm intra-row spacing. Conversely, at 10WAT, higher plant heights, LA and fibre length at harvest were recorded using cow dung; while goat manure recorded the highest leaf fresh weight plant-1 at 10WAT, stem fresh weight plant-1 at 6WAT coupled with stem girth and fiber width at harvest. Poultry manure produced the highest stem fresh weight plant-1 at 10WAT and fiber weight at harvest. Generally, the control plots significantly recorded lowest growth, yield and jute fibre colour indices. It is concluded that the intra-row spacing’s used in this study and the addition of organic manure enhanced the growth, yield and fibre colour of jute mallow. The golden color fibre, adjudged best, was obtained with application of poultry manure at 5t ha-1 and closest (10cm) intra-row spacing. Indeed, jute is rated one of the cheapest and strongest of all natural fibers and its easy biodegradable qualities has attracted greater focus to its environmental friendliness and market value. It is thus considered the potential fiber of the future.

**Keywords:** *Jute, Spacing, Organic manures, Growth, Yield, Fibre.*

**INTRODUCTION**

Jute mallow (*Corchorus olitorius*), commonly known as wild okra, is a crop also called the “*west African sorrel*” in English (PROTA, 2010). In Nigeria it is locally called “*Ayoyo”* in Hausa, “*Ewedu”* in Yoruba and “*Atyevee”* in Tiv (Muntari, 2019). It is a member of the family Taliacea and is presently found all over the tropics (Muntari, 2019). The origin of jute mallow is often disputed, though Africa is considered as its primary center of origin. It is the most common leafy vegetable in many African countries including Cote d’Ivoire, Benin, Nigeria, Cameroon, Sudan, Kenya, Uganda, Zimbabwe, Egypt and South Asia, existing as either wild or cultivated vegetable (Muntari, 2019). Farmers often grow Jew’s mallow in association with other vegetables or food crops such as okra, tomato, watermelon, groundnut or yam (Fondio and Grubben, 2011). The plant is an upright annual herb that grows up to 2m tall. It branches profusely and has reddish, fibrous and tough stems. It is grown as a vegetable on fallow land or cultivated in home gardens and occasionally sold at the market (Hedrick, 2010).

Jute mallow leaves are eaten cooked and sometimes the young leaves and the immature fruits are added to salads. These are high in protein and can be dried and/ or used as a thickener in soups (Hedrick, 2010; Masarirambi *et al.,* 2011). Jute is also a source of natural, long and soft vegetable fiber with a golden silky shine, termed as “*The Golden Fiber*” (Gordon*,* 2005). As one of the cheapest and strongest of all natural fibres, it is considered as fibre of the future (Shahid et al., 2016). It’s fibre is renewable, cheap, biodegradable and can be recycled (Adediran et al., 2015). It is a versatile and environment-friendly natural ﬁber that generates diversiﬁed value-added products. Traditionally, being among the strong and durable fabric, jute fiber has been used to manufacture packaging materials like hessian, sacks, bags, ropes, twines and home textiles as carpet floor mats, carpet backing cloth, jute shoe rack etc (Gordon, 2005). In fact, it is reported to fall into the best ﬁber category along with Kenaf (Hibiscus cannabinus L.), industrial hemp (Cannabis sativa L.), Ramie (Boehmerianivea L.) and Banana (Musa acuminatacolla) ﬁbers (Siddiqur, 2010).

Fibre yields equivalent to over 2,500kg ha-1 of fibre have been obtained from small experimental plots (Phillips, 1977; Medhanie *et al.*, 2017). However, there is little or no statistics about the fiber production in Nigeria.

Jute mallow requires warm and humid climate with temperatures ranging between 240C to 370C for annual growth. Constant rain or water logging soil conditions are deleterious to the crop growth. Grey alluvial soils with good depth, are reported to be best for jute cultivation. However, jute is widely grown on sandy loam's and clay loam's (WorldJute.Com, 2002). It tolerates soil pH of 4.5 - 8.0 (Palada and Chang, 2003; Mgolozeli *et al*., 2022). Traditionally, farmers broadcast seed without any consideration to spacing or the optimal density per area of cultivation. About 5-7 kg seeds per hectare are recommended to be sown using inter-row spacing of 60cm with subsequent thinning using intra-row spacing of 5-7cm; following germination 3 -10 days after sowing (WorldJute.com, 2002).

The crop removes large quantity of plant nutrients from the soil. Therefore, manures such as compost or farmyard manures, Phosphorous, Potash and Nitrogen fertilizers are used for soil amelioration (WorldJute.Com, 2002). The use of green manure has been reported to give better crop performance than chemical fertilizers as a result of the inherent low fertility (especially low organic matter - OM) status of most Savannah soils which results in poor crop productivity (Sambo *et al.,* 2013). However, there is need to determine the rate of application of the organic soil amendments which is in turn dependent on the nutrient composition of the manure, the fertility status of the soil as well as other agronomic practices such as plant spacing (Garjila *et al.,* 2017). But, there is paucity of information on utilization and application rates of different sources of manures as fertilizer and improved agronomic practices for enhanced jute production for fibre production in Nigeria (Enwezor *et al*., 1989; Maity *et al*., 2012; Naim *et al.,* 2015).

Indeed, one key to soil fertility maintenance is regular recycling of organic wastes in the soil (Madhu *et al*., 2018); which helps in maintaining soil organic matter and enhances crop yields in a sustainable manner (Sambo *et al.,* 2013, Garjila *et al.*, 2017).

Hence, this work was undertaken with the aim of evaluating the performance of Jute mallow (*Corchorus olitorius)* under different intra-row spacing and application of different organic manure types.

**METHODOLOGY**

**Description of study area:** This study was conducted in the Teaching and Research Farm, Department of Crop Production and Protection, Federal University Wukari, Taraba State Nigeria; during the 2021-2022 cropping season. Wukari is located on latitude 70 52’.17.000 N and longitude 90 46’40.300 E in the southern Guinea Savannah agro-ecological zone of Nigeria. The vegetation exhibits seasonal pattern and is mainly of trees; with the dominant species being Daniellia, which provides a limited amount of shade (Kehinde *et al.,* 2015). The annual precipitation is about 1205mm, with an average temperature of 26.8 0C. The soils are deep, well drained and medium to coarse in textured.

**Experimental materials, designs, treatments and field layout**

The treatments were made up of two (2) intra-row spacing's (10cm and 20cm) delineated along 40cm inter-row spacing; three (3) types of organic manure with stipulated rates of application as stated: poultry manure (5t ha-1), cow dung (10t ha-1), goat (10t ha-1) manure and control (0t ha-1); given a total of eight (8) treatment combinations. The 2 x 4 factorial experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated three (3) times. Alley spacing between plots and blocks were 1m and 1.5m respectively. The plot size was 3m × 2m (6m2), while the total experimental land area was 46m × 21m (0.096ha).

**Agronomic practices**

A well-drained fertile soil was selected for this trial. The land at the experimental site was weeded with the aid of simple farm tools like the hoe and cutlass. Subsequently, the plots were marked out with pegs. The different manures were incorporated into the soils of plots delineated for the treatments. Jute mallow seedlings were transplanted to the plots at 8 weeks after broadcasting (WAB) on raised beds; which coincided with 5 weeks after manure application at the specified spacing. Weeds were controlled manually as and when due; while insect pests were controlled using the insecticide Chlorpyrifos. The matured crop was harvested with the aid of sickles at 120 days after transplanting (DAT); when the leaves and the seed capsules had turned yellowish and brownish in colour respectively. Data collection started at 4 WAT and was done fortnightly till 10 WAT. Data were collected on germination survival rate, height (cm), leaf and stem fresh weights (gm), Leaf Area (LA) cm2), fiber length, fiber width, stem girth, fibre yield at harvest and fiber color.

**Harvesting and processing**

Harvested plants were first tied into bundles and left in the sun in pyramids for 3-4 days to shed leaves. The jute crop was processed into fibre by following the procedure described by WorldJute.com (2002). The stems were retted by immersing in water for 30 days; and the fibre was extracted by stripping. The extracted fibre were washed and dried for 2-3 days; weighed and the yield (kg) per ha estimated.

**Data Collection and Analysis**

The data collected on jute mallow growth, fibre dimensions, yield and colour were subjected to Analysis of Variance (ANOVA); and were means of treatments were significant, they were separated using the Turkey-HSD.

**RESULTS**

**Germination survival rate (%) and plant height (cm)**

The effect of different intra-row spacing and application of organic manure types on germination survival rate and plant height of jute mallow is presented in Table 1. There was no significant difference (p≤0.05) between the intra-row spacing and the application of different organic manure types on germination survival rate. Similarly, intra-row spacing had no significant effect (p≤0.05) on plant height throughout the growing period. However, there was a significant difference (p≤0.05) in the application of different organic manure types on plant height at 8 WAT only. The highest mean (85.40cm) plant height was recorded using cow dung; though this was statistically the same with other manure sources. On the other hand, the lowest mean (60.10cm) plant height was recorded on the control plots.

**Leaf fresh weight plant-1 (gm)**

The effect of different intra-row spacing and application of organic manure types on leaf fresh weight plant-1 of jute mallow is shown in (Table 2). Intra-row spacing had no significant (p≤0.05) effect on leaf fresh weight plant-1 throughout the growing period. However, leaf fresh weight at 10 WAT was significantly highest (39.83gm) at the lowest (10cm) intra-row spacing; while the highest intra-row spacing (20cm) recorded the lowest (39.75gm) leaf fresh weight plant-1. The application of different organic manures did not have a significant difference (p≤0.05) on leaf fresh weight plant-1 throughout the growing period. However, the highest leaf fresh weight plant-1 (42.50gm) at 10 WAT was recorded using goat manure, while the lowest (32.83gm) was recorded on the control plots.

**Stem fresh weight plant-1 (gm)**

Intra-row spacing did not significantly (p≤0.05) affect stem fresh weight plant-1 throughout the growing period (Table 3). However, the highest (50.50gm) stem fresh weight plant-1 at 10 WAT was recorded at the widest plant spacing (20cm); while the lowest (47.50gm) was recorded with the lowest spacing (10cm). The application of different types of organic manure on stem fresh weight plant-1 was significant at 4 and 6 WAT only (Table 3). However, at 10 WAT, it was generally observed that stem fresh weight plant-1 was highest (58.83gm) using poultry manure; while the lowest (37.16gm) was recorded on the control plots.

**Leaf Area (LA) cm2)**

The effect of different intra-row spacing and application of organic manure types on leaf area (LA) of jute mallow is presented in (Table 4). The LA was not significantly (p≤0.05) affected by intra-row spacing throughout the growing period. However, the highest LA (48.39cm2) at 10 WAT was recorded at the widest (20cm) intra-row spacing; while the lowest (44.14cm2) was recorded at the lowest (10cm) intra-row spacing (Table 4). The application of different organic manure types significantly (p≤0.05) affected LA at 6, 8 and 10 WAT only. Though cow-dung produced significantly higher LA than the control, it was statistically on par with plants treated with other types of manure. The lowest LA was recorded on control plots.

 **Stem girth (cm)**

The effect of different intra-row spacing and application of organic manure types on stem girth at harvest is presented in (Table 5). The effect of the treatments on stem girth were not statistically significant (p≤ 0.05). However, the narrowest (10cm) intra-row spacing and goat manure produced the highest stem girth (3.73 and 4.06cm respectively); compared to other manure types and the control which recorded the lowest (3.02cm).

**Fiber length (mm)**

The effect of different intra-row spacing and application of organic manure types on jute fiber length at harvest is presented in (Table 5). Intra-row spacing had no significant (p≤ 0.05) effect on fibre length, while cow dung recorded significantly (p≤ 0.05) the highest (1574.00mm) fibre length compared to all other types of manure applied. The control recorded significantly the lowest fibre length (877.83mm).

**Fiber width (mm)**

The effect of different intra-row spacing and application of organic manure types on jute fiber width at harvest is presented on (Table 5). While intra-row spacing had no significant (p≤ 0.05) effect on fibre width, goat manure produced significantly (p≤ 0.05) the highest (13.33mm) fibre width than all other types of manure applied. The control which recorded significantly the lowest (11.69mm) fibre width.

**Fiber yield (kg ha-1)**

Table 5, presents the effect of intra-row spacing and application of different organic manure types on jute fiber yield. Results showed that intra-row spacing had no significant (p≤0.05) influence on harvested fibre yield; however, the highest fibre yield (60.42kg) was obtained with the narrowest (10cm) intra-row spacing compared with the widest (20cm (39.62kg) spacing. On the other hand, poultry manure produced significantly (p≤0.05) the highest (75.62kg) fibre yield than all other types of manure applied. Recorded fibre yield was significantly lowest (17.26kg) on the control plots.

**Fibre colour**

The result of jute fibre quality, characterized by its colour as influenced by different intra-row spacing and application of organic manure types is presented on (Table 6). jute fibre colors ranged from golden to grew depending on the treatment combination.

**Table 1: Effect of different intra-row spacing and application of different organic manures on plant germination survival rate (%) and plant height (cm) of Jute mallow in Wukari; during the 2021-2022 rainy season**

|  |  |
| --- | --- |
| **Treatment**                                    |  |
|  |  |  | **Plant height (cm)** |  |
| **Spacing (cm)** | **Germination Survival rate (%) (4WAT)** | **4WAT** | **6WAT** | **8WAT** | **10WAT** |
| 10 | 76.33 | 13.40 | 35.75 | 74.93 | 90.94 |
| 20 | 70.50 | 13.39 | 38. 97 | 76.21 | 95.90 |
| S.E.M**+** | 6.79 | 1.28 | 2.89 | 3.50 | 5.64 |
| **Types of manure (t ha-1)** |  |  |  |  |  |
| Poultry manure (5) | 70.00 | 15.08 | 40.62 | 81.06a | 94.85 |
| Goat manure (10) | 74.33 | 14.65 | 39.15 | 75.72ab | 92.43 |
| Cow dung (10) | 78.83 | 12.69 | 40.22 | 85.40a | 101.60 |
| Control (0) | 70.50 | 11.19 | 29.45 | 60.10c | 84.81 |
| S.E.M**+** | 9.60 | 1.81 | 4.09 | 4.96 | 7.97 |
| **Interactions** | N.S | \*\* | \*\* | \*\* | N.S |

*Means having the same alphabet(s) in the same column are not significantly different at P=0.05 according to Turkey-HSD. \*\* = Highly significant at P=0.01; NS = not significant*

**Table 2: Effect of different intra-row spacing and application of organic manures on leaf fresh weight plant-1 (gm) of jute mallow at Wukari; during the 2021-2022 rainy season**

|  |
| --- |
| **Treatment Leaf fresh weight (gm)** |
| **Spacing (cm)** | **4WAT** | **6WAT** | **8WAT** | **10WAT** |
| 10 | 14.50 | 25.08 | 17.41 | 39.83 |
| 20 | 19.95 | 1. 33
 | 25.08 | 39.75 |
| S.E.M**+** | 2.29 | 2.51 | 2.86 | 3.17 |
| **Types of manure (t ha-1)** |  |  |  |  |
| Poultry manure (5) | 24.33 | 27.00 | 25.33 | 42.33 |
| Goat manure (10) | 16.66 | 30.00 | 22.83 | 42.50 |
| Cow dung (10) | 15.83 | 25.33 | 19.16 | 41.50 |
| Control (0) | 12.08 | 16.50 | 17.66 | 32.83 |
| S.E.M**+** | 3.24 | 3.55 | 4.04 | 4.49 |
| **Interaction** | \*\* | \*\* | NS | NS |

*Means having the same alphabet(s) in the same column are not significantly different at P=0.05 according to Turkey-HSD. \*\* = Highly significant at P=0.01; NS = not significant*

**Table 3: Effect of different intra-row spacing and application of organic manures on stem fresh weight plant-1 (gm) of jute mallow at Wukari; during the 2021-2022 rainy season**

|  |  |
| --- | --- |
| **Treatment** | **Stem fresh weight (gm)** |
| **Spacing (cm)** | **4WAT** | **6WAT** | **8WAT** | **10WAT** |
| 10  | 8.83 | 28.16 | 28.50 | 47.50 |
| 20 | 10.29 | 30.33 | 40.25 | 50.50 |
| S.E.M**+** | 1.22 | 3.30 | 5.68 | 3.72 |
| **Types of manure (t/ha)** |  |  |  |  |
| Poultry manure (5) | 14.66a | 32.66ab | 44.00 | 58.83 |
| Goat manure (10) | 6.00c | 37.00a | 36.83 | 51.66 |
| Cow dung (10) | 9.50ab | 30.83ab | 31.83 | 46.33 |
| Control (0) | 8.08b | 16.50c | 24.83 | 37.16 |
| S.E.M**+** | 1.72 | 4.67 | 8.03 | 5.26 |
| **Interaction** | \*\* | \*\* | \*\* | \*\* |

*Means having the same alphabet(s) in the same column are not significantly different at P=0.05 according to Turkey-HSD. \*\* = Highly significant at P=0.01; NS = not significant*

**Table 4: Effect of different intra-row spacing and application of organic manures on leaf area (LA) cm2) of Jute mallow at Wukari; during the 2021-2022 rainy season**

|  |  |
| --- | --- |
| **Treatment** | **Leaf Area (LA) cm2)** |
| **Spacing (cm)** | **4WAT** | **6WAT** | **8WAT** | **10WAT** |
| 10 | 20.55 | 39.35 | 40.45 | 44.14 |
| 20 | 24.55 | 42.68 | 45.04 | 48.39 |
| S.E.M**+** | 2.52 | 2.62 | 2.92 | 2.82 |
| **Types of manure (t ha-1)** |  |  |  |  |
| Poultry manure (5) | 22.61 | 43.19ab | 39.09ab | 47.21ab |
| Goat manure (10) | 25.03 | 43.56ab | 45.15ab | 45.73ab |
| Cow dung (10) | 23.86 | 47.38a | 54.71ab | 57.62a |
| Control | 18.72 | 29.94c | 32.03c | 34.50c |
| S.E.M**+** | 3.56 | 3.70 | 4.13 | 3.99 |
| **Interaction** | \*\* | \*\* | \*\* | \*\* |

*Means having the same alphabet(s) in the same column are not significantly different at P=0.05 according to Turkey-HSD. \*\* = Highly significant at P=0.01; NS = not significant*

**Table 5: Fibre yield and dimensions of jute mallow fibre at harvest in Wukari, during the 2021-2022 rainy season**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Intra-raw spacing (cm)** | **Stem girth (cm)** | **Fiber length (mm)** | **Fiber width (mm)** | **Fibre Yield (kg ha-1)** |  |
| 10 | 3.73 | 1245.16 | 11.53 | 60.42 |
| 20 | 3.63 | 1295.41 | 13.55 | 39.62 |
| **S.E.M+** | 0.199 | 5.095 | 0.089 | 0.475 |
| **Types of Manure Sources (t ha-1)** |  |  |  |  |
| Poultry litter (5) | 3.78 | 1402.83b | 12.83b | 75.62a |
| Goat manure (10) | 4.05 | 1226.50c | 13.33a | 58.79b |
| Cow dung (10) | 3.87 | 1574.00a | 12.30c | 48.41c |
| Control (0) | 3.02 | 877.83d | 11.69d | 17.26d |
| **S.E.M+** | 0.282 | 7.206 | 0.126 | 0.671 |
| **Interaction(s)** | N.S | \*\* | \*\* | **\*\*** |

*Means having the same alphabet(s) in the same column are not significantly different at P=0.05 according to Turkey-HSD. \*\* = Highly significant at P=0.01; NS = not significant*

**Table 6: Jute fibre color as an indication of its quality in Wukari; during the 2021-2022 rainy season**

|  |  |  |
| --- | --- | --- |
| **Organic manure (t ha-1)** | **Inter-row Spacing (cm)** | **Jute fiber color** |
| Poultry manure (5) | 10 | Golden |
| Poultry manure (5) | 20 | Silk brown |
| Goat manure     (10) | 10 | Off white |
| Goat manure     (10) | 20 | Golden yellow |
| Cow dung          (10) | 10 | Brown |
| Cow dung(10) | 20 | Grew |
| Control (0) | 10 | Grew |
| Control(0) | 20 | Grew |

**DISCUSSION**

**Effect of different intra-row spacing and application of organic manures on growth of jute mallow**

Intra-row spacing produced statistically similar jute plant germination survival rates (70 - 76%) at 4 WAT. At 10 WAT, the tallest plants, highest stem fresh weight and leaf area (LA) were recorded at the widest (20cm) intra-row spacing. However, leaf fresh weight was highest at the lowest (10cm) spacing. This result agrees with Masum *et al.,* (2011) who reported that the highest plant height (2.73cm) of *Corchorus olitorius* at harvest was recorded at 10 x 20cm spacing. But in this work, though, the effect of intra-row spacing on growth of jute mallow was not consistent, it can be adduced that even at the 20cm intra-row spacing tested, there was adequate coverage of the soil surface, interception and utilization of sunlight for production of taller plants, higher leaf fresh weights and LA for plant growth (Williams, 1975; Williams and Joseph, 1976; Kayembe, 2015; Mcunu, 2023).

There was no statistical difference in germination survival rates (70 - 78%) at 4 WAT due to the application of different manure types. Plant height at 8 WAT, LA at 6, 8 and 10 WAT were significantly influenced; while leaf fresh weight was not significantly affected by the application of different types of manure. Stem fresh weight was significantly influenced at 4 and 6 WAT. Generally, cow-dung produced the tallest plants and highest LA; while the highest leaf and stem fresh weights were recorded using goat manure, though these were statistically not different from each other. On the whole, significantly lower growth parameters were recorded on control plots. Without doubt, the application of manure which is most widely used for growing crops, increases growth as reported by Okunlola *et al.,* (2011) who found manure to increase growth of jute mallow (*Corchorus olitorius).* It is evident that organic nutrient from different sources positively affect the growth of crops; as they have the potential to increase the nutrient status of the soil through gradual release of nutrient (Egherevba and Ogbe, 2002; Ibeawuchi *et al*., 2006; Emuh, 2013; Asmaa *et al.,* 2014); and ultimately support crop performance (Adebayo and Akoun, 2002; Yousef *et al*., 2020).

**Effect of different intra-row spacing and organic manures on fibre yield and colour (quality) of jute mallow**

The highest (60.42kg ha-1) fibre yield at harvest was recorded at the narrowest (10cm) intra-row spacing and this was 34.45% higher than the fibre yield at the widest (20cm) intra-row spacing. This is in conformity with the findings of Masum *et al.,* (2011) who reported that the highest fibre yield (3.12t ha-1) at harvest was found from plants spaced at 25cm × 10cm. This could be attributed to the increase in number of plants per unit area and the total area of leaves which increases the plants photosynthetic efficiency, growth and yield of the crop (Williams and Joseph, 1976; Kayembe, 2015).

Fibre yield was 77.18%, 70.64% and 64.35% higher on plots applied with poultry, goat manure and cow-dung respectively over the control. The fibre yield in this study ranged between 48.41 - 75.62kg ha-1. While this may be considered low, lower fibre yields of 2.7 kg ha-1 have been recorded elsewhere (Stoklasa, 2023) and higher fibre yields of about 2,500kg ha-1 have equally been reported (Phillips, 1977; Medhanie *et al.,* 2017). Indeed, organic nutrient sources positively affect the growth of crops; as they have the potential to increase the fertility status of the soil through gradual nutrient release (Egherevba and Ogbe 2002; Ibeawuchi *et al.,* 2006; Emuh, 2013; Ibeawuchi *et al.,* 2015); and this ultimately supports the general performance of crops (Adebayo and Akoun, 2002; Asmaa *et al.,* 2014). Without doubt, the application of manure which is most widely used for growing crops, increases growth as reported by Okunlola *et al.,* (2011) who affirmed that manure enhanced the growth and yield of jute (*Corchorus olitorius).*

In this study, the quality indicators investigated were characterized by jute fiber length, fiber weight, fiber width, stem girth and fiber color. Plots applied with goat manure recorded the highest stem girth (3-4cm) and fibre width; while cow-dung produced the highest fibre length. Indeed, various workers had reported similar findings. Adediran *et al.,* (2015) and Garjila *et al.,* (2017) noted that stem girth was highest when various rates of goat manure were applied. Usman (2015) in a similar study concluded that the applications of organic manures (cow-dung, poultry, goat and/ or sheep manures) significantly increased the stem girth of jute mallow compared with its non-application. The recorded fiber length in this work ranged between 800 - 1500mm; and this could be said to be within the length range (1000-4000mm) reported by (FAO, 2023). On the other hand, the recorded fiber width ranged 11 - 13mm; and could be said to be quite low compared to the fibre width (48cm) reported by (Stoklasa, 2023).

It was generally observed that all the fibre dimensions indicative of quality were higher on plants applied with manures, compared to the control plots. It is instructive to note that organic materials derived from animal, human and plant residues which contain plant nutrients in complex organic forms, are capable of sustaining higher crop productivity and improving soil quality through influencing the soil properties on a long term basis. The low fibre yields recorded in the present study could in part probably be ascribed to the poor retting process and/ or the variety cultivated.

Jute fiber is known as “golden” fiber because of its golden coloration and in the present work, the fibre colour ranged from golden to grew. It has been reported that because of the variation among jute mallow seeds, climatic conditions and soil types (nutrient composition), fiber color could be affected. Hence, jute fiber has different colors which include the golden color, considered the best. In this study, the golden color, was obtained using poultry manure (5t ha-1) and at the closest intra-row spacing (10cm). On the whole, the fiber colors recorded fall within the reported colors for good quality jute fibres (WorldJude.com, 2002).

**Market-Economic potentials of jute**

The bast-fibre from jute is used for coarse fabrics, because the length: diameter ratio of the jute filaments is between 100–120 mm, which is much below the reported minimum (1000mm) required for fine spinning quality. However, it is one of the cheapest and the strongest of all natural fibres (Shahid *et al.,* 2016). In recent times, with the huge negative effect of plastic to the environment, attracting high global consciousness over its continuous utilization, many countries have instituted legislation's out-rightly banning the production and use of plastic bags and its derivatives; while others are working towards reducing the use of plastic commodities especially plastic bags. Therefore, if the usage of plastic bags is drastically reduced, the alternative cheap, strong, natural, biodegradable, renewable and environment-friendly product would be jute bags. Here then lies a good economic prospect of the jute (Islam and Ahmed, 2012; Ahmed and Kader, 2014; Adediran, 2015; Chowdhury and Rashed, 2015; Shahid *et al.,* 2016).  It is now accepted and increasingly used to make floor-mats and market bags and other diverse products, thereby growing its marketable value. For instance, the global demand for shopping bags is been estimated to be about 500 billion pieces, with a market value estimated at $500 billion per year. Without doubt, it is a plant that is reportedly cost effective and useful for diverse purposes than reinforced plastic and is fast replacing wood in the pulp and paper industry (FAO, 2018).

**CONCLUSION**

From the result of this study, it can be concluded that Jute mallow can be grown at intra-row spacing of 10 - 20cm as it is found to generally promote crop growth. Also, the application of organic manure types {poultry (5t ha-1), goat and cow-dung (10t ha-1)}; as source of nutrient supply to the crop, facilitated better growth of Jute mallow (*Corchorus olitorius*). Likewise, the highest (60.42t ha-1) fibre yield at harvest was recorded at the narrowest (10cm) intra-row spacing; while the application of goat droppings at 10t ha-1 and poultry manure at 5t ha-1 gave the highest fibre yield, compared to cow dung at 10t ha-1 and the control. Without doubt, the adoption of appropriate spacing and application of organic manure increased nutrient supply and promoted crop growth, fibre yield and colour in the Wukari agro-ecological zone of Nigeria. Indeed, the market prospects of jute in Nigeria is very high. The challenge is how to develop new applications for the production of diversified products aimed at higher contribution to sustainable economic growth and development of the country.

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