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The Production of Jute (Corchorus capsularis L.) as Influenced by spacing and Organic fertilizer Grown in Gombe and Benue state, Nigeria

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Abstract: The experiment aimed to evaluate the effect of residuals species on the growth and yield of jute grown at Gombe and Makurdi during the 2020 Rainy Season. The treatments used were Spacing (5, 10 and 15cm), Organic source (Poultry dropping, Cow dung, NPK and control) was used. The experiment is a 3 by 4 experiment laid in a randomized complete block design with three replications. During the investigation, some physiological variables, such as growth, plant height, the number of leaves, number of branches, 1st flower initiation, and 50% flowering were measured. Other characters like number of calyx shoot weight; calyx weight, number of pod, number of seeds per pod and 100 seed weight were also recorded. The results of the investigation revealed that sorrel generally responded to both spacing and nutrient source. All the parameters studies have significantly ($P \leq 0.05$) responded to spacing 15cm, where it was observed to perform higher in both growth character such as plant height (129.11), the number of leaves (109.01) and the number calyx (8.11), number of seed per calyx (18.11) and calyx weight (102.12) number of pod (21.12), 100 seed weight (4.41) and shoot weight (2891.01). On nutrient source NPK was superior in both growth and yield related character followed by poultry droppings such as, as plant height (139.01), the number of leaves (99.01) and the number calyx (5.12), number of seed per calyx (19.12) and calyx weight (112.12) number of pod (22.12), 100 seed weight (5.01) and shoot weight (30129.96). Jute grown in Benue outgrows those cultivated in Gombe in both growth and yield-related character. Based on the results obtained it can be suggested that the use spacing 15cm and NPK fertilizer and poultry dropping which is second to NPK fertilizers in both growth and yield characters for less privilege farmers will lead to optimum yield in jute cultivation in the study areas.

Keywords: Jute, Organic nutrient and Spacing

1. Introduction

Jute is a long, soft, and lustrous plant Fiber that can be spun into coarse, long-lasting threads. It was derived primarily from plants of the genus corchorus. formerly placed in the Tiliaceae family and, more recently, the Malvaceae family. White jute (corchorusolitorius) is a common and vitally important leafy vegetable in Makurdi (Dansiet al.,2009). It is an annual herb that varies in height

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from 60 to 150 centimetres, depending on the cultivar. It grows in fields adjacent to residential areas, on market garden sites, and in home gardens across the globe. Jute plays an important role in household food security and nutrition. The average leaf contains 15% dry matter, 4.8g of protein, 25mg of calcium, 4.5mg of iron, 4.7mg of vitamin A, 92 gof folates, 1.5mg of nicotinamide, and 105mg of ascorbic acid (Grubben and Denton, 2004; Harbome et al., 2001). Despite its nutritional and economic significance, scientific research in the study area has ignored it. The application of organic manure improves both the crop's growth and yield, while cultivation of the crop without the use of fertilizer benefits from the soil's natural fertility and, possibly, small amounts of fertilizer applied to increase yield. This residual fertility is inadequate to meet the plant's nutrient requirements. Consequently, fertilization is necessary to maximize their yields. For optimal yield, white jute requires nutrients such as NPK, Mg, Ca, Na, and S. These nutrients serve a specific purpose and must be supplied to the plant at the proper time and in the proper amount. Jute responds favourably to fertilization, especially nitrogen (Ogunrinde and Fasinmirin, 2011).

Moreover, the majority of jute is produced by marginalized farmers whose low incomes make access to mineral fertiliser's prohibitive (Genschet al., 2011). In addition, the excessive and indiscriminate use of chemical fertilizers degrades soil and poses a great threat to human health (Fujimoto, 2008). Jute is also grown on a small scale by women only, so the yield does not cover the cost of purchasing and transporting mineral fertilizers. With increase in both nutritional and medicinal value of jute, its nutrient for growth is not ascertained which plays an important role in jute cultivation. The required plant population of crop is not known which will increase crop productivity and helps in controlling weeds. The use of organic sources has the following advantages in the soil, which ranges from improving soil organic matter, porosity, CEC and safe for plant that are cultivated under these sources. (Ngeze, 2000; Adeniyan and Ojeniyi, 2003; Mbah, 2006; Ayeni*et al*., 2008; Alabadan*et al*., 2010). Among the great constraints facing the smallholder farmers who produce jute in the nation is low yield due to inadequate plant spacing. Plant spacing influences population and hence plant competition. The closer or wider the plant spacing, the higher or lower is the plant population, respectively. Application of suitable plant spacing can lead to good growth and development, leading to optimum yield while inadequate plant spacing could result to relatively low yield and poor-quality fruits (Madina *et al.,* 2015). Ekwu and Nwokwu (2012) observed significant rigorous tall plants, poor fruit quality and low yield per plant due to intra specific competition with closer plant spacing than wider plant spacing. That is to say, suitable plant spacing leads to optimum yield whereas too low plant spacing or too high plant spacing could result in relatively poor quality and lower yield, respectively (El Naim*et al.,* 2011). There is therefore the need to employ adequate plant spacing to obtain maximum fruit yield. Harvesting can begin six weeks after planting. The entire plant can be harvested (for jute production), or several times during the vegetative period, the leaves can be harvested by pruning (for food production). Variety, soil fertility, and sufficient water, and weed and pest control are all important factors in shoot regeneration. The quantity and quality of pruned shoots decreases with each harvest. Edible leaf yields are typically around 2.5 t per hectare in farming conditions. Under experimental conditions and with very high fertility application, yields of around 28 tonnes per hectare have been reported (Lao, 2008). Main Objective of the study. This study aims to determine the rate of organic manure application that produces the highest yield of *corchoruscapsularis* compared to the NPK rate under North central and North-eastern Nigeria condition. Specific Objective of the Study, to determine the organic nutrient in the cultivation of jute, to determine the required spacing in the cultivation of jute to determine if interaction exist between nutrient source and spacing.

2. Material and Method

The experiment took place in Tal, Billiri Local Government, Gombe State, and Makurdi, Benue State, at (9^o 50'N 11^o 09'E). 7^o 44' 0" N 8^o 32' 0" The goal of the experiment was to see how spacing affected jute growth and yield in Gombe and Makurdi during the rainy season of 2021. Spacing (5, 10 and 15cm) was used, as well as organic sources (poultry droppings, cow dung, NPK, and control). Poultry dropping (100 percent Dry Matter, Organic Material 55 percent, Total Nitrogen 6.2 percent, Total Phosphorus 2.01 percent, and Total Potassium 2.12 percent), Cow dung (Dry matter 22 percent, Organic Material 21 percent, Total Nitrogen 11.0 percent, Total Phosphorus 0.8 percent, and Total Potassium 0.9 percent), and NPK 60N/ha, 40P/ha, and 40K/ha) and NPK 60N/ha, 40P/ha, and All of the organic manure was kept under strict conditions and allowed to partially decompose for four months before being used in the experiment and as a control, as recommended by Bello (2015). A 3 by 4 experiment with three replicates on a $4m^2$ A randomized complete block design was set up with 1m between plots and 1m between blocks (RCBD). To ensure weed-free plots, manual weeding was performed 2 and 6 weeks after planting, and all data was collected within a $4m^2$ net plot with a total of 10 plants tagged for data collection within each net plot.. During the investigation, some physiological variables, such as growth, plant height (as taken with the aid of measuring tape from the base of the plant to the tip), the number of leaves (were counted), number of branches (were counted), 1st flower initiation (were counted), 50% flowering (were counted), and days of maturity were measured (were counted). Other characters like number of calyx (were counted), length of calyx (were measured with a tap), and 100 seed weight (weight with digital weighing scale), calyx weight (weight with digital weighing scale), plant weight (weight with digital weighing scale) and dry calyx weight (weight with digital weighing scale) were also recorded. All collected data were analyzed using ANOVA, with the least significant difference (LSD) at a probability level of 5% used to separate the means.

3. Results and Discussion

Table 1 shows the effect of spacing and nutrient source on plant height of jute, grown in Makurdi, significant difference ($P \leq 0.05$), the result shows that spacing 15cm had the tallest plant height in all the weeks under consideration when compared to spacing 10 and 5. This could be as a result of having moderate spacing leading to taller plants. This work is in conformity with the work of Ogah and Madina (2019) who stated that moderate spacing lead to utilization of solar radiation, nutrients and prevent mutual shading which could affect not only vegetative growth but also overall yield.

On Nutrients source significant different ($P \leq 0.05$) was recorded, with the application of NPK 20:10:10 having taller plants followed by poultry manure and control is having the least. NPK has the tallest because it is an inorganic fertilizer have ability to dissolve fast and has a great influence on plant which enhances growth when compared to organic source of nutrient due to its slow release. This study is consistent with the finding of Ngeze (2002) who reported chemical nutrient, not only affects vegetative growth but also influence yield positively. The result shows no interaction between the spacing and nutrient source.

On location, the cultivation of jute in Benue superseded that of Gombe in terms of height, this could be as a result of temperature, rainfall, relative humidity and also probably agronomic practice variation in the two locations, this finding agrees with the work of NIMET (2002) who reported that climate variability, temperature and agronomic practice affects plant vegetative growth either positive or negative.

Table 1. The Influence of Plant Spacing and Nutrient Source on Jute Plant Height in Makurdi, Benue State Nigeria.

Spacing(S)	2	4	6	8	10
5	14.12	28.12	52.12	75.22	98.81
10	19.22	32.21	67.01	93.45	102.20
15	12.39	46.12	84.12	104.11	129.11
F-LSD(P≤0.05)	1.05	2.03	3.21	4.10	5.01
Nutrient source(N)					
Poultry D.	22.21	47.41	89.49	102.93	121.21
Cow dung	14.32	32.34	72.88	98.81	111.52
NPK	25.23	55.78	95.72	110.32	139.01
Control	15.92	30.83	63.52	89.41	101.81
F-LSD (P≤0.05)	1.01	1.04	3.00	3.01	4.01
Location (L)					
Gombe	21.01	46.23	78.82	90.14	131.90
Benue	25.21	53.12	85.41	111.51	142.01
F-LSD(P<0.05)	2.12	3.12	4.00	4.12	6.00
S X N	**	NS	**	**	NS
N X L	NS	NS	NS	NS	NS
S X L	NS	NS	NS	NS	NS

S=Spacing, N= Nutrient Source, LSD= Least Significant Differences at 5% Level of probability. NS= Not significant. (P ≤ 0.05)

Table 2 shows significant different (P≤0.05) on number of leaves, the use of spacing 15cm had higher number of leaves in all the weeks under consideration when compared with spacing 5 and 10cm, with spacing 5cm having the least, reason could be as a result of wider spacing making the plant to trap light for photosynthetic activities enabling the plant to produce more number of leaves when compared with spacing 5cm, this work collaborate with the finding of (Oti, 2014).

On nutrient source significant different (P≤0.05) was also recorded with the use of inorganic fertilizer in form of NPK (20:10:10) having higher number of leaves when compared with organic source with control having the least, this is true due to the ability of chemical fertilizer to enhance photosynthetic activities thereby affecting plants producing higher number of leaves, this is supported by the finding of (Oti 2014 and Alo 2018) who reported same trend.

On location, more number of leaves is recorded in Benue than Gombe, which could be attributed to climatic factors like and also soil nutrient which was supported by the finding of NIMET (2008) Who reported that soil nutrient, geographical variation affect plant vegetation and also physiological activities and over all crop growth.

Table 2. Effects of Spacing and Nutrient Source on Number of Leaves of Jute Grown in Benue State. Nigeria.

Spacing(S)	2	4	6	8	10
5	8.92	16.22	22.12	35.12	86.91
10	9.24	20.61	37.01	45.15	96.00
15	12.99	24.12	44.12	53.11	109.41
F-LSD(P≤0.05)	1.01	3.13	4.21	5.00	6.01
Nutrient source(N)					
Poultry D.	10.01	27.21	39.29	56.93	89.61
Cow dung	8.39	20.24	32.48	43.81	79.51
NPK	11.26	30.78	45.02	63.32	99.01
Control	7.90	18.82	23.32	39.41	69.81
F-LSD (P≤0.05)	1.01	1.01	3.21	4.01	5.01
Location (L)					
Gombe	8.01	26.23	38.52	43.12	92.90
Benue	10.21	31.12	45.11	58.61	101.01
F-LSD(P<0.05)	1.12	2.12	3.00	3.12	6.00
S X N	**	NS	**	**	NS
N X L	NS	NS	NS	NS	NS
S X L	NS	NS	NS	NS	NS

S=Spacing, N=Nutrient Source, LSD = Least Significant Differences at the 5 Percent Probability Level. Not significant = NS. ($P \leq 0.05$)

Table 3 is the effects of spacing and nutrients source on flowering, number of branches and calyx of jute grown in Benue, significant different (P≤0.05) shows that spacing 5cm had higher 1st flowering, 50% flowering and spacing 15cm had the least number of for flower initiation and 50%flowering, which could be attributed to stress and closer spacing leading to mutual shading. This was supported by the work of Zacharie, (2009). On nutrient source control plots recorded early 1st flowering which is not far from the fact that stress, mutual shading could have led to this, signifying early maturity to other source of nutrients.

Table 3 recorded significant difference ($P \leq 0.05$) on number of branches where spacing 15cm had higher number of branches, this could be as a result of moderate spacing leading to utilization of soil resources, sun light, and also other climatic factors, (Amor, 2010) Lead support to this work, starting that moderate spacing lead the branch initiation due to its ability to utilize both climatic and soil resources. On nutrient source significant difference ($P \leq 0.05$) was recorded were application N.P.K fertilizer had higher number of branches when compared with other nutrient sources used, this may be due to fact that chemical fertilizer lead to fast utilization and transmission of assimilate for vegetative growth which leaves is part of it (Egwe, 2011), lead support to the work where he stated that chemical fertilizers initiate leaves, and branch formation and overall plat growth.

Table 3 recorded significant difference ($P \leq 0.05$) on number of calyx where spacing 15cm recorded higher when compared to spacing 10, and 5cm. this is not far from the fact that vegetative growth could have led to higher production of calyx, number leaves and number of branches as reported by Oga and Madina 2020. On nutrient source significant difference ($P \leq 0.05$) with the application of NPK recording high number of calyx with control recording the least, this is not far from the fact that chemical fertilizer plays an important role in vegetable stage and yield of crops as reported by Fagan, (2020). Reporting that calyx is a product of nutrient availability in the soil and utilization.

Significant differences ($P \leq 0.05$) were found in terms of location, with the cultivation of jute in Benue outperforming Gombe in terms of 1st flowering, 50% flowering, number of branches, and number of calyx. This is not surprising given that environmental factors, soil factors, and agronomic practice could all have played a role. (2010) who stated that crops performs differently in different environmental condition and cultural practice, he added that yield and yield related factors is a product of environment factors, soil nutrients, pest control and agronomic practice.

Table 3. Effects of spacing and nutrient source on flowering, number of branches and calyx of just grown in Benue State. Nigeria**.**

Spacing(S)	1st flowering	50% flowering	No. of branches	No. of calyx
5	37.12	70.12	3.12	6.12
10	42.18	73.91	3.01	7.15
15	49.01	82.12	4.12	8.11
F-LSD(P≤0.05)	1.01	2.03	0.01	1.00
Poultry D.	39.01	80.01	3.19	4.91
Cow dung	40.19	75.12	3.18	3.91
NPK	49.96	85.08	4.12	5.12
Control	38.00	70.18	3.02	3.01
F-LSD (P≤0.05)	0.21	3.21	0.01	0.01
Location(L)				
Gombe	40.01	81.23	4.12	7.12
Benue	46.21	89.12	5.61	10.61
F-LSD(P<0.05)	3.12	3.02	0.12	2.12
S X N	**	NS	**	**
N X L	NS	NS	NS	NS
S X L	NS	NS	NS	NS

S=Spacing, N=Nutrient Source, LSD=Least Significant Differences at 5% Level of probability, **=95% level of probability. NS=Not significant.

Table 4 is an interaction between spacing and nutrient source on 50% flowering of jute in Benue, a perfect interaction exist at ($P \leq 0.05$) significant different with NPK with 15cm having longer days of 50% flowering with control spacing 5cm having early 50% flowering.

Table 4: show a perfect interaction between nutrient source and spacing, where NPK fertilizer and spacing 15cm recorded higher 50% flowing. This means that the use of chemical fertilizer (NPK 20:10:10) and spacing 15cm could produce more flower which will later translate to seed production, (Alode, 2011) in his work stated that the application of chemical fertilizer and appropriate spacing had led to flower initiation, fruit development increase in seed production and over all crop yield.

Table 4. Interaction between spacing and nutrients source on 50% flower of jute in Benue State, Nigeria.

	Spacing (cm)		
Nutrient source	5	10	15
Poultry droppings	69.81	73.91	80.21
Cow dung	65.19	70.00	73.99
NPK	70.99	79.21	89.04
Control	60.21	65.99	70.21
F-LSD(P≤0.05)	2.01	1.93	2.10

Table 5 recorded significant different ($P \leq 0.05$) on shoot weight, calyx weight, number of pod, number of seeds and 100 seed weight where spacing15cm had higher shoot weight, calyx weight, number of pods, number of seeds, and weight of 100 seeds when compared with other spacing used, with 5cm having the least in terms of weight in all the yield related parameter measured. This could be as a result of using appropriate spacing leading to heavier yield related parameters this finding is in agreement with the work of (Ajue 2014) who stated that appropriate spacing increase shoot weight, calyx number of pod number of seed and 100 seed weight, he further report that closer spacing such as 5cm can lead to mutual shading which could inhibit photosynthesis and other metabolic activities affecting the yield of Jute Production Baker (2000) who stated in his earlier work that moderate spacing leads to utilization of both environmental resources and soil nutrients leading to vigorous growth in plants and reduces competition on nutrient space and solar radiation enabling plant growth and over all crop yield.

On nutrient source significant different ($P \leq 0.05$) where the application of NKP (20:10:10) fertilizer produce higher shoot weight, calyx weight number of calyx, 100 seed weight when compared to other nutrient source used, this is not far from the fact that chemical fertilizer has ability to dissolve fast and been utilized by plant for both vegetative/floral and yield related characters. This is collaborated by the finding of (Obatiju 2012) who stated that chemical fertilizer especially the application of macro element gotten from compound fertilizer improves floral growth and Initiate yield and yield related characters, (Oyedele 2013) also reported that poultry dropping also have fast ability to release its nutrient and environmental friendly and can produce as the use of chemical fertilizer which can lead to both vegetative and yield of Jute, he added that poultry dropping released their nutrient a bit slower that chemical fertilizers but it has corrective effects on the soil structure, texture and colour and improves microbial activities. It also collaborates with the finding that chemical nutrients are rapidly assimilated by plants for physiological and morphological activities, which affects overall yield, as reported by Fagam (2009). They also report that chemical nutrients can be rapidly dissolved and utilized by plants for fruits, shoot weight, calyx weight, calyx number, 100 seed weight, and even maturation (2005). Brady and Weil (2004) found that chemical fertilizers,

Particularly macronutrients tend to influence the uptake of other non-essential elements, which has a positive effect on yield.

On location, crops grown on Benue are superior to crop cultivated in Gombe in all the yield and yield related characters, this could attribute to climatic factors, agronomic practice, soil factors and decomposition of the organic manure leading to that, this finding agrees to the work of Bello (2012) who reported same, started that geographical difference plays a major factor in crop/jute production.

Table 5. Effects of spacing and nutrient source on yield related parameters of jute grown in Benue State, Nigeria.

Yield and yield related parameters of jute grown in Makurdi, Benue State					
Spacing(S)	Shoot weight	Calyx weight	No. of pod	No. of seeds/pod	100 seed weight
5	2121.12	78.12	19.12	15.12	3.91
10	2412.18	83.91	18.01	17.15	4.00
15	2891.01	102.12	21.12	18.11	4.41
F-LSD(P≤0.05)	1.01	5.63	1.21	1.00	0.001
Nutrient source(N)					
Poultry D.	2991.01	101.01	19.19	18.91	4.61
Cow dung	2210.19	92.12	17.18	16.91	3.51
NPK	30129.96	112.08	22.12	19.12	5.01
Control	2001.00	85.18	15.12	14.11	3.81
F-LSD (P≤0.05)	1.21	4.21	0.21	1.01	0.01
Location(L)					
Gombe	2212.01	98.23	20.12	14.12	2.99
Benue	2567.21	122.12	25.61	18.61	4.01
F-LSD(P<0.05)	23.12	10.12	3.12	2.12	1.00
S X N	**	NS	**	**	NS
N X L	NS	NS	NS	NS	NS
S X L	NS	NS	NS	NS	NS

S=Spacing, N=Nutrient Source, LSD=Least Significant Differences at 5% Level of probability, **=95% level of probability. NS=Not significant.

Table 6 is a perfect interaction between nutrient source and spacing on shoot weight the result recorded NPK fertilizer and spacing 15cm having a perfect interaction so also spacing 15 and poultry dropping with spacing 5cm and control recording the least. This shows with the application of chemical fertilizer at a moderate spacing, jute is expected to have higher shoot, as reported by (Leo,

2012). Stating that plants at appropriate spacing and right application of fertilizer not only affects shoot weight but also over all-yield.

Table 6. Interaction between spacing and nutrients source on shoot weight of Jute grown in Benue State, Nigeria**.**

	Spacing(c)		
Nutrient source	5	10	15
Poultry droppings	2121.01	2611.91	2821.46
Cow dung	2001.19	2111.00	2241.09
NPK	2991.96	9014.31	3116.94
Control	1981.00	2011.31	2143.91
F-LSD (P≤0.05)	1.21	1.03	1.00

Table 7 shows significant difference (P≤0.05) where an interaction exist between spacing 15cm and the application of chemical fertilizer in form of NPK on pod per plant followed by the interaction between spacing 15cm and poultry dropping. This is not far from the facts that right spacing and right appropriate fertilizer application can lead to higher number of pod per plant, the result is in confirmation with the finding of (Kao, 2011), Who reported that pod initiation and overall yield of plant is greatly affected with the application of macro nutrient.

Table 7. Interaction between spacing and nutrients source on pod per plant of Jute grown in Benue State, Nigeria.

	Spacing (cm)		
Nutrient source	5	10	15
Poultry droppings	20.01	21.91	22.16
Cow dung	18.19	19.10	19.99
NPK	21.96	22.31	23.04
Control	17.00	18.21	19.91
LSD	1.31	1.03	0.21

Table 8 recorded significant difference (P≤0.05) with an interaction between the application of NPK fertilizer and spacing 15cm followed by spacing 15cm and poultry dropping on seed per plant which is a factor of applying appropriate nutrient source at an appropriate spacing, seed formation and seed production is the products of nutrients, environment factors, soil and spacing as reported by (Woe, 2013) in his work. Stating that spacing, nutrients and environmental factors play a major part in seed formation and seed/crop yield

Table 8. Interaction between spacing and nutrients source on seed per plant of Jute grown in Benue State, Nigeria.

	Spacing (cm)		
Nutrient source	5	10	15
Poultry droppings	19.81	19.91	20.21
Cow dung	14.19	15.00	15.99
NPK	19.99	20.21	21.04
Control	13.21	13.99	14.21
F-LSD (P≤0.05)	0.01	0.03	0.10

4. Conclusion and Recommendation

Conclusion:

The result of the experiment prove that Jute can be cultivated in Makurdi, Benue State and Gombe State at the spacing of 15cm x 75cm with effective interception of solar radiation, utilization of nutrient source, the use of chemical compound fertilizer NPK (20:10:10) at the rate of N60kg/ha, P40kg/ha and K40kg/ha, led to increase in both vegetative growths, yield related characters and over all yield, followed by poultry dropping which is environmentally friendly and to farmers who cannot afford chemical fertilizer in the study area.

Recommendation:

From the result gotten, I therefore recommend the use of spacing 15x75cm and the use of NPK (20:10:10) at the rate of N60kg/ha, P40kg/ha and K40kg/ha and the application of Poultry dropping at 20tonne/ha for optimum yield in the location.

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