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Research article

Title- Growth, yield and quality of Jute mallow (*Corchorus olitorius* L.) as affected by different nutrient sources.

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Abstracts

Field experiment was conducted at the teaching and research farm, Federal University of Technology, Minna, Niger state Nigeria during 2014 rainy season to determine the effect of different nutrient sources on the growth, yield and quality of jute mallow *(Corchorus olitorius* L). The experiment was a randomized complete block design. The treatments were control (no fertilizer), poultry manure at the rate of 8 t/ha, organomineral fertilizer (4 t/ha poultry manure + 125 kg NPK 20:10:10 /ha), NPK 20:10:10 fertilizer at the rate of 250 kg/ha. The data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) and means were separated using least significant difference ($LSD_{0.05}$). The results showed that all the parameters measured were significantly affected by the different nutrient sources. Largest leaves and stems were observed in plants which received poultry manure. There was no significant difference between the values of plant height and number of leaves recorded in plants treated with poultry manure and NPK fertilizer. The lowest values of all the growth parameters measured were recorded in the control plants. The highest yield values (fresh and dry matter yield) were obtained in plants which received poultry manure followed by NPK fertilizer while the least was recorded in the control plants. The highest values of crude protein and phosphorus were recorded in plant treated with poultry manure whereas the least values were recorded in control plants. There were no significant differences between the values of ash, Na, K and moisture content recorded in plants that received poultry manure and NPK fertilizer. Plants treated with poultry manure were more mucilaginous than plants that received other treatments. Poultry manure seems to be a better alternative for the production of jute mallow.

Key words: jute mallow, nutrient sources, poultry manure, shoot yield, quality.

Introduction

Jute mallow (*Corchorus olitorius* L.) is one of the popular tropical leafy vegetable in Africa, Asia and some parts of the Middle East and Latin America [1]. It is a leading leafy vegetable in Cote d'Voire, Benin, Nigeria, Cameroon, Sudan, Kenya, Uganda and Zimbabwe [2]. The mucilaginous leaves are consumed along with other staples. It is extremely consumed as a health vegetable, because it contains abundant β-carotene and other carotenoids, vitamins B1, B2, C and E, and minerals. The vegetable also has varying proportion of dietary fibre and protein required for health [3]. Nutritionally, Jute mallow on the average contain 85-87g H_2O, 5.6 g protein, 0.7 g oil, 5g carbohydrate, 1.5 g fiber 250-266 mg Ca, 4.8 mg Fe, 1.5 mg 300010 vitamin A, 0.1 mg thiamine, 0.3 mg riboflavin, 1.5 mg nicotinamide, and 53-100 mg ascorbic acid per 100 g [4]. The leaves have been variously used in folk medicines for ascites, pain, piles, tumors, cystitis, dysuria, fever, and gonorrhea while the cold infusion is said to restore appetite and strength [5]. Jute mallow is also a stem fibre of international importance. It is the world most important bagging and wrapping textile crop [6].

The major problem facing crop production in the tropics are low inherent nutrients and rapid soil nutrient depletion as a result of poor agricultural practices such as over grazing, erosion, denitrification, deforestation and other human activities. The estimated net annual losses of nutrients in Sub-Saharan Africa is as high as 7,629,900 metric tons. This represents a total loss of US$1.5 billion per year in terms of the cost of nutrients as fertilizers [7]. Increasing the yield of crops to meet the demand of ever growing population, requires application of fertilizer to replace the lost nutrients in the soil. Inorganic fertilizers are commonly used because they are quick releasers of nutrients making nutrients readily available for plant use and they are easier to handle. However the use by farmers is limited because of scarcity, high costs and its continuous usage leads to build up of toxic salts over time. These have necessitated the need for an alternative nutrient source that are cheap, readily available and eco-friendly.

Organic fertilizers are better alternatives to chemical fertiizers due to the fact that they are more eco-friendly. Studies have confirmed that poultry manure is an effective nutrient source for increasing yield and nutrient status of some vegetable crops [8, 9]. Adenawoola and Adejoro [10] reported that organic matter and soil nutrients increased with application rate of poultry manure and that depletion of soil organic matter under intensive cropping can be amended by proper addition of poultry manure into the soil. Despite the advantages of organic fertilizer application, its use is also limited by the following factors; the composition of organic fertilizers is variable, organic fertilizers have to decompose before it can release nutrient for plant uptake thereby making its action slower, the use of organic fertilizers increases the risk of infections and the main disadvantages is their bulk, which causes high transportation and labour costs.

Organomineral fertilizer on the other hand is a low input technology of improving the nutrient status of tropical soils for sustainable crop production [11]. They combine the attributes of both organic and inorganic fertilizers. Many authors who have discovered the merits of combining organic and mineral fertilizers – as organomineral fertilizers. Babatola *et al*. [9] reported that high and sustained yield could be obtained with judicious and balanced NPK fertilizer combined with organic source of plant nutrients. Nweke *et al* [12] reported that organomineral fertilizers performed competitively better than all the other treatments applied and therefore can be used for effective maize production. The objective of this study was to compare the response of jute mallow to organic, inorganic and organo-mineral nutrient sources.

Materials and Methods

The field experiment was carried out at the teaching and research farm, Federal University of Technology, Minna (9^o36'N, 6^o33'E), located in the Nigeria Southern Guinea Savanna. The experiment was laid out in a randomized complete block design with four treatments replicated four times. The treatments were control, poultry manure at the rate of 8 t/ha, organomineral fertilizer (4 t/ha poultry manure + 125 kg NPK 20:10:10 /ha) and NPK 20:10:10

fertilizer at the rate of 250 kg/ha. Jute mallow seedlings were raised in the nursery and later transplanted to the field after three weeks at a spacing of 50cm x 50cm. The net plot size was 4m^2 while the gross plot size was 6.25 m^2. Poultry manure was applied to the field two weeks before transplanting to give room for decomposition and mineralization. NPK fertilizer was applied a week after transplanting. The shoot were harvested at 4 weeks after transplanting. The following data were taken on five tagged plant: plant height (cm), number of leaves, stem girth (cm), leaf area (cm^2), shoot fresh weight and shoot dry weight. The plant samples were oven dried at 65^{o}C until a constant weight was obtained to obtain the dry matter yield. The leaf samples were analyzed for % ash, %lipid, %crude protein, Na, K and P according to the methods described by AOAC [13]. The viscosity of fresh leaves was measured using a viscometer after the leaves samples were blended with equal quantity of water. All the data collected were subjected to analysis of variance (ANOVA) using version 9.0 of SAS (GLM procedure). Treatment means were separated using the least significant difference where significant differences occurred at 5% level of probability.

Results

The result of the soil and poultry manure analysis done at the beginning of the experiment is presented in table 1. The result shows that the soil is marginal in N, P and rich in K. The poultry manure has higher values of these nutrients which shows its ability to enrich the soil. The soil is slightly acidic while the poultry manure is alkaline.

Table 1. Chemical properties of the soil and poultry manure used

Parameters	Soil	Poultry manure
Total Nitrogen g/kg	0.15	0.57
Available P mg/kg	13.50	48.9
Na cmol/kg	1.10	6.90
K cmol/kg	5.40	11.10
pH	6.24	8.54

Table 2. Growth parameters of Jute mallow as affected by different nutrient sources at 4 weeks after transplanting.

Treatment	Plant height (cm)	Stem girth (cm)	Number of leaves	Leaf area (cm^2)
Nutrient sources				
Control	43.1	1.3	53	57.5
Poultry manure	67.0	2.0	88	100.4
Organo-mineral	53.6	1.5	70	73.8
NPK	65.2	1.9	85	86.6
LSD(0.05)	4.21	0.07	5.61	3.56

** LSD- Least significant difference (0.05)*

The effect of different nutrient sources on the yield of jute mallow are presented in table 3. There was significant difference between all the treatments in respect of the fresh and dry yield. The order of response in terms of fresh and dry yield is poultry manure >NPK>organo-mineral>control.

Table 3. Shoot yield of jute mallow as affected by different nutrient sources

Nutrient sources	Fresh weight (t/ha)	Dry matter yield (t/ha)
Control	1.40	0.66
Poultry manure	3.05	1.34
Organo-mineral	2.02	0.91
NPK	2.58	1.13
LSD(0.05)	0.25	0.17

** LSD- Least significant difference (0.05)*

The result of the effect of nutrient sources on the nutritional content of jute mallow leaves are presented in table 4. The highest ash content was recorded in plants treated with poultry manure while the least was recorded in the control plants. However, there was no significant difference

Table 4. Nutrient content of jute mallow as affected by different nutrient sources

	Ash	Lipid	C.P	Na	K	PO4	M.C
Nutrient sources	%	%	%	mg/100g	mg/100g	mg/100g	%

Control	4.24	9.59	8.73	51.20	60.60	60.22	66.52
Poultry manure	8.86	3.28	17.20	119.07	126.60	129.88	88.53
Organo-mineral	4.56	7.06	11.75	89.50	79.63	88.95	77.17
NPK	8.26	4.90	16.04	106.83	105.16	105.16	83.21
LSD(0.05)	1.40	1.06	0.91	15.45	24	16.90	6.37

** LSD- Least significant difference (0.05)* *C.P-Crude protein*

between the values recorded in poultry manure and NPK as well as control and organo-mineral.

The lipid contents in the plants were significantly affected by all the treatments. The control plants have the highest lipid content followed by organo-mineral treated plants. Plants treated with poultry manure had the lowest lipid content. There were significant differences among all the treatments in respect of crude protein and PO_4. The order of response was poultry manure >NPK>organo-mineral>control in terms of crude protein and PO_4. The same order was obtained for Na, K and moisture content but there were no significant differences between the values recorded in poultry manure treated plants and NPK treated plants.

The effect of different nutrient sources on the viscosity of jute mallow leaves are presented in table 5. The viscosity of leaves is significantly affected by fertilizer application. The highest viscosity was recorded in poultry manure treated plant followed by NPK and the least viscosity was recorded in control plants.

Table 5. Leaf viscosity of jute mallow as affected by different nutrient sources

Nutrient sources	**Viscosity (mm^2/s)**
Control	8.98
Poultry manure	18.24
Organo-mineral	14.22
NPK	16.97
LSD	0.90

** LSD- Least significant difference (0.05)*

Discussion

The highest values of growth parameters and yield parameters observed in poultry manure treated plant is in agreement with the report of Adenawoola and Adejoro [10] and Madisa [14] who found poultry manure to increase growth and yield of *Corchorus olitorius*. Better cell division and enlongation in poultry manure treated plants may be responsible for the higher growth values recorded in poultry manure treated plants. These contributed to the highest yield values recorded in poultry manure treated plants. Akanbi *et al*. [15] reported that organic fertilizer improved cell activity, enhanced cell multiplication and enlargement of fluted pumpkin. Phosphorus is very essential for cell division and elongation. Kavanova *et al* [16] reported that P deficiency decreases cell division and elongation in grass leaves. The higher P recorded in the plant tissue of poultry manure treated plant is an indication that more P was available for plant uptake in poultry manure treated plot. This might have encouraged better cell activities (division and elongation). Nitrogen is very important for photosynthetic activity and vegetative growth. Kavanova *et al* [17] reported that nitrogen deficiency severely reduced leaf blade growth by increasing cell cycle duration and decreasing mitotic and post-mitotic growth rates. The nitrogen present in poultry manure is released slowly and consistently to meet the growth requirement of the plant throughout its growth stages unlike inorganic N source that is easily lost soon after application through rapid crop removal, run-off, volatilization, leaching and/or denitrification. Nitrogen from poultry manure has been reported to be superior over inorganic fertilizers because of the greater ability of the former to conserve N [18]. The better N supply throughout the growth period may also be responsible for the better vegetative growth and shoot yield values recorded in poultry manure treated plants. This also reflected in the higher crude protein value recorded in the poultry manure treated plants.

The non-significant difference between the values of plant height and number of leaves recorded in poultry manure treated plants and NPK treated plants as well as the higher yield values recorded in poultry manure treated plants is an indication that poultry manure is a better alternative to NPK fertilizer for the cultivation of jute mallow. Makinde *et al* [19] reported that poultry manure where available is better for the production of *Corchorus olitorus* and *Celosia argentea*. Poultry manure has been reported to be the most valuable of all manures produced by livestock [20] because it contains higher nutrient content than other animal manure. It also improves biological activities, soil tilth and soil chemical properties [21].

Poultry manure being an organic source of plant nutrient is a store house of complete food for the plant. It contains all the essential nutrients needed for plant growth. It acts as a major contributor to cation exchange capacity and a buffering agent against undesirable pH fluctuations [22]. It improves soil water availability through retention, aeration and better crop utilization of nurients. Organic manure is known to be capable of activating many species of micro-organisms which release phytohormones that stimulate nutrient absorption and plant growth [23].

Better nutrient availability and uptake throughout the growth period in poultry manure treated plot may be responsible for the higher P and crude protein value recorded in the plants harvested from the plot. The crude protein value is a reflection of the N absorbed by the plants. Application of organic fertilizer was reported to increase P availabity and absorption [24]. Mishra and Ganesh [25] reported that plant uptake of nutrients was better in organic fertilizer plots than inorganic fertilizer plots.

Fertilizer application seems to promote the production of mucilage in the plant tissue. The mucilaginous polysaccharide in the leaves is responsible for the viscosity of the leaves which is highly relished by those who eat the plant as a vegetable. The mucilaginous polysaccharide in the leaves is rich in uronic acid (65%) and consists of rhamnose, galactose, glucose, galacturonic acid and glucuronic acid in a molar ratio of 1.0:0.2:0.2:0.9:1.7 in addition to 3.7% acetyl groups [26]. Ebrahimi and Farahani [27] also reported that compost and NPK fertilizer application increased the mucilage of Borage plant.

Conclusion

The increase in growth, yield and quality, recorded in all the treated plants over the control suggests that fertilizer application is inevitable for a successful crop production. The significantly higher performance of poultry manure treated plants over NPK on growth, yield and quality related characters is an indication that poultry manure where available, can conveniently be used to replace NPK fertilizer in order to ameliorate the adverse effect of the use of chemical to ensure better environmental protection.

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