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Growth and yield response of *Corchorus olitorius* in the treatment of *Arbuscular mycorrhizae* (AM), *Poultry manure* (PM), Combination of AM-PM and Inorganic Fertilizer (NPK)

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ABSTRACT

Five accession of Corchorus olitorius, obtained from two teaching and research and institution in Nigeria were used to access the effect the effect of Arbuscular mycorrhizal (AM) poultry manure (PM), Inorganic fertilizer (NPK), and the synergy of Arbuscular mycorrhizal fungi (AM) and Poultry manure on the growth and yield of Corchorus olitorius. The experiment was a 5x5 factorial laid out in a randomized complete block design with 3-replication. The experiment was conducted in the teaching and research farm of the Department of Agriculture Babcock University, between November 2011 to February 2012. Data were collected on seven yield related character. The combined Analysis of variance showed significant treatment, accession, replication and accession x treatment interaction effect on majority of the traits evaluated at 0.01 and 0.05 probabilities. AM-PM treatment produced significantly higher weight of pod per plant suggesting that AM-PM treatment has high potential in influencing high crop yield even above NPK. There was significant positive correlation between weights of leaf per plant and plant height at maturity and number of branches per plant at maturity, suggesting that, selection directed toward plant height and number of branches will enhance leaf yield. Accession BUCR7 and BUCR9 were best in number of leaves per plant, weight of leaves per plant and number of pods per plant all at maturity and can be considered as parents in breeding for leafy vegetable yield.

Keywords: Accession, Arburscular Mycorrhizae, Poultry Manure, Fertilizer and yield.

INTRODUCTION

Corchorus olitorus (Jew's mallow) belongs to the genus of about 40-100 species of flowering plant in the family Malvaceae. According to Fondio and Grubben, [1], tropical Africa has been suggested as the crops center of origin as a result of huge genetic diversity observed within *C. Olitorius* in this region, with a secondary center of diversity in the Indo-Burmese region. Jute mallow is famous for its sturdy natural fibre. The strong, weatherproof fibre is used in the manufacturer of everything from burlap sacks to fashions and furnishing.

Jute mallow is an important food for many families in the Middle East, Africa, and Asia. The leaves are a rich source of iron, protein, calcium, thiamin, riboflavin, niacin, folate, and dietary fibre [2]. Root scrapings of C. Olitorius are used are used to treat toothache in Kenya whereas in Nigeria concoction prepared from seeds are used as purgative [1]. The yield and productivity of the crop including *Corchorus Olitorius* is plagued by poor cropping system, pest incidence of the soil, therefore there is always the need to ameliorate soil fertility using organic and inorganic sources [3][4]. Soil organic matter is low in farm lands and there is little amount of nitrogen in the soil of high rainfall areas, therefore it is important to apply organic fertilizer on annual basis for optimum yield of vegetables [5].

Poultry manure, is the most valuable of all manure produced by livestock. It has historically been used as a source of plant nutrients and as a soil amendment [6]; however, in area of intense poultry production, over fertilization of pasture land with poultry manure occurs. Poultry manure should be applied to match nutrient need for crops [7]. Poultry manure promotes and enhances the growth and yield of vegetables plants [6][8], not all micro and secondary nutrients are readily available for the plant uptake, and this could bring about slow growth and poor yield.

Arbuscular mycorrchizae fungi associates with the roots of plants in a symbiotic relationship and are particularly important in improving uptake of phosphorous because of the very short transmission distance of phosphate ions in the soil. They also enhance the uptake of the secondary and micro nutrients including calcium, zinc and copper [9][10]. They have been explored deliberately as alternatives to Inorganic fertilizer in soil amendment for crop growth and yield [11][3].

In other to meet the world food needs and to satisfy industrial demand, most developing countries have very real constraints, on the use of inorganic fertilizer because of its negative side effects on soil pH and residual deposit in the soil.

There is no information so far on the growth and yield response of Jute Mallow to the combination of Arbuscular Mycorrhizae(AM) and Poultry Manure(PM). This has therefore brought to mind the synergy of bio – fertilizer (AM) and organic fertilizer (PM) so as to achieve optimum production and yield.

Hence, this study was set up to examine the growth and yield response of the use of *Arburscular mycorrhizae* (AM), poultry manure (PM), NPK fertilizer and the combination of AM-PM on *Corchorus oiltorius* with the aim of finding suitable alternatives to inorganic fertilizer and also guaranteeing steady and rapid release of soil nutrient and environmental protection.

MATERIALS AND METHODS

This experiment was conducted at Babcock university teaching and research farm Ilishan Remo Ogun state, Nigeria, during the late farming season from November 2011 to January 2012, The site is situated in the rainforest vegetation at lat 6^0 43E and long 6^0 5N. A total of five accessions of *Corchorus olitorius* collected from two institutions of teaching and research in Nigeria namely Babcock University germplasm and National Institute of Horticulture (NIHORT), Ibadan was used for this experiment (Table 1).

Poultry manure was obtained from Babcock University poultry Farm, located at Ilara, Ogun state. The poultry droppings were collected wet and sundried to a reasonable moisture content of 13% and finally sampled for laboratory test along with the soil sample using IITA standard methods, where micro and macro element of the samples was determined (Table 2). The arbuscular mycorrhizae species used was a soil inoculum obtained from the Department of Bioscience and Biotechnology, Babcock University and the species used was *Glomus mossea (20g of soil inoculum contains approx. 100 spores of G. Mossea by Olawuyi personal communication)*. The inorganic fertilizer used was NPK compound fertilizer (12:12:17) obtained from the Department of Agriculture, Babcock University.

The experiment is a 5 X 5 factorial, set out in a randomized complete block design and replicated three times. The five factors were

- A = 100Kg/ha^{-1} Poultry manure (PM) (100kg/ha^{-1})
- B = 100kg/ha^{-1} Arbuscular mycorrhizal (AM)
- C = 50kg/ha^{-1} Poultry manure 50kg/ha^{-1} Arbuscular mycorrhizal (AM-PM)
- D= 100kg/ha^{-1} NPK fertilizer
- E = Control

The seed dormancy for each accession was first removed with hot water treatment for ten seconds before planting. Seed was sown by drilling method on already prepare beds of 1meter x1meter, Each treatment consists of 3 rows of 60cm per accession, with spacing of 30cm between rows. Arbuscular mycorrhizae and Poultry manure were applied at the day of planting and two weeks later NPK (12-12-17) fertilizer treatment was applied. Weeding was done manually by the use of hoe, two weeks after planting and subsequently at two weeks interval, while insect pest control was done by the application insecticide (Cyperfit), 2ml per one liter of water as necessary.

Table 1: Accessions and their source

Accession	**Sources**
NH1	NIHORT
NH2	NIHORT
NIHORT	NIHORT
BUCR 7	BU
BUCR 9	BU

NIHORT= National Institute for Horticulture, Ibadan, BU= Babcock University, Ogun state

Table 2: Chemical Analysis of soil and Poultry Manure sample

Sample	%N	Ppm	Ca	Mg	K	Na	ppZn	ppmCu	ppmMn	ppmFe
Soil	0.217	7.61	2.00	0.46	0.17	0.10	8.61	1.36	73.88	57.15
Poultry manure	3.02	2.00	4.98	0.53	1.98	32.23	44.31	6.48	157.28	194.48

Data collection

Data were collected on the following yield character of *Corchorus olitorius* using destructive sampling at 4 and 8 weeks after planting.

- Plant height at four weeks, (cm)
- Number of leaves per plant at maturity,
- Weight of leaves per plant at maturity, (g)
- Number of branches per plant,
- Plant height at maturity, (cm)
- Number of pods per plant
- Weight of pod at maturity (g)

Data Analysis.

The data obtained were subject to analysis of variance using SAS [12], after the approach of Steel and Torrie [13], and significant difference between treatment means were separated using Duncan multiple range test.

RESULTS AND DISCUSSION

Mean Square from combined analysis of variance of seven agronomic and yield characteristics of *C. olitorius.*

The result of analysis of variance of seven agronomic characters of *C. olitorous* is presented in table 3. There was significant treatment affect at (5% and 0.01% probably) in all the characters studied except in number of pod per plants at maturity. Similarly, significant accession effect was observed on all the characters except in number of branches per plant and weight of pods per plant of maturity. However, significant replication effect was only observed in plant height at 4 weeks and at maturity as well as in number of pods per plant. Meanwhile, there was a significant treatment accession effect on all the traits except in number of branches per plant at maturity and weights of pods per plant at maturity. There result simply that the treatment was able to influence the expression of the accessions in the characters considered. Furthermore, the result also suggests variability among the accessions, sufficient enough for selection toward crop improvement.

Mean performance of the accession in the nine agronomic characters under the treatments applied.

Table 4, shows a mean performance of *C. olitorous* in seven agronomic characters under the treatment.

Plant height at 4 weeks ranged from 11.22 and 15.03. The control was highest (15.03) but was not significantly different from AM-PM (14.80) and PM (14.73). The lowest plant height was observed in AM treatment (11.20). This result suggests that the interaction between AM-PM, was positive to enhance plant height and that AM must have enhanced the nutrient absorption capacity of the accession of the nutrient in PM and agrees with the report of [11]. Number of leaves per plants at maturity was significantly highest in Means with the same letter along the column are not significantly different from one another.

control (30.83), but not significantly different in NPK (30.60), the lowest number of leaves per plant was observed in AM treatment (23.15). This result suggests that sole AM interaction with accession is inhibiting. This agrees with report of [11]), using lower amount of AM treatment on *Cucumber*.

Similarly, weight of leaves per plant at maturity ranged from 2.21g and 4.26g. The highest was observed in AM-PM treatment (4.26g), which was not significantly different from the value obtained with NPK treatment (4.12). However, the lowest value was observed with Am treatment (2.21g). This result also suggest that AM-PM interaction with the accessions enhance leaf yield and that AM-PM can replace NPK, without any reduction in leaf yield in *Corchorus*.

Table 3: Means Square from combined analysis of variance of seven agronomic characteristics of *C.olitorious*

Source of variance	Degree of frequency	Plant height at 4 weeks	Number of leaves per plant at maturity	Weight of leave per plant at maturity	Number of branches per plant at maturity	Plant height at maturity	Number of pod per plant at maturity	Weight of pod per plant at maturity
Treatment	4	41.68**	187.51**	13.28**	1140.13**	223.36**	5.94^{ns}	2.27**
Accession	4	98.84**	119.51**	0.76**	11.26^{ns}	202.92**	25.39**	0.18^{ns}
Replication	2	124.64**	11.61^{ns}	$o.07^{ns}$	2.40^{ns}	244.42**	15.78*	0.38^{ns}
Tret*ace	16	23.90**	47.56*	1.38**	13.91^{ns}	87.96*	11.84*	0.37^{ns}
Error	48	7.49	18.46	0.12	13.65	29.04	3.96	0.25
Total	74							
Cv(%)		19.95	15.90	10.22	19.58	15.76	34.80	10.65

*Key: *Significant at 0.05, **Significant at 0.01, ns=Not Significant*

TABLE 4: mean performance of *C. olitorious* under different treatment for seven agronomic characters, during the late season

Treatment	Plant height at 4 weeks (cm)	Number of leaves per plant at maturity	Weight of leave per plant at maturity (g)	Number of branches per plant at maturity	Plants height at maturity (cm)	Number of pod per plant at maturity	Weight of pod per plant at maturity (g)
Am	11.20c	23.15b	2.21d	8.41b	28.94b	5.73a	4.46bc
Pm	14.73ab	24.37b	2.47c	10.29b	35.85a	6.09a	4.67b
Ampm	14.80ab	26.18b	4.26a	25.65a	37.00a	5.05a	5.10a
Npk	12.80bc	30.60a	4.12a	25.15a	31.35b	5.18a	5.08a
Control	15.03a	30.83a	3.61b	24.83a	37.83a	6.57a	4.20c

Number of branches per plant at maturity was significantly higher in treatment with AM-PM (25.65), but not significantly different from values obtained with NPK treatment (25.15) and control (24.83). The lowest value was recorded in AM treatment (8.45). This also suggests that AM treatment alone using *G.mosiac* inhibit branching in *C.olitorius.* However, AM-PM combination produce favourable interaction which promoted yield. It also suggests that AM-PM could convincingly replace NPK in *C.olitorius* cultivation.this agrres with the report of [3] [11].

Plant height at maturity ranged from 28.94cm and 37.83cm. The highest values with no significant differences were observed in control (37.83), AM-PM (37.00) and PM (35.85cm). These values are significantly different from values observed in NPK (31.35) and AM (28.94cm) which recorded the lowest value.
There was no significant difference in number of pods per plant across the treatments. However, the highest of pods per plant was observed in control (6.57) and lowest in AM-PM (5.05). This seems to imply that AM-PM treatment more of vegetative growth in *C. Olitorius*. This disagrees with the report of [3].

Weight of pod per plant at maturity was highest with AM-PM treatment (5.10g) but not significantly different from value observed in NPK (5.085). However the lowest value was observed in control (4.20).

Mean performance of the seven agronomic characteristics in five accessions of *C. olitorius.*
Table 5 shows the mean performance of 5 accessions of *C. olitorius* in seven agronomic characters. Plant height at 4 weeks ranged from 10.43cm and 17.43cm. The highest value was observed in NH1 (17.43cm), which was significantly different from values observed in all other accession. This was followed by NH2 (14.53cm), BUCR7 (13.47) but was lowest in Nihort (10.43cm)

However, number of leaves per plant at maturity ranged from 23.66 and 31.12. BUCR7 recorded the highest (31.12) which was not significantly different from BUCR9 (28.31), but was significantly different from value observed in NH1 (23.66) which was the lowest. This suggests that the two Babcock accessions will be good putative parents in *C. olitorius* improvement for leafy vegetative yield. They are recommended for leaf vegetable harvesting.

Weight of leaves per plant at maturity was highest in BUCR9 (3.64) followed by BUCR7 (3.50), though not significantly different from each other. The lowest value was observed in NH1 (3.14)

There was no significant difference in number of branches per plant at maturity between the accessions. However, NH1 recorded the highest value (20.17) while the lowest was observed in BUCR7 (18.05)

TABLE 5: mean performance of five accessions of *C. olitorius* for seven agronomic characters during the late season

Accession	Plant height at 4 weeks	Number of leaves per plant at maturity	Weight of leave per plant at maturity	Number of branches per plant at maturity	Plants height at maturity	Number of pod per plant at maturity	Weight of pod per plant at maturity
Nh1	17.43a	23.66c	3.14b	20.17a	38.77a	5.75b	4.70a
Nh2	14.53b	25.81bc	3.23b	19.17a	36.43ba	4.72b	4.62a
Nihort	10.43c	26.22bc	3.16b	18.13a	29.18c	4.93b	4.57a
Bucr7	13.47b	31.12a	3.50a	18.05a	34.15b	7.94a	4.78a
Bucr9	12.70b	28.31ab	3.64a	18.79a	32.44bc	5.27b	4.84a

Meanwhile, plant height at maturity was significantly highest in NH1 (38.77), followed by NH2 (36.43), though not significantly different from NH1. The lowest value was observed in Nihort (29.18). This suggest that Nihort accessions are the tall types which may be recommended for continuous harvesting since that would regenerate to produce new vegetative flushes.

Number of pods per plant at maturity ranges from 14.71 and 7.94 BUCR7 recorded the highest value (7.94) which was significantly different from all others and followed by NHI (5.75), BUCR9 (5.27), Nihort (4.93) and NH2 (4.72), which recorded the lowest value.

Similarly, there was no significant difference between the accessions in weight of leaves per plant at maturity. However, the highest value was observed in BUCR9 (4.84), whereas the lowest value was observed in Nihort (4.57).

Correlation coefficient between seven agronomic characters of *C. olitorius*.
Table 6 shows the correlation coefficient between seven agronomic characters in *C. olitorius* cultivated during the late season. Plant height at 4 weeks had a strong significant positive correlation with plant height at maturity (0.73) and number of pods per plant at maturity (0.25). Similarly strong positive association existed between number of leaves per plants at maturity and per plants at maturity (0.35) and number of pods per plant at maturity (0.37). This suggests that any selection directed toward plant height will favour or lead to increase in number of pods. This agrees with the report of [14] on okra.

Meanwhile, weight of leaves per plant has significant and positive correlation with number branches per plant at maturity (0.67), plant height at maturity (0.26).

This also suggests that selection based on plant height in *C. olitorius* will also lead to an increase in number of branches. This is also an advantage since; the number of branches will favour dense vegetation and number of flower for pod, and weight of pods per plant at maturity (0.28), whereas plant height at maturity has a significant positive correlation, with number of pods per plant at maturity (0.28).

TABLE 6: correlation coefficient between seven agronomic characters of *C. olitoriuos* during the late season

	Plant height at 4 weeks	Number of leave per plant at maturity	Weight of leave per plant at maturity	Number of branches per plant at maturity	Plant height at maturity	Number of pod per plant at maturity	Weight of pod per plant at maturity
Plant height at 4 weeks	--	-0.1081^{ns}	0.2060^{ns}	0.1250^{ns}	0.7314**	0.2486*	--0.1301^{ns}
Number of leaves per plant	--	--	0.4432**	0.3494**	0.0353^{ns}	0.3717**	--0.0178^{ns}
Weight of leave per plant	--	--	--	0.6655**	0.2629*	0.1380^{ns}	0.2848*
Number 0f branches per plant	--	--	--	--	0.1671^{ns}	--0.1482^{ns}	0.2133^{ns}
Plant height at maturity	--	--	--	--	--	0.2834*	--0.0109^{ns}
Number of pod per plant	--	--	--	--	--	--	*--0.2123^{ns}*
Weight of pod per plant	--	--	--	--	--	--	--

CONCLUSION

The five treatments, Arbuscular mycorrhizal (AM) poultry Manure (PM), inorganic fertilizer (NPK) combination of AM-PM and control produced significant varying effects on the traits exposed by the accessions. Similarly, the five accessions also revealed some level of genetic variability.

The significantly high performance of the combination of AM-PM treatment on yield related characters such as weight of leaf per plant, number of branches per plant and weight of pod per plant can guarantee the convenient replacement of AM-PM treatment over the use of NPK in order to ameliorate the adverse effect of the use of NPK alone. It will also help in saving cost and guarantee environmental protection.

The two Babcock accessions BUCR7 and BUCR9 prove to be good in vegetative yield and will be good as parental material in *Corchorus* vegetative yield improvement.

Selection directed towards plant height, number of branches will lead to increase in vegetative yield in *C. olitorius.*

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