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FLOWERING, FRUIT PRODUCTION AND YIELD OF *Jatropha curcas* L. AS INFLUENCED BY ORGANIC AMENDMENTS

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Abstract

An experiment was conducted at the experimental site of Institute of Agricultural Research and Training, Moor Plantation Ibadan (IAR&T) located in South-West region of Nigeria on effects of organic amendments on reproduction and yield of Jatropa curcas. This was to evaluate the capacity to improve reproduction, seed yield and oil yield of Jatropa curcas. Poultry Manure and Cow Dung were used, each at 0, 10, 20 and 40 t/ha (M0, P10, P20, P40, C10, C20 and C40).These were evaluated on land area of 6m×6m with 20 plants/plot in Randomised Complete Block Design (RCBD), replicated four times. At 28 weeks after sowing, the following parameters were assessed: number of days to first flower formation, first fruit formation and first matured fruit formation. Seed yield (g/plant) and oil yield (%) were also assessed following standard procedure. Data were analysed using descriptive statistics and ANOVA at $\alpha_{0.05}$ Results showed no significant difference in the phenology of the plant in terms of numbers of days to first flower formation, first fruit formation and first matured fruit formation across all treatments. Seed yield and oil yield were significantly higher at P20 (58.6; 40.8), P40 (74.7; 41.6), C20 (68.6; 40.4) and C40 (69.8; 41.1) than control (27.3; 40.0) and other treatments. The dry weights showed that application of manure produced dry weights that was significantly higher than the control. Poultry manure and cow dung applied especially at 20 t/ha improved seed yield and oil yield of Jatropha curcas and may be adopted in its production.

Key Words: *Crop improvement, Environmental sustainability, Reproduction and yield, Jatropa curcas*

Introduction

Jatropha curcas is a multipurpose, energy plant useful for biodiesel production as well as other industrial purposes (Zhang *et al.,* 2011). Growth, flowering and yield of this species are low due to poor soil fertility (Hussein *et al.,* 2012). Organic amendments have potential to improve yield of plants. However, the influenced of organic amendment on flowering, fruit production and yield of *J. curcas* has not been adequately explored. *J. curcas* has the ability to produce high amount of good quality oil and is not edible for human consumption (Openshaw, 2000). The main sources of energy in Nigeria are fossil fuels such as petroleum and coal. However, various damaging environmental effects have been attributed to the use of these energy sources. There is need to investigate alternative energy sources in order to reduce these negative environmental effects. (Zhang *et al.,* 2011). The most practicable and promising of all the possible alternatives currently available is the bio-fuel obtainable from the plant kingdom, which *J. curcas* is one. The first step towards bio-diesel production is the cultivation of *J. curcas* trees to produce oil-bearing fruits (Achten *et al.,* 2008). Information on the phenology of the plant is important as this will determine the harvest time to reduce seed wastage caused by pod shattering and thereby increase yield.

Fertiliser is a major source of plant nutrients in crop production and crops respond to fertiliser application based on need (Akanbi and Togun 2002; Adediran *et al.*, 2003). Plants will benefit and manifest to its full potential if it was supplied with appropriate type and amount of nutrient. The utilization of manure is very important in sustainable agriculture and should be encouraged. This will eliminate the problems associated with crop production using mineral fertilizers. Organic fertiliser is a good source of soil organic matter, unlike mineral fertiliser the organic fertiliser contains wide range of micro and macro nutrients, and it ameliorates soil acidity and improves soil physical properties without the adverse effects associated with mineral fetiliser *J. curcas* is not usually planted on agricultural land, so as not to compete with food crop; it is usually planted on waste or degraded land. It can grow on poorly fertile and alkaline soils, but yields can be improved if fertilised. There is need to augment its production as this will in turn increase biodiesel production.

Despite great interest in *J. curcas* cultivation on large-scale, studies on how to improve yield especially in terms of the nutritional requirements for growth, good fruiting in tropical agro climatic conditions has not been sufficiently resolved. As part of needs for sustainable biofuel production, this experiment was carried out to assess the effects of application of poultry manure and cow dung at different rates on flowering, fruit production and oil yield of *J. curcas*

Methodology

Poultry droppings and cow dung were air dried, cured and crushed for easy handling. The chemical properties were determined in the laboratory along with the pre-cropping soil and there effects were assessed on the performance of *J. curcas.* The *J. curcas* seeds used for this experiment were obtained from Omi-Adio, a suburb of Ibadan city in Oyo State South-West Nigeria where the plants were in abundant in the wild**.** The seeds were taken to National Centre for Genetic and Biotechnology (NACGRAB) for proper identification before planting. The seed was classified as NGB/Omi-Adio /2012/011. Soil sample was collected randomly at 0-15cm depth with the aid of soil auger. All the soil samples were put together to make a composite sample. The samples were then air dried before crushing and sieved through 2mm mesh. The particle size, pH, total nitrogen (N), organic carbon (C), available phosphorus (P), Cation Exchange Capacity and base salt were determined. The experiment was a 2 x 4 factorial, laid out in a Randomized

Complete Block Design (RCBD) with 4 replicates. The factorial combination of the types and levels of the manure resulted into 8 treatments. A land area of 60 m × 33 m was ploughed, harrowed and mapped in to seven plots of size 6 m × 6 m each. Plant spacing was 2 m x 1.5 m and 3m within and between each plot, making a total of 20 plants. Manure was added to each designated plot and left for two weeks to allow for mineralization of the manure before seeds were sown. Weeding was done as required and pests were also controlled with Cypermethrin at the rate of 2L/ha according to manufacturer recommendation to prevent damage to the plant when white flies infestation was noticed.

At 28 WAS when a bud was noticed, the following phenological parameters were assessed: Days to first flower formation, days to fruit formation, and days to fruit maturity. At fruit maturity when the seed coat turned yellow, the following yield parameters were assessed: total number of matured fruits obtained per plant, weight of mature fruits per plant (g), number of seeds per plant, weight of seed per plant (g), seed husk weight (g), 100 seed weight (g), fruit length (cm), fruit breadth (cm), seed length (cm), and seed breadth (cm). After harvesting plants were partitioned into leaves, stem and root and oven dried at 80°C to constant weight to determine the dry weight. Oil was extracted from 350g of seed from each treatment in the Laboratory using Soxhlet extractor, weight of oil (g) was determined using Metler Top Loading balance and percentage oil yield was calculated using the formula:

$$Percentage\ Oil\ Yield = \frac{\text{Weight of oil obtained}}{\text{Weight of Sampled}} \times 100$$

The collected data were analysed with analysis of variance (ANOVA) and significant mean were separated with Duncan Multiple Range Test (DMRT) at $\alpha_{0.05}$.

Results

The manure and soil used for the experiment were analysed for the physical and chemical properties (Table 1), the post planting soil analysis is presented in Table 2 .The characteristics of the seed used as at the time of planting is also presented in Table 3. In terms of days to first flower formation, the treatments were not significantly different from each other. Days to first fruit formation and days to first mature fruit formation followed a similar trend as days to first flower formation without a significant difference across all the treatments. (Table 4).

The fruits yield and yield components of *J. curcas* were significantly influenced ($\alpha_{0.05}$) by the manure applied (Table5). Numbers of fruits per plant showed a significant difference in favour of plants where higher levels of manure were applied. The P20 (16.75), C20 (19.25), P40 (20.75) and C40 (19.00) were significantly higher than P10 and C10 that had 11.75 and 10.75 respectively. P10 and C10 were not significantly lower than control that gave 8.25. Fruit weight showed some levels of significant differences, C20 (301.06g), P40 (317.34g) and C40 (296.09g), P10 and C10 have the value (139.33g) and (130.80) respectively. Control has the least value of 89.95 which was significantly lower than other treatment. There were significant differences in terms of number of seeds on plants that received higher level of manure, P20 gave (47.25) which was lower but not significantly lower than C20

(55.25) P40 (60.25) and C40 (55.55). Control gave the least value of (22.00), although not significantly lower than P10 (33.50) and C10 (30.75) respectively. The seed weight followed a similar trend just like the numbers of seeds, P20 (58.62g), C20 (68.51g), P40 (74.71 g) and C40 (69.76g). Control had the least value of (27.29g) which was not significantly lower than P10 (42.65 g) and C20 (37.44g). Weight of husk after removing the seed showed that plants that received higher level of manure also have denser husk compared to control and those with lesser manure level. P20 has 161.54g which was significantly lower than C20, P40, and C40 with the following values; 232.64g, 242.72g, and 226.33g respectively. Control had the least value of 59.87g which was significantly lower than P10 (96.68g) and C10 (91.86g) (Table 5). In terms of 100 seed weight, control gave the least 100 seed weight of 83.13g which was significantly lower than other treatments. This was followed by P10 and C10 that gave 105.00g and 109.32g, respectively.

Table 1: Properties of manure used in the experiments on *Jatropha curcas* performance

Properties	Manure	
	Poultry Manure (%)	Cow dung (%)
C	5.97	7.41
N	1.66	1.06
P(Avail)	2.43	0.48
K	1.98	1.97
Na	0.68	0.60
Ca	3.95	0.13
Mg	3.73	0.38

Table 2: properties of the pre-cropping soil

	Properties	Soil
Textural class	Sand (%)	81.80
	Clay (%)	9.40
	Silt (%)	8.80
	C (%)	1.36
	N (%)	0.14
	P(Avail, %)	2.73
	Base salt (%)	99.56
	C E C (%)	35.95
	K (%)	0.29
	Na	0.87
	Ca ($Cmol^1$)	0.28
	Mg ($Cmol^1$)	6.38
	pH	5.10

Table 3: Characteristics of *Jatropha curcas* seeds used for the experiment

Parameters	Characteristics
Seed colour	Black
Moisture content	8.00%
Seed weight	2.48g
Seed length	1.30cm
Seed circumference	1.40cm
Plant height at 2 months after sowing	38.40cm
Leaf diameter	10.80cm
Mature leaf count	9.00
Immature leaf count	4.4
Leaf colour	Green

Table 4: Influence of Poultry manure and cow dung on phenological parameter of *Jatropha curcas*

Treatment	Days to 1st flower formation	Days to 1st fruit formation	Days to 1st mature fruit formation
Mo	224.00a	232.50a	336.00a
P10	220.00a	227.50a	321.00a
P20	218.00a	228.00a	318.75a
P40	212.75a	222.50a	312.75a
C10	216.25a	225.75a	321.00a
C20	217.25a	225.25a	313.25a
C40	219.75a	226.50a	319.75a

Table 5: Effects of different levels of poultry manure and cow dung on yield parameter of *Jatropha curcas*

Treatment	No.of fruit/plant	Weightof fruit(g)	No.of seed/plant	Weighof seed(g)	Seed husk (g)	100 seed weight (g)
M0	8.25b	89.95d	22.00c	27.29c	59.87cd	83.13c
P10	11.75b	139.33c	33.50bc	42.66bc	96.68c	105.00b
P20	16.75ab	215.66ab	47.25ab	58.62ab	161.54b	136.13a
P40	20.75a	317.34a	60.25a	74.71a	242.72a	132.44a
C10	10.75b	130.80c	30.75bc	37.44c	91.86c	109.32b
C20	19.27a	301.06a	55.25a	68.51a	232.64a	126.13a
C40	19.00a	296.09a	55.50a	69.76a	226.33a	124.73a

Fruit length showed no significant difference across the treatment levels. Control had the least value of 2.76cm (Table 6). Fruit breath also showed a slight significant difference in the mean. Control gave a value of 2.09cm, which was not significantly lower than P10 (2.19cm). C10 (2.18cm), P20 (2.20cm).These were also not significantly lower than C20 (2.34cm), P40 (2.40cm) and C40 (2.40cm) (Table 6) Seed length showed that control plant produced the shortest seed, 1.79cm which was significantly lower than other treatments. All other treatments have values that were not significantly higher than each other (Table 6). Significant difference was not observed in terms of seed breath across all the treatment levels.

The result of the laboratory analysis of the oil showed that P20 produced the highest amount of oil in terms of quantity, weight and percentage oil (Table7). This was closely followed by C40 and P40.Control plant produced the least oil.

The leaf dry weight showed that application of P20, P40 and C40 produced dry leaf weight that was significantly similar. The control gave the least dry leaf weight which was significantly lower than other treatments (Table 8). Stem dry weight also follow a same similar trend but control was not significantly lower than application of poultry manure and cow dung at 10t/ha (Table 8). Root dry weights also follow the same pattern in which control produced the least dry weight which was significantly lower than all other treatment.

Table 6: Influence of application of manure on yield attribute of *Jatropha curcas*

Treatment	Fruit length (cm)	Fruit breath (cm)	Seed length (cm)	Seed breath (cm)
Mo	2.76a	2.09b	1.79c	1.08a
P10	2.86a	2.19ab	1.85b	1.10a
P20	2.84a	2.18ab	1.91ab	1.12a
P40	3.03a	2.20ab	1.91ab	1.16a
C10	2.91a	2.34a	1.91ab	1.13a
C20	3.06a	2.40a	1.93a	1.15a
C40	3.03a	2.40a	1.92ab	1.14a

Table 7: Influence of application of manure on oil yield of *Jatropha curcas*

Treatment	Quantity (ml)	Weight (g)	%Oil Yield
Mo	158.5	139.9	39.99
P10	161.1	142.7	40.75
P20	163.0	145.7	41.60
P40	159.8	143.2	40.90
C10	159.5	140.5	40.14
C20	158.7	141.4	40.40
C40	162.1	144.0	41.14

Table 8: Effect of manure application on dry weight (g) of *Jatropha curcas*

Treatment	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)
M_0	33.61c	105.84c	29.64c
P_{10}	40.00bc	166.84bc	39.32b
P_{20}	58.82a	213.44ab	41.00ab
P_{40}	57.00a	255.00ab	43.79a
C_{10}	38.81bc	108.31c	40.00ab
C_{20}	52.91b	243.38b	42.27a
C_{40}	57.83a	263.11a	44.34a

Mean having different letters among treatments are different significantly at $\alpha_{0.05}$ with DMRT

Table 9: Laboratory post planting soil analysis

TRT	pH	CEC (Mol/kg)	C	N	Av.P (ppm)	K(mol[1])	Na	Ca	Mg	Base salt (%)
M0	7.10	21.28	3.80	0.32	18.92	0.22	0.70	14.17	4.44	99.63
P5	7.40	24.14	4.36	0.81	20.23	0.81	0.83	16.71	5.61	99.78
P10	6.90	30.95	4.33	0.99	23.30	0.57	0.87	21.40	8.75	99.81
P20	7.80	32.46	5.61	1.94	33.83	3.13	1.37	19.75	8.21	99.94
P40	8.10	39.27	4.79	1.03	40.95	7.26	2.08	18.50	11.42	99.97
C5	7.30	23.86	4.08	0.74	20.14	0.62	0.91	18.62	5.23	99.87
C10	7.30	30.23	4.58	0.81	21.28	1.08	1.00	19.67	9.12	99.86
C20	7.10	33.27	4.18	0.85	21.47	1.68	1.14	24.25	6.17	99.82
C40	8.00	32.54.	8.28	1.45	26.81	4.28	2.08	17.75	8.42	99.97

Where; Mo = Control experiment; P = Poultry manure, t/ha; C = Cow dung manure, t/ha

Discussion

Application of manure enhanced reproduction in *J. curcas* as all plants that received manure started fruiting earlier than controlled plants. This may be due to the nutrient availability and water holding capacity of the soil enhancing the performances. Application of manure enhanced the seed yield of *J. curcas* in the experiment. The number of fruits, weight of fruits, number of seeds, weight of seeds, 100 seed weight, showed that application of manure enhanced seed yield, as plants that received manure performed better than control plants. Furthermore, plants that received higher amount of manure out performed those with lesser amount. This confirmed the findings of Adediran and Banjoko (2003) they reported that application of manure enhanced yield of crop especially seed yield and biomass weight .The dry matter accumulation potential of *J. curcas* plants used in this experiment were highly enhanced by application of manure as both poultry manure and cow dung at the rates of 20t/ha and 40t/ha increased dry matter accumulation potential of *J. curcas.* Togun *et al.* (2004) and Akanbi *et al.* (2007) reported that organic amendments enhance plant photosynthetic activities and hence more dry matter is produced. Manhas and Gill (2010) found that increment in application of organic manure increased the growth, dry matter accumulation, yield and quality of plant. The results from post planting soil analysis showed that application of organic fertiliser increased the alkalinity of the experimental soil. The soil C.E.C increases gradually as the level of manure increases. Poultry manure improved the C.E.C better than the cow dung. The percentage Carbon, Nitrogen, Phosphorus and Potassium also increases with application of organic manure. This was corroborated by Dauda *et al.* (2008), and Mishra and Jain (2013) who reported that organic manure can serve as a better alternative to mineral fertilisers. Ayoola *et al.* (2008) also reported that organic fertiliser resulted in significant increase in soil carbon, nitrogen, pH, cation exchange capacity and exchangeable Ca, Mg and K which invariably enhance crop yield and productivity. Adeleye *et al.* (2010) also confirmed that organic manure improved soil organic matter, total N, available P, exchangeable Mg, Ca, K and lowered exchangeable acidity

Conclusion

Jatropha curcas responded positively to added fertiliser and fertilised plants were found to grow better than control plants. The result showed that number of days to flowering, fruit formation and fruit maturity were not affected by manure application significantly but seed yield, oil yield and biomass were positively influenced by organic amendment

Recommendation

Poultry manure and cow dung applied especially at 20 t/ha improved seed yield and oil yield of *Jatropha curcas* and may be adopted in its production

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