Determination of Appropriate Rate of Cattle Dung for Effective Weed Control and Higher Yield of Castor Bean Seed (*Ricinus Communis* L) At Badeggi, Nigeria

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Abstract: Castor field of National Cereals Research Institute (NCRI) Badeggi is becoming over mined as a result of continuous cropping over a long period of time and thereby leading to high leaching of added inputs such as herbicides, inorganic fertilizer; and water by causing high infiltration of both rain and irrigation water and consequently, affecting weed control and castor yield (kg/ha). Therefore, possible way to reclaim or ameliorate the soil to improve weed control and enable higher productivity of castor seed is necessary. Field trials were established on castor experimental field of National Cereals Research Institute, Badeggi in 2013 and 2014 wet seasons. The treatments evaluated were different rates of air dried cattle dung manure at the following rates 5.0t/ha, 10.0t/ha, 15.0t/ha, 20.0t/ha, NPK inorganic fertilizer at 60-60-20kg/ha and the control where nothing was applied. All the rates of cattle dung evaluated offered better weed control and castor bean yield (kg/ha) than the control where no fertilization took place in both years. The incorporation of cattle dung in both years at all the rates evaluated gave significantly better weed control and yield (kg/ha) of castor seed than plots treated with inorganic fertilizer alone at 60-60-30kg/ha NPK. Among the various rates of cattle dung evaluated for effective weed control and castor seed yield (kg/ha), the weed control and castor seed yield achieved from the incorporation of 10.0t/ha of cattle dung was significantly comparable to the weed control and castor yield (kg/ha) obtained from the incorporation of higher rates of 15.0t/ha and 20.0t/ha in 2013 and 2014.

Keywords: Castor, cattle dung, weed control, seed, yield kg/ha, Nigeria.

1. INTRODUCTION

Castor (*Ricinus communis* L.) is an important non-edible oil crop of the spurge (*Euphorbiaceae*) family and is believed to have originated in Abyssinia. It is widely distributed throughout the tropics and subtropics, and is well adapted to the temperate regions of the world. Castor is grown on a total land area of 1.4m ha with an average production of 1.3m tones, and productivity of 950kg/ha -2.0tones/ha [1]. The major castor producing countries in the World are India, Brazil, USSR, China and Thailand, while the major importing countries are India, USA, China, USSR, the EEC and Japan. India is the leading producer of castor in the world with current levels of production, the country accounts for 56% of area and nearly 69% of the world's output of castor [1].

In Nigeria, hectarage was estimated at about 6000 ha with the major producing states then were Cross River and Ebonyi [2]. The report of NCRI (2014) [3] on germplasm collection and identification of castor stakeholders in Nigeria identified the following states Cross River, Oyo, Kogi, Abia, Enugu, Anambra, Delta, Eboyi, Yobe and Zamfara as the major castor producers in Nigeria.

Castor seed is the source of castor oil, which has a wide variety of uses. The seeds contain between 40 and 60% oil that is rich in triglycerides, mainly ricinolein. The castor oil makes up 35 to 55% of the weight of the seeds, and contains 85 to 90% ricinoleic acid [4]. The seed contains ricin, a toxin, which is also present in lower concentrations throughout the plant. The seeds, leaves, and stems of the plant contain the glycoprotein ricin, which is poisonous to humans and animals. The most notorious uses of ricin have been as an assassination weapon by the secret intelligence services [5].

Although castor can be successfully cultivated in areas of marginal agronomic potential, production is nonetheless sensitive to extreme climatic variations, particularly with regard to rainfall distribution. Castor produces its highest yield with minimum rainfall of 600mm-700mm. When total rainfall approaches the minimum required to grow a castor crop, it is essential to plant following the first major rainfall, when soil moisture is adequate for germination and soil temperature has not been depressed. Where rainfall is above this minimum, planting early in rainy season will result in poor emergence due to low seed-bed temperature and fungal attack.

Castor requires a moderately high temperature ranging from 20-26℃, with low humidity throughout the growing season to produce maximum yields. Long,

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clear, sunny days are most suitable, and cloudy or humid days irrespective of temperature will reduce yields.

The castor plant is a thermophilic plant, that is, it suffers from frosts. Shoots perish at temperatures below -1℃; adult plants die at temperatures below -3 to -4℃. Temperatures should not fall below 20-25℃ to ensure normal plant development. It withstands some drought, although at least 300mm of precipitation during the vegetative period is needed for growth. With moisture deficits, seed yield is sharply reduced.

Manure refers to substance added to the soil in order to increase the supply of plant nutrients for higher productivity [6]. The application of organic manure has the aim of increasing soil fertility, and thus productivity, but the effect of the addition depends partly on the existing fertility of soil and possibly the application method. According to Gupta *et al*. (2004) [7], the effect varies according to the inherent physical and chemical properties of the soil particularly on the nature and content of the clay and humus colloid. Uses of chemical fertilizers decreased recycling of crop residues and losses of crop nutrients due to leaching and erosion [8].

Cattle excrement aids in disseminating weed seeds. Baig *et al*. (2001)[9] reported 75,100 wild seeds per 100kg of cattle manure. In maize field, application of cowdung at 10 tones/ha significantly increased the population of *Cynodon dactylon* and *Eleusine coracan* [9]. Effective control of viable weed seeds disseminating by cowdung and enhancement of N and K availability are achieved by heaping manure to a height of 1.5m for three months before field application for curing [10].

In recent years, a growing consensus has emerged on the need for both organic and inorganic fertilizer to reverse the negative nutrient balances in cropping systems in agriculture in Sub-Saharan Africa (ASS) as continuous sole application of either of these inputs tend to create soil related constraints to crop production [11].

Therefore, the objective of this study was to determine appropriate rate of cattle dung that could offer good weed control and higher castor seed yield (kg/ha).

2. MATERIALS AND METHODS

The experiment was established on the castor experimental field of the National Cereals Research Institute, Badeggi (lat. 9°45N, long. 0.6°07E; 70.5metres above sea level) in the Southern Guinea Savannah ecological zone of Nigeria in 2013 and 2014 wet seasons. The soil of the experimental site had been classified as ultisol and sandy loam in texture with a bulk density of 1.459gcm^3 [12]. The area has an average annual rainfall of 1124mm and mean temperature of 23°-33℃. Details of the physicochemical properties of the soil before the establishment of the trials, the common weed species observed at the experimental sites and analyses of cattle manure which was analyzed in the National Cereals Research Institute are indicated in Tables **1-3**.

2.1. Determination of Soil Nutrient Status

Soil samples were collected using a soil auger before the establishment of the trial from four different randomly selected spots at soil depth of 0-30cm to determine the initial physicochemical properties of the soil. The following soil parameters were analyzed for at the NCRI Badeggi laboratory services.

2.2. Particle Size Analysis

Particle size distribution was analysed for by using the hydrometer method and textural class was determined by the soil textural triangle (IITA, 1979)[13].

2.3. Soil pH

Soil pH was determined in water by using a soil solution ratio of 1:2.5 by means of a Philip analogue pH meter (IITA, 1979) [13].

2.4. Total Nitrogen

The nitrogen content of the soil was determined by Macro Kjeldahl procedure (Bremner, 1965) [14].

2.5. Available Phosphorus

Available phosphorus was determined by Trough method. The extracted phosphorus was determined by the molybdate blue colour method (Bremner, 1965)[14].

2.6. Exchangeable Bases

The exchangeable bases, calcium (Ca) magmesium (Mg) potassium (K) and sodium (Na) were extracted using ΣIN acetate (pH 7.0) (Breamer, 1965) [14].

Table 1: List of Common Weeds Present at the Castor Experimental Field before the Establishment of 2013 and 2014 Trials

S/N	Weed Species	Class	Life Cycle	Level of Occurrence 2014	Level of Occurrence 2015
1	*Dactyloctenium aegyptium (L)*	Grass	Annual	***	***
2	*Eragrotis tremula (Hochst)*	" "	Annual	**	**
3	*Elytrophorus spicatus (A. Camus)*	" "	Annual	**	**
4	*Rottboellia cochinchinensis (L)*	" "	Annual	*	*
5	*Digitaria horizontalis (Wild)*	" "	Annual	***	***
6	*Imperata cylindrica (Anderrs)*	" "	Perennial	*	*
7	*Paspalum orbiculare (Forst)*	" "	Annual	*	*
8	*Hyparrhenia invlucrata (Stapf)*	" "	Annual	*	*
9	*Andropogon gayanus (Kanth)*	" "	Annual	*	*
10	*Cenchrus biflorus (Roxb)*	" "	Annual	*	*
		Broad leaves			
1	*Hibiscus asper (Hook)*	" "	Annual	***	***
2	*Commelina diffusa (L)*	" "	Perennial	*	*
3	*Sida rhombifolia*	" "		*	*
4	*Ipomoea triloba (Linn)*	" "	Annual	*	*
5	*Cleome viscosa (L)*	" "	Annual	**	**
6	*Hyptis suaveolens*	" "		***	***
7	*Cochlospermum planchoni (Hook)*	" "	Annual	*	*
		Sedges			
1	*Cyperus esculentus*		Perennial	**	**

Key:

*** ------ High Occurrence.

** ------ Moderate Occurrence.

* ------ Minor Occurrence.

Table 2: Soil Physico-Chemical Characteristics of Castor Experimental Field before the Establishment of 2013 and 2014 Trials

Soil Properties	Values 2013	Values 2014
Sand (%)	75.60	76.96
Silt (%)	18.00	9.28
Clay (%)	6.40	13.76
Textural class	Sandy loam	Sandy loam
pH in water	6.2	6.72
Organic carbon (g/kg)	0.50	0.89
Organic matter (g/kg)	1.10	1.55
Total nitrogen (g/kg)	0.039	0.034
Available phosphorus (Meq/kg)	8.95	50.95
K	0.35	0.25
Mg	0.29	2.66
Ca	1.00	10.72
Na	0.16	0.50
CEC	5.85	17.43

Table 3: Laboratory Analysis of Cattle Dung 2013 and 2014

Nitrogen (%)	0.28	Nitrogen (%)	0.28
Phosphorus(ppm)	19.96	Phosphorus(ppm)	19.96
Potassium (Cmolkg-1)	5.14	Potassium (Cmolkg-1)	5.14
Organic matter (%)	45.19	Organic matter (%)	45.19

Source: Cattle dung was obtained from the cattle market behind Gwadebe New Market, Bida.

2.7. Soil Organic Carbon

This was determined using Walkley - Black method (IITA, 1979) [13].

2.8. Soil Organic Matter

This was determined by multiplying product of organic carbon with a factor of 1.724 (IITA, 1979) [13].

2.9. Cation Exchange Capacity (CEC)

Cation exchange was determined by ammonium saturation method using IN ammonium acetate (pH7.0) saturation followed the displacement of the absorbed ammonia (IITA, 1979) [13].

The treatments evaluated were different rates of cattle dung manure at the following rates 5.0t/ha, 10.0t/ha, 15.0t/ha, 20.0t/ha, NPK inorganic fertilizer at 60-60-20kg/ha and the control where nothing was applied. The cattle dung was cured and was incorporated on 1st July, 2013 a month before the establishment of the trial. Soil sample was collected before planting and both the soil sample and cattle dung was analyzed in NCRI Badeggi laboratory. The trials were set up in a randomized complete block design with three replications. Castor was planted on 1st August, 2013 at 0.50m inter-row and 0.75m intra-row spacing. The treatments were accommodated in a gross plot size of 6.0m^2 (4.0m x 1.5m) containing four rows of castor plants, while the net plot was 2.0m^2 (4.0m x 0.5m).

The variety of castor used for the trial was NCRICAST/005 a small seeded variety. This variety yields castor bean seeds of between 1000-1800kg/ha depending on the weed control, soil fertility and level of soil moisture or rainfall available. It withstands some drought, although at least 600mm of precipitation during the vegetative period is needed for growth. With moisture deficits, seed yield is sharply reduced. It requires fertile soil; produces high yield on fertile, well-aerated soils with a pH of 6-7.3. It is a short-day species, photophilous. Vegetative period (from shoot emergence to maturing of first raceme) lasts 120-150 days. The variety was obtained from National Cereals Research Institute Badeggi and was sown at the seed rate of 12.0kg ha^{-1}.

Data collected include weed cover score at 3months after planting (MAP) through visual observation using the scale (0–10), 0 = Clean plot, 10 = completely weed covered plots, Crop vigour score at 3MAP through visual observation using the scale 0-10, where 0 = weak, diseased plant, 10 = most vigorous and healthy plant, days to 50% flowering, number of branches per plant at 5MAP, length of spike at 5MAP, number of racemes per plant at 5MAP and yield kg/ha at harvest (5MAP). Castor was harvested between November and December 2013 and 2014.

All the data that were obtained from the experiment in 2013 and 2014 were subjected to statistical analysis of variance (ANOVA) to test for the significance of treatment effects using ‘F’ test as described by Snedecor and Cochran (1969) [15]. Where the ‘F’ test showed significance, the means were then partitioned using the Duncan’s multiple range test (DMRT).

3. RESULT AND DISCUSSION

Exception of cattle dung at 5.0t/ha in cooperated, all the rates of cattle dung evaluated offered significantly (0.05) better weed control, castor growth performance and yield (kg/ha) than plots treated with inorganic fertilizer at 60-60-30kg/ha NPK and the control where no fertilization was carried out in 2013 and 2014 respectively (Tables **4** and **5**). This could be as a result

Table 4: Effect of Air Dried Cattle Dung Manure on the Weed, Growth and Yield of Castor at Badeggi 2013

Treatments	Weed Cover Score(MAP)	Crop vigor Score(3MAP)	Length of Spike (cm) (5MAP)	Days to 50% Flowering	No of Branches Per Plant(5MAP)	No of Racemes per Plant(5MAP)	Yield (Kg/ha)(5MAP)
Air dried cattle dung(5.0t/ha)	1.50	5.00	23.93	68.00	1.00	1.33	613.34
Air dried cattle dung(10.0t/ha)	1.00	7.33	26.67	68.00	3.67	5.00	1,201.67
Air dried cattle dung(15.0t/ha)	1.00	7.93	26.67	68.00	4.67	6.00	1,213.90
Air dried cattle dung(20.0t/ha)	0.99	7.97	26.57	68.00	4.97	6.33	1,228.84
N.P.K. (60: 60: 30Kg/ha)	1.67	5.50	20.10	69.33	1.67	2.67	667.34
Control (No fertilization)	3.05	3.33	16.87	68.67	2.00	2.67	223.40
SE (±)	0.17	0.42	1.10	1.29	0.34	0.47	10.34

Plot size 6.0m^2 (4.0m x 0.5m), MAP = Months After Planting.

Table 5: Effect of Air Dried Cattle Dung Manure on the Weed, Growth and Yield of Castor at Badeggi, 2014

Treatments	Weed cover score (3MAP)	Crop vigor score (3MAP)	Length of spike (cm) (5MAP)	Days to 50% flowering	No of branches per plant(5MAP)	2014	No of racemes per plant(5MAP)	Yield (Kg/ha) (5MAP)
Air dried cattle dung(5.0t/ha)	1.55	6.00	21.93	68.00	2.00		1.33	753.34
Air dried cattle dung (10.0t/ha)	1.06	8.30	26.67	68.10	3.88		5.00	1,301.67
Air dried cattle dung (15.0t/ha)	1.08	8.90	29.67	68.20	4.77		6.00	1,313.90
Air dried cattle dung (20.0t/ha)	0.95	8.97	29.57	68.20	4.98		6.33	1,328.84
N.P.K.(60: 60: 30Kg/ha)	1.61	5.90	23.10	68.33	1.69		2.67	767.34
Control (No fertilization)	3.00	3.05	17.87	68.67	2.00		2.67	242.40
SE(±)	0.17	0.42	1.10	1.29	0.34		0.47	10.34

Plot size 6.0m^2 (4.0m x 0.5m), MAP = Months After Planting.

of better vegetative growth with dense canopy cover achieved as a result of nutrients supplied (released) by the in cooperated cattle dung at various rates which led to the suppression of weeds. The possible reason could be as a result of slow release of cattle dung and its ability of improving the soil structure and thereby, improve better canopy formation which helped in weed suppression. According to Gana (2010) [6] farm yard manure (FYM) by binding the soil particles together helps in improving soil structure, soil aeration and thereby, improving crop productivity. Animal manures include animal dung, urine and animal by products such as bone meal and dried blood. Dung contains the undigested portions of the animal's food, whereas urine contains only the soluble products and has a higher nitrogen and potassium content than dung, and since these are in solution they are quickly available to plant. A great part of the virtue of animal manures lies in their slow mineralization and the addition of organic matter to the soil, which they produced. Greater efficiency portion of manure is obtained when applied in small amounts and more often. Similarly, Baig *et al.* (2001)[9] reported poor weed performance and decline in the growth and yield of food crops as a result of gradual reduction in soil fertility by the crop without replenishment. Better performance of crop growth and castor yield (kg/ha) obtained in plots that were treated with cattle manure combined with inorganic fertilizer at various rates than at separate application of cattle manure in both years (Tables **4** and **5**) may be attributed to adequate nutrients derived from both the cattle manure and inorganic fertilizer applied. Delipathy *et al.* (1994)[16] earlier stated that soil with high fertility influences high productivity of crop growth and yield. Similarly [17] earlier reported that the difference in crop growth and yield was based on the rates of nutrients released into the soil and taken by the crop.

Poorest castor growth and yields were achieved from the control where no fertilization took place in both years (Tables **4** and **5**). The yield (kg/ha) obtained from the application of inorganic fertilizer was significantly (0.05) lower than the yield (kg/ha) obtained from the application of cattle dung at all the rates. Gana (2011) [18] in his experiment on the use of cattle manure in reclaiming an over mined soil of sugarcane field observed that due to decades of indiscriminate use of chemical fertilizers the organic matter content of soils has gone down. The use of chemical fertilizers is a major cause of concern for the safety of food and sustainable production.

4. CONCLUSION

The results obtained from the two years' trial consistently showed that weed control was better achieved in the plots incorporated with cattle dung at all rates. While the weed control and castor yield obtained from the application of lower rate of cattle dung at 10t/ha was significantly similar to higher rates of 15 and 20 t/ha. The poorest growth and yield of castor seed (kg/ha) was obtained from the control where no fertilization took place. Therefore, cattle dung at 10t/ha can be recommended for the farmers in this ecology and other ecologies with similar soil physicochemical properties.

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