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EFFECT OF CASTOR CAPSULES (RICINUS COMMUNIS) AND NEEM LEAVES (AZADIRACTA INDICA) ON SOIL PROPERTIES AND FUNGI INFECTION ON TOMATO (LYCOPESICUM ESCULENTUM)

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Abstract

The effect of castor capsules (*Ricinus communis*) and neem leaves (*Azadiracta indica*) on soil properties and fungi disease on tomato (*Lycopersicum esculentum*) in southern Nigeria was studied as a potted experiment. The study was established in a complete randomized design (CRD) with four treatments and four replications. The treatment studied were; castor capsules (CACS); Neem leaves (NELS); castor capsules + neem leaves (CACNELS) and control that received no application (COS). The result findings showed that incorporated castor capsules and neem leaves as treatments significantly improved the soil physico-chemical properties and agronomic parameters tested. Soil pH, OC%, OM%, TN%, total exchangeable bases (TEB), available P and effective cation exchange capacity (ECEC) showed significant higher values in amended pots and lesser values in total acid (TA) and total exchangeable acidity (TEA) were recorded in amended pots relative to the control pots. The treatments were observed to have reduced the soil bulk density (BD) gcm^{-3}, increased total porosity (TP) % and gravimetric moisture content (GMC) %. The recorded values of OC% (0.61) and OM% (1.12) follow the order CACS > CACNELS > NELS > COS. The effect on tomato yield (number of fruits and fruit weight) showed that CACNELS gave the highest fruit yield of 25 fruits with a total weight of 15.0g whereas CACS gave 22 fruits with a total weight of 12.76g, NELS gave 19 fruits with a total weight of 11.61g and the control gave zero yield (no yield). From the findings of the study it shows that castor capsules and neem leaves treatments are very efficient in improving soil nutrient status and in reducing fungal infections in tomato.

Introduction

Agricultural sustainability in Nigeria has being a serious challenge limiting food production and nutrition security. The challenges are bound ranging from soil, pest and disease factor, cultural and management practices etc especially in humid tropical environment like Nigeria. This humid nature helps to breed pest and diseases, wash and leach away soil nutrients due to torrential rainfall that render the soil barren of plant nutrients and encourage environmental degradation, hence reduction in crop yield. This scenario compound most of the problems of lands within the humid tropical environment that make them bio-physical and chemical incapable of supporting sustainable agriculture. However agricultural sustainability is dependent on a lot of factors such as the extent of inputs to maintain both the physical, biological and chemical status

of soils, conservation methods deployed over the years etc. Most of the inputs and conservation impacts on soil – water- nutrient-plant continuum have been documented in Nweke and Igwe 2021 and Nweke and Chime (2021)

The use of chemicals (pesticides, fungicides, nematicides etc.) for controlling plant diseases in developing countries like in Africa and Nigeria in particular is still a common practice. Plant disease though can be controlled with synthetic chemicals, the hazardous impacts on human health and environment is best imagined than experienced. Further pest resistance may exist with their continuous and extensive applications. In view of the problems emanating from the use of these synthetic chemicals in agriculture, natural plant products have been found as an effective alternative in plant disease management. Though, for any plant products to be used as suitable alternatives to synthetic fungicides or chemicals, that plant product according to Gnanamanickam (2002) must be natural in origin, have minimum adverse effects on the physiological processes of plants and are easily convertible into common eco-friendly organic materials. Plant natural products such as gums, resins, essential oils etc. have been shown by works of Fawzzi et al. (2009); Jalili et al. (2010) and Romanazzi et al. (2012) to exert biological activity against plant fungal pathogen in vitro and in vivo, hence can be used as bio-fungicidal products. Thus Chuang et al. (2007) opined that these products are more acceptable and less hazardous for the ecosystem, hence an alternative product for the treatment of crop and plant diseases. Usually natural products have a narrow target range with specific mode of action. This makes them suitable for a specific target organism and nontoxic for antagonistic microbes. They show limited field persistence and have a shorter shelf life and no residual threats. This made Nuzhat and Vidyasagar (2013) to emphasize on the need for them to be adopted by farmers in developing countries who ordinarily used these plant extracts traditionally for the treatment of human diseases. Cowan (1999) estimated that there are more than 250,000 higher plant species on the earth offering a vast virtually untapped reservoir of bioactive chemical compounds with many potential uses including their application as pharmaceutical and agrochemicals. Plant based products and by products from castor and neem plants were proven by literature to be medicinal, but their beneficial effect in control of pest and diseases of crop plants are yet to be maximized. Thus the essence of this study was to ascertain their beneficial effect on fungi disease of tomato and their significant effect in soil amelioration.

Materials and Methods

Study Location

The study area Nnamdi Azikiwe University is located at Awka, in Awka South L.G.A of Anambra State, in the derived savannah agro-ecological zone of Nigeria. Nnamdi Azikiwe University is at a coordinate of 7.118289^0E and 6.242889^0N. The rainfall distribution is bounded with wet seasons from April to July and peak in June and September to November. It has an annual rainfall of 1700mm. The annual temperature of the area ranges from 27 to 31^0C. The relative humidity of the study area is between 60 and 80%. The soil of study area is sand-loam soil with sparse vegetation cover.

Map showing the location of Nnamdi Azikiwe University in Awka South L.G.A of Anambra State.

Experimental Area: The potted experiment was carried out under a screen house located at Garuba Square at the Faculty of Agriculture Annex behind the Soil Science Laboratory block Nnamdi Azikiwe University, Awka.

Screen House Preparation: The dimension of the screen house is an area of 12ft x3ft. Screened to protect the pots from rain and sun (controlled experiment). Pots was arranged in between rows and columns in a randomized pattern.

Planting Material

The tomato seeds used was procured from Anambra Ministry of Agriculture (ADP). The variety is cherry tomato (sweet million). Castor capsules was sourced from Ikechukwu Nweke, a scientist and researcher, in the Department of Soil Science, Chukwuemeka Odumegwu Ojukwu, University Igbariam Campus. And was transported to Soil Science laboratory unit, Nnamdi Azikiwe University Awka. The neem leaves were plucked from neem trees located before Commissioner's Quarter gate government House Awka and was transported to soil laboratory unit, Faculty of Agriculture Annex, Nnamdi Azikiwe University

Soil/Pot Preparation: An area within the Faculty of Agriculture Annex Garuba square was selected for soil collection. The area has sparse vegetation cover, with those vegetation, showing symptoms of nutrient deficiencies evident in the leaf color (yellow and brown) in appearance. The vegetation was removed using cutlass. Auger soil samples was randomly taken from 5 different locations in the experimental area at a depth of 0 to 15cm. The soil samples were thoroughly mixed to generate a composite.

Treatments preparation:

Castor Capsules Preparation Steps:

- Castor capsules of 75g was washed in clean tap water to get rid of dirt, wasps, and other surface contaminants.
- Samples was air dried for 7 days (one week).
- The air dried samples was crushed with mechanical grinder to provide a larger surface area.
- 75g was measured using a sensitive balance and carefully wrapped in a foil.
- Total of four measurements of equal amount was weighed and wrapped in a foil and coded as CACS

Neem leaves preparation Steps:

- Neem leaves was washed in clean tap water to get rid of dirt, wasps, and other surface contaminants.
- Samples was air dried for 7 days (one week) to ensure moisture reduction to the lowest minimal.
- The air dried samples was crushed with mechanical grinder to provide a larger surface area
- 75g was measured using a sensitive balance and carefully wrapped in a foil.
- Total of four measurements of equal amount was weighed and wrapped in a foil and coded as NELS

Nursery Practices

A media was compounded with top soil, poultry manure and sharp sand in the ratio 3:2:1 respectively. The mixture was left for one month, to ensure adequate decomposition and curing. This cured media was turned into seed trays. The seeds were planted in the seed trays at the rate of one seed per hole, then placed in the nursery shade, which was constructed with aluminum zinc and palm fronds.

Experimental Design

Experimental design was a complete randomized design (CRD). The treatments are; Castor capsules, Neem leaves, castor capsules plus neem leaves and the control (no treatment). All was replicated four times (4 x 4 design) giving a total of 16 pots

Potting and Amendment

The pot preparation and amendment was done in 16 (sixteen pots), and treatments was formulated according to experimental design. Each pot contained 4.5kg of soil thoroughly mixed differently with granulated castor capsule and neem leaves of equal amount (75g) differently in each pot and was replicated four times. Another treatment of half the amount (37.5g) of the two treatment samples in (75g) of soil sample was potted in a replicate of four, the control pots of no treatment (only soil) was replicated four times and all was coded as follows:

CACS - Castor Capsules (75g mixed with 4.5kg soil)
NELS - Neem Leaves (75g mixed with 4.5kg soil)
CACNELS - Castor Capsules + Neem leaves (37.5g Castor capsules +37.5g neem leaves + 4.5kg soil)
COS - Control (4.5kg soil)

The mixture was watered to field capacity and left for 7 days for ageing. Tomato seedling infected with fungus disease was then transplanted two seedlings per pot in the evening around 6.30pm. The experiment was watered every order day at rate of 75cl per pot and weeding was done as the need arise. The tomato fruits were harvested at maturity and weighed with a sensitive balance.

Laboratory Analysis

Physical Analysis:

- Particle size distribution was determined using Bouyoucous hydrometer method, (Bouyocous, 1951).
- Bulk density was determined using (Core method)

Chemical Analysis

- Soil pH was determined (Electro-conductometric method) with a digital pH meter in the supernatant suspension of 1:2.5 soil to water ratio.
- Available phosphorous was determined by Bray 1 method using 0.03N NH_4F and 0.025N HCl in the distilled water as the extraction solution. (Bray and Kurtz., 1945).
- Total Nitrogen (N) was determined by Kjeldahl digestion method (Black et al., 1965).

- Organic carbon was determined by the chronic acid oxidation method by (Walkley and Black., 1934) as modified by Nelson and Sommers, (1996)
- The exchangeable bases; Ca Mg, K Na was determined by the ammonium acetate saturation method using atomic absorption spectrophotometer (Zhang, et.al., 2012).
- Exchangeable acidity (H^+ and Al^{3+}) was analyzed by the 1N KCl extraction method (Dewis and Preitas, 1970).

Statistical Analysis

The data collected from the experiment was subjected to analysis of variance (ANOVA) using SPSS of Statistical Analysis. The mean separation was by Duncan's Multiple Range Test in the 5% probability level of generalized model (GLM) procedure.

RESULTS AND DISCUSSION

Effects of castor capsules and neem Leaves on soil chemical properties

The soil pH varied with the organic treatments applied. The mean value of soil pH obtained was 5.9 indicating an overall acidic soil condition (Table 1). In the control pot, soil pH was moderately acidic with a mean value of 5.5. This value was significantly lower ($P < 0.05$) than the pH values obtained across the treatment pots. Results indicated that all the treatments had soil pH which was significantly higher than the control. Pots amended with CACS treatment had a mean pH value of 6.5, CACNELS had a mean pH of 6.05, and NELS had a mean value of 5.62 (Table 1). The soil pH across the entire treatment pot progressed from CACS > CANELS > NELS > COS. Higher pH values in the amended pots indicated that the treatments significantly increased the pH of the soil. The low soil pH obtained in the control pot could be attributed to the leaching of basic cations by heavy rainfall obtained in the area thereby leaving the soil solution with acidic cations which were responsible for soil acidity.

Soil organic matter (SOM) is an important soil property as it adds to the bulk of the soil and it also increases the nutrient availability and water retention ability. Results indicated significant differences ($P<0.05$) in the mean values of SOM across the entire treatments. For the control pot, SOM had a mean value of 0.638. This value was significantly lower than the values across the treatment pots. The sequence of SOM across the entire pots is given as CACS > CACNELS > NELS > COS.

The mean value of SOC obtained is given as 0.51% (Table 1). Results indicated that CACS had the significant highest SOC with a mean value of 0.61%. This was closely followed by CACNELS with a mean value of 0.55%. The higher values of SOC in the amended pots reflect the inherent capacities of the amendments to increase the organic carbon content of the studied soil. It could be attributed to the accumulation of OM. This agrees with Nweke (2020) who reported that organic soil amendments significantly increase the SOC content in comparison with the control. The sequence of SOC across the entire pots is given as CACS > CACNELS > NELS > COS.

Table 1 Effects of castor capsules and neem leaves on soil chemical properties

Treatment	Soil pH	OC	OM	Total Acid	Total N	Al^{3+}	H^+	Ca^{2+}	Mg^{2+}	Na^+	K^+	P	CEC
		%		$cmolkg^{-1}$	%	TEA		$cmolkg^{-1}$			TEB	$Mgkg^{-1}$	$cmolkg^{-1}$

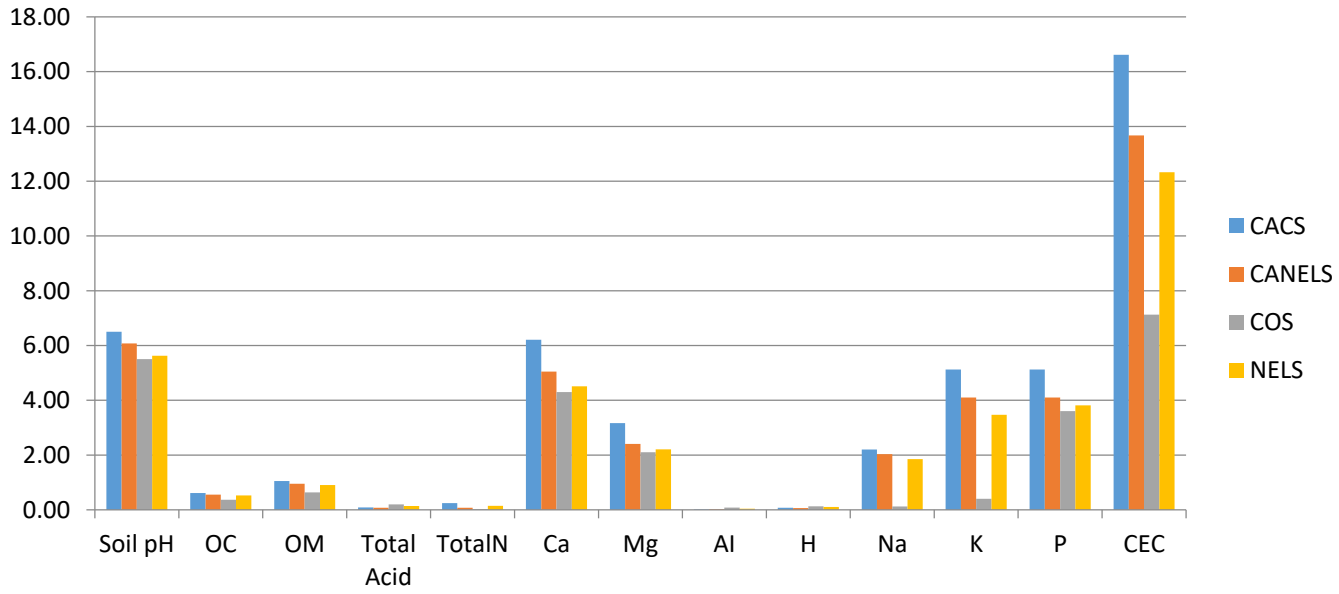
CACS	6.50[a]	0.61[a]	1.05[a]	0.09[c]	0.25[a]	0.02[d]	0.08[c]	6.21[a]	3.17[a]	2.20[a]	5.13[a]	5.13[a]	16.62[a]
CANELS	6.08[b]	0.55[b]	0.95[b]	0.08[d]	0.08[b]	0.02[c]	0.06[d]	5.05[b]	2.41[b]	2.03[b]	4.10[b]	4.10[b]	13.67[b]
NELS	5.63[c]	0.53[c]	0.91[c]	0.14[b]	0.14[c]	0.04[b]	0.11[b]	4.51[c]	2.21[c]	1.85[c]	3.47[c]	3.82[c]	12.32[c]
COS	5.50[d]	0.37[d]	0.64[d]	0.20[a]	0.02[d]	0.08[a]	0.13[a]	4.30[d]	2.10[d]	0.12[d]	0.40[d]	3.60[c]	7.13[d]
MEAN	5.93	0.51	0.89	0.13	0.34	0.04	0.09	5.02	2.47	1.55	3.27	4.16	12.44

Treatments; CACS- Castor Capsules/ Soil, CACNELS- Castor Capsules/ Neem leaves/ Soil, COS- Control Soil, NELS- Neem Leaves Soil

Total Nitrogen across the entire pot had a mean value of 0.12%. There were significant differences in the mean values of the total nitrogen in the potted experiment. CACS had the highest value of 0.25% indicating the influence of the high organic matter content on the total nitrogen obtained. This agrees with Angelova et al. (2013) who reported that changes in organic content of soils brought about changes in the total nitrogen content. Thus total nitrogen in soils increases with application of organic soil amendments. CACNELS had a mean value of 0.075% which was significantly higher than 0.14% obtained in NELS and 0.02% obtained in the control pot. The sequence of TN across the entire pots is given as CACS > CACNELS > NELS > COS. Basic cations analyzed in the treatment pots was observed that CACS > CACNELS > NELS > COS. The control pot of no treatment gave the least value. Nweke et al. (2020), stated that the amended soils had largest amount of the exchangeable base cations, cation exchange capacity and bases saturation. Nwite et al. (2013) also stated that the exchangeable cations of calcium, magnesium and potassium, effective cation exchange capacity and percent base saturation were significantly ($P < 0.05$) higher in soils amended with organic residues than in the control pots.

The acidic cations evaluated in this study were aluminum and hydrogen. The mean values of aluminum and hydrogen obtained in the study were 0.039% and 0.094% respectively. Results indicated that the mean values obtained in control pots were significantly ($P<0.05$) higher than all the treatment pots. In COS, the mean values of Al and H were 0.08% and 0.13% respectively. The low acidic cations obtained in the amended could be attributed to the inherent basic properties of the soil additives which buffered the effects of soil acidity. The sequence of TEA across the entire pots is given as COS > NELS > CACNELS > CACS. The mean value of phosphorus obtained in this study was 4.16 $mgkg^{-1}$. The lowest content of phosphorus was observed in the control pot with mean value of 3.6$mgkg^{-1}$. There was a significant increase in soil phosphorus with the application of organic amendments. The highest mean value was observed in CACS

(5.12 mgkg^{-1}) followed by CACNELS with 4.10 mgkg^{-1}. The data obtained in this study agrees with the report by Liu *et al* (2013) which stated that the content of phosphorus in the soil is influenced by applications of organic amendments. The sequence of P across the entire pots is given as CACS > CACNELS > NELS > COS. The highest value of CEC obtained in this study was observed in CACS with mean value of 16.62 cmolkg^{-1}. This was significantly higher than all other treatments and the control pots. CACNELS pots closely followed with a mean value of 13.67cmolkg^{-1} which was significantly higher than 12.32 cmolkg^{-1} obtained in NELS. Results indicated that the control pot had the least mean value of CEC with 7.13 cmolkg^{-1}. The sequence of CEC across the entire pots is given as CACS > CACNELS > NELS > COS.



Graphical representation of soil chemical properties

Effects of Castor Capsules and neem leaves on Soil Physical Properties

The results of the effect of castor capsules and neem leaves on the soil physical characteristics is presented in Table 2. In the control pot, the sand content was significantly higher than all the amended pots with a mean value of 70%. The silt content was 20.0% and clay content was 10.0% giving a textural class of sandy loam. Sandy loam textural class was also reported in NELS treated pot with sand, silt and clay contents of 60%, 30% and 10% respectively. In CACS and CACNELS treated pots, clay contents were significantly higher than in NELS and COS pots. The textural class of soils in CACS and CACNELS was reported as sandy clay loam due to the higher clay content observed in the fractions.

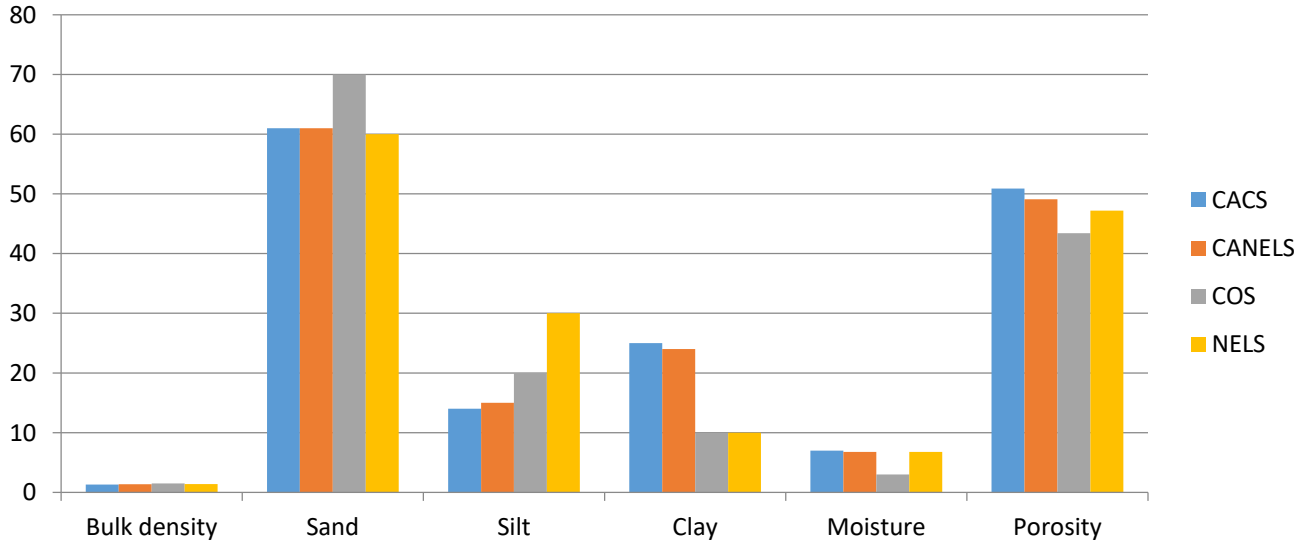
The soil bulk density was significantly ($P < 0.05$) affected by the various input management practices. Soils amended with castor capsules and neem leaves recorded significantly lower bulk density values than the control soil. Soil bulk density in the control pot had a mean value of 1.5 gcm^{-3} which was significantly ($P < 0.05$) higher than 1.4 gcm^{-3}, 1.35 gcm^{-3}, and 1.30 gcm^{-3} obtained for NELS, CACNELS and CACS respectively. The lower bulk density in CACS could be attributed to the lower particle size fractions as compared with other treatments.

Table 2 Effect of castor capsules and neem leaves on soil physical properties

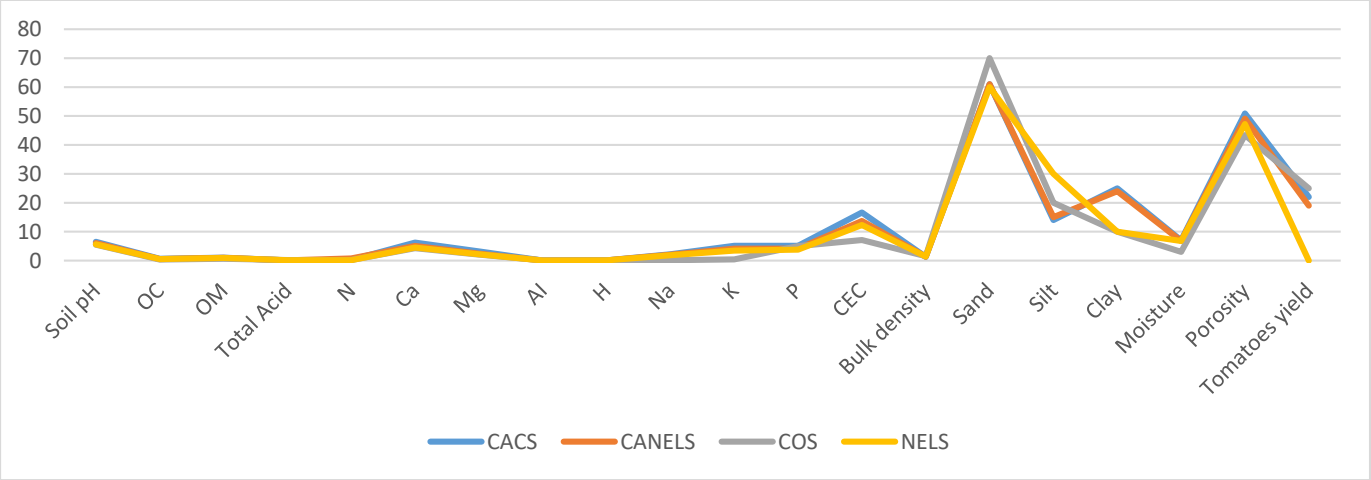
Treatments	Textural Classes	Sand	Silt	Clay	Bulk density	Moisture	Porosity
		%			gcm^{-3}	%	
CACS	Sandy Clay Loam	61.00[b]	14.00[d]	25.00[a]	1.30[d]	7.00[a]	50.90[a]
CANELS	Sandy Clay Loam	61.00[b]	15.00[c]	24.00[b]	1.35[c]	6.78[c]	49.10[b]
COS	Sandy Loam	70.00[a]	20.00[b]	10.00[c]	1.50[a]	3.00[d]	43.40[d]
NELS	Sandy Loam	60.00[c]	30.00[a]	10.00[c]	1.40[b]	6.78[b]	47.20[c]

Treatments; CACS- Castor Capsules/ Soil, CACNELS- Castor Capsules/ Neem leaves/ Soil, COS- Control Soil, NELS- Neem Leaves Soil

Soil moisture content was significantly higher ($P < 0.05$) in CACS with a mean value of 7.0% than in all other treatments. In the control pot, the least value of moisture content was 3.0% which was statistically the smallest of all observed values. In CACNELS and NELS, the soil moisture content was 6.76% and 6.78% respectively. Results in Table 2 indicated that the highest porosity was in CACS pot with a mean value of 50.9%. This was significantly higher than all other treatments and could be attributed to the lower bulk density value of 1.30 g/cm^3 observed in the pot. In the control pot, the mean value of porosity was 43.4% and results indicated that it was the least amongst all statistically ($P < 0.05$).



Graphical representation of Soil Physical Properties



Mean chart curve of soil physico-chemical properties of both the amended and non-amended soil and tomato yield

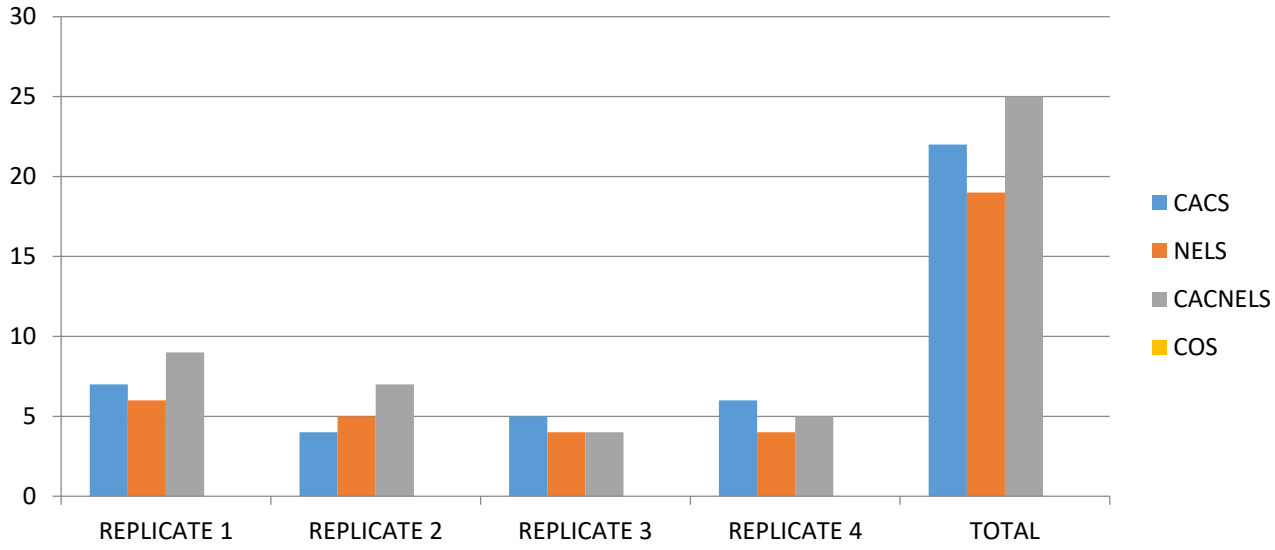
Effect of Castor Capsules and Neem leaves on Tomato Yield

The data for the tomato yield is presented in Table 3. From the yield data, the highest value was obtained in the CACNELS pots with a total yield of 25 fruits and 15g weight. This could be attributed to a combination of the genetic makeup of the crop with the ecological modification of the soils by castor capsules and neem leaves amendments. The amendments probably have significant anti-fungal properties which created the best ecological composition and actively colonize themselves with the tomato plant roots and protect the plant from pathogenic fungi and other phytopathogens that might affect the tomato growth and yield as compared to non- treated pots. Akinfoesoye et al. (1997) and Ray and Sinclair (1997) attributed the growth characters of crop species not only to genetic constitution of the crop but also to the suitable agro-ecological zone where they can express their full genetic resources for growth and yield enhancement. In the NELS pots, even though the amendment effect in terms of soil chemical properties apart from the control was the least, the fruit yield was significant enough to show that the treatment was obvious in inhibiting the fungal load. The result indicated that modification of the soil with castor capsules and neem leaves amendment reduced the fungal loads in treated pots and made the treated pots to produce fruits relative the result obtained from the control soil. No tomato fruit was recorded in the control pots could result from inherent low fertility status of the soil and little or no organism to produce growth promoting substances and secondary metabolites to suppress tomato fungus disease hence no yield was recorded in the none treated pots

Table 3 Effect of castor capsules and neem leaves on tomato yield

Treatments	Number of fruits	Fruits (fresh weight)g
CACS	22.00	12.76

CACNELS	25.00	15.00
NELS	19.00	11.61
COS	0.00	0.00
MEAN	16.50	9.84



Yield characteristics of the cultivated Tomatoes

Conclusion

Castor capsules showed the highest significant level of amendment especially in increasing soil pH level and hence, can be a good source of organic ash material to reduce soil pH as clearly seen or shown in its' high content of potassium (Table 1). Neem leaves even though had less significant effect on soil parameters compared to castor capsules, has positive effect on fungal load which gave room for fruiting to occur even with the little added and available nutrient that result in fruit yield. Control soil did not record any fruit yield the fungus disease affected the tomato plant such that many died before the maturity. From the result findings the farmers are therefore, advised to adopt this technology for soil amelioration and disease control in the field for food sustainability in humid environment like Nigeria.

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