Journal of Engineering and Applied Sciences 2 (1): 86-89, 2007

The Effect of Physical Soil Properties on the Prospects of Castor Seed Production

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Abstract: Castor plant, formerly known only for its laxative properties, is becoming popular in the modern world due to the commercial value of industrial vegetable oil it contains. Therefore, there is the need to improve the yield of its seeds through optimal selection of soil needed for its planting. This study presents the effect of physical soil properties such as bulk density, PH, soil texture, electrical conductivity and porosity on the early growth stages of castor plant and the prospect of the castor seed farming in the development of small-scale industries.

Key words: Physical soil, castor seed, soil texture

INTRODUCTION

Castor seed plant (*Ricinus communis*) got its name from a Latin word Ricinus, due to the structure of the castor bean seed that looks like a blood- filled tick[1].

The ancient Egyptians valued its oil almost as lightly as that of the olive oil for their lamps. This plant is often seen along the road sides and on the dump sites or heaps throughout the tropics and subtropics. The unripe clusters of the seed capsules are spread on the ground until they dry, split open and the seed fall out.

The principal producing countries are India and Brazil with lesser amount from other Latin American countries. In continents such as West Indies, Africa, Asia and United States of America, manufacturers use about 40% of the world crop and import 90% of this castor oil.

Its products have hundreds of industrial uses, hence castor oil is termed industrial oil. Its uses include its importance in paint industries, pharmaceutical and cosmetics. Castor oil can be made into special lubricant for jet engines, racing cars and brake fluid, since it is unaffected by temperature, the bean has sufficient nutrient and moisture to sustain the vigorous growth and it also contains poisonous ricin (RYE-SIN) and a very deadly protein called lectin[2].

This is often found in the cake after extraction; however, they are a source of numerous economically important products. Part of its residue is also used as fertilizer. This plant may grow up to 2-5 metres high in one season. Its larger palmately-lobbed leaves may be 50 cm across and resemble a typical arelia. Although, it grows rapidly with little care or insect pests, its cultivation can be improved upon through proper soil physics applications for agronomical purposes in other to reap its industrial benefit.

Castor (*Ricinus cummunis)* is a tropical crop native to Africa and possibly India. In Nigeria, the crop is not grown at commercial scale despite the abundant land and ecological and climatical condition which are favourable to its cultivation. But naturally, the crop grows widely all over the country from coastal areas to dry northern fringes, hence the need to have it cultivated in commercial scales.

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There is also the need to have a means of optimum selection of soil needed for castor seed oil cultivation since castor plant can withstand very poor soil, indeed a fertile soil may render a low yield of seed as the plant tend to grow very tall and produce thick leaves at the expense of development of the infloresence and consequently castor seeds plant cannot be raised on a black cotton soil with high clay content.

This study, therefore, attempts to study the influence of soil physical characteristics on the early growth stage of castor plant with the objective of ascertaining the optimum physical soil properties required and hence improve the quality and quantity of yield per hectare.

Agronomical practice: Castor plant is a perennial plant in Nigeria, whose size of seed is influenced by environmental factors such as soil, temperature, humidity and level of water or porosity of the soil. Castor plant varieties includes wild type and improved breed type. It can be grown in both upland and lowland area. Although castor can withstand very poor soil, however the soil should be sufficiently loose (friable) and well drained. The optimum soil needed for castor planting can be obtained through the study of the soil physics of the site to be used for plantation and this justifies the need for this research in order to have a balance between varieties of seed, climatic condition and soil types.

Castor plant requires full sun exposure during the late summer and early fall. It is draught tolerant and best grown on soil with PH value 6.1 to 6.5 (Mildly acidic) or 6.6-7.5 (neutral). Propagation is through direct sow from the seed on a spacing of 90-120 cm between rows and 35 cm-40 cm between plants.

THE PHYSICAL PROPERTIES OF SOIL

The physical properties of soil have critical importance to the growth of plants and to the stability of cultural structures such as roads and buildings. These properties are classified[3] as fixed (e.g. size distribution, colour, textural properties, conductivity etc.) or transient (e.g. water content, air or gas content). The soil properties considered in this study are bulk density, porosity, electrical conductivity, textural classification and PH.

Bulk density: It is an important property used to characterize the structural state of a soil. The true density of a soil is a measure of the density of the constituent components and from about 2.65 g/cm^3 for the mineral particles to about 0.2 g/cm^3 for the organic matter. The bulk density which takes into account both the density of the soil materials and their arrangement or structure is expressed, as bulk density =

$$\frac{\text{Weight of soil (g)}}{\text{Volume of Soil (cm}^3\text{)}}$$

Therefore, a loose porous soil will have a smaller bulk density than a compact soil even though the density of the individual particles in the two soils may be the same. Bulk density is an important soil property in fertility or crop production studies because continuous cultivation by heavy implements increases the bulk density by inducing compaction, which reduces percolation and root penetration. Agricultural soils in the plow depth ordinarily have bulk density ranging from 1.0-1.5 g/cm^3[4].

Porosity: It is an aspect of soil structure, which has a major practical importance. Pore size helps to determine water retention as well as water and air transport properties of a soil and, in some studies, the ease with which plant roots penetrate and living organisms can move. The larger pores (>10 μm) conduct water, the medium-sized pores (>10-0.2 μm) hold water which is available to plants while the fine pores (<0.2 μm) hold unavailable water. Where the particle density of soil materials is uniform (usually 2.65 g cm^{-3}), it is possible to determine the total pore space fraction of a soil from measurement of bulk density using the relationship:
Pore space fraction =

$$1 - \frac{Db}{Dp}$$

Where Db and Dp are bulk and particle densities respectively Agricultural soils usually have pore space fraction between 0.4 to 0.6[3,4].

Electrical conductivity: Conductivity refers to the conductance of a cube of one-centimeter side of a substance and is reported in mhos/cm, micromhos/cm or millisiemens. The presence of dissociated ions in soil water renders it conductive, although different salts have different conductivities for a given concentration. A single salt content may produce a linear relationship between its concentration and conductivity but within certain limits of concentration, after which the relation is asymptotic. For soil-water containing several salts in solution, no definite relations exist between the conductance and dissolved solids.

Soil texture: This refers to the mineral composition of a soil with respect to size and size distribution of the primary particles. The textural classification of soil is based upon the relative quantities of clay, silt and sand particles found in a sample. Different soils may have the same texture but they may not have the same particle size distribution and vice versa. This is due mainly to variations in the amounts of organic matter, type of clay, shape of particles and degree of aggregation. Sandy soils generally have a low water and nutrient holding capacity, clays have a good nutrient and water holding capacity, but they may become water logged. The very silty soils tend to erode very easily. The most desirable soils for cultivation are the loams particularly those containing about 5-10% organic matter.

Soil pH: Although pH is not a physical property, it is a very important factor in plant growth, hence its inclusion in this study. The pH of a solution is a measure of its acidity or alkalinity and is defined as the negative logarithm of the hydrogen ion concentration. Soils do not behave like simple solutions; its range for soils is normally from pH 3 to 9. Very low values develop following the drainage of coastal marshes and swamps that contains pyrite which is oxidized, producing sulphuric acid. At the other extreme, very high values result from the presence of sodium carbonate. Within the normal range the two main controlling factors are organic matter and the type and amount of cations.

Large amount of organic matter induce acidity except when counter - balanced by high concentrations of basic cations such as exchangeable calcium, magnesium and free carbonates. PH is often used to determine lime requirements for acidic soils.

MATERIALS AND METHODS

The study was conducted at the Kaduna Polytechnic main campus and at the Panteka staff quarters, all within 500 meters space. The topography varies from well-drained upland to medium slope area and marshy valley. Two castor seed varieties were used in all the trials and they can be classified as local wild type and the hybrid variety supplied by the Raw Materials Research and Development Council, (RMRDC) Abuja. The seed varieties were planted at five different locations under rain fed conditions. The cultural practices carried out were similar for all the experimental plots. Seeds were sown 5 cm deep at a spacing of 60 cm. Planting was carried out on the same day, one after the other in each plot 2×3 m in size. Soil samples were collected using core cutter for undisturbed samples and cutting samples as disturbed samples for soil physical characteristics determination. The soil physical properties determined from the soil samples are bulk density, porosity, electrical conductivity and textural class. The pH was also carried out to know the soil reaction property.

RESULTS AND DISCUSSION

The results of the analyses of soil physical properties and pH as observed from the five plots planted are given in Table 1.

One of the objectives of this work was to study the early growth stage of castor plant because the plant usually does not encounter serious natural growth limitations or hindrances once it germinates. Since all the five experimental sites are within 500 m, they are ultimately exposed to the same rainfall, temperature, humidity, sunshine and evaporation conditions. The bulk

Table 1: Physical properties of experiment soils

Soil sample location	Bulk density (g/cm^3)	Total porosity (%)	Soil pH 1:2.5 Water	CaCl$_2$	Electrical conductivity mS (25°C)	Soil textural class
A	1.58	40.38	5.1	4.2	0.17	Sandy Loam
B	1.38	47.92	3.8	3.2	0.27	Loam
C	1.50	43.40	5.3	4.4	0.11	Sandy Loam
D	1.49	43.77	5.4	4.2	0.08	Sandy Loam
E	1.57	40.75	6.2	5.1	0.20	Sandy Loam

densities of the soils for the five locations range from 1.38 g cm^{-3} at location B to 1.58 g cm^{-3} at location A. The result showed lower level of compaction at site B than at the remaining sites and incidentally location B is a marshy land. The total porosity is highest at the same location B with a value of 47.92% while the lowest porosity was obtained at location E with a value of 40.75%. Total porosity value is highest at site B, suggesting that the marshy nature of site B may be due to the presence of a less permeable or clay pan layer underlying the porous top soil. Also, this total porosity value consists of both the micro porosity and macroporosity and the former is usually larger in fine-textured soils as observed at location B.

Site B has the lowest pH (in water) value of 3.8 and the soil reaction according to soil survey staff[5] for this value is rated as extremely acidic in nature. The pH for sites A, C and D are rated as strongly acidic, while only site E has a value of 6.2 which is slightly acidic and tends towards neutral condition Table 1. The electrical conductivity which indicates the presence of dissociated ions in soil water and hence the salt content is rather very low at all the five sites and according to[6], all the soils can be categorized as non-saline. The mechanical analyses of the soil samples indicated that all the soils are mainly sandy loam except for site B which is loam. The outstanding features of these soils are the bulk density and the porosity, which can be compared with the early stage of growth of the castor seed plant.

Although all the seeds were planted at the five experimental plots on the same day and at the same depth, the following observations were made. First of all, the wild type seed did not germinate at any of the sites, as they remained unchanged after 2 weeks of planting. The hybrid seed variety germinated at locations C, D and E, while no evidence of germination was noticed in plots A and B. The first germination was observed at plot C as the first leaf appeared 7 days after planting while the second leaf emerged on the 12th day.

Germination and emergence of first leaf occurred on the 8th day at plots D and E, but thereafter growth and foliation became more rapid at D and E that at C, as the leaves became broader and the plants grew taller. Fertilizer (NPK 50-50) was applied after 3 weeks of planting to enhance growth and development. Soon after the attack of insect pest was observed. The plants were sprayed with pesticide (Chlorpyrifos at a rate of 10 cl/15 liters of water). Plot E showed the most favourable soil condition for the growth of castor plant under rainfed condition.

CONCLUSION

Castor plants grow in a variety of soils especially under well-drained condition. There was no germination at all under marshy soil condition in this study. Also, neutral to weakly acidic and weakly basic soils represent better growth conditions than very low or very high pH conditions. Once germination takes place, the plant grows very rapidly with little care and reduces a mass of lush tropical foliage. Its growth may however be hindered by insect pests if not adequately taken care of.

REFERENCES

1. Lewis, W.H. and M.P.F. Elvin-Lewis, 1977. Medical Botany: Plant affecting man's health. John Willey and Sons, New York.
2. Robinson, T., 1964. The organic constitunt of higher Plants: Their Chemistry and Interrelationships. Burgess Publishing Co., Minneapolis, Mnn.
3. McGraw-Hill Encyclopedia of Science and Technology (MEST), 1987. 6th Ed. Mcgraw-Hill Book Company, U.S.A. pp: 523-525.
4. Fitzpatrick, E.A., 1986. An Introduction to Soil Science. 2nd Edn. Longman Scientific and Technical, England.
5. Soil Survey Staff, 1993. Soil survey manual. Soil conservation Service, USDA. US government printing Office, Washington DC, Handbook. pp: 18-437.
6. Esu, I.E., 1991. Detailed soil survey of NIHORT farm at bunkure, Kano State Nigeria. IAR, ABU, Zaria. pp: 72.