Influence of Soil Compaction On the Early Growth of Sesame Seeds in A Sandy Loam Soil

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Abstract
The influence of soil compaction on the early growth of sesame (Sisecum Indicum L) (Hirhri variety) seeds experiment using sandy loam soil in the University of Maiduguri Agricultural and Environmental Resources Engineering laboratory was studied. The soil moisture content was raised to varying moisture content of 10%, 12% and 14% moisture from the initial moisture of 5.7%. The soil was subjected to five (5) compactive efforts of 0, 5, 10, 15, and 20 blows of proctor hammer which is equivalent to 66.7Kpa, 177Kpa, 288Kpa, 399Kpa and 599Kpa to establish variable penetration resistance and bulk density. At the various moisture contents result indicated that penetration resistance and bulk density increased as the compactive effort increased. The results obtain for plant height, seedling diameter, weight of shoot and root showed that compaction significantly affected these parameters. Out of the three moisture levels used, 10% moisture content gave the highest yield of the crop 32.8g, 12% moisture content 29.0g and 14% moisture content 28.5g. The lowest yield at 14% moisture content 16.1g. The result indicated that there is a great potential for optimum compaction effort and at appropriate moisture content of sandy loam for the production of sesame for high seedling emergence, fast growth and possibly yield.
Keywords: Sesame Seeds, Growth, Sandy Loam Soil, Moisture Content, and Compaction.

1.0 Introduction
Sesame (*Sesamum indicum*), is otherwise known as sesamum or benniseed. Most of the sesame seeds are used for oil extraction and the rest are used for edible purposes, its oil percentage ranges from 43- 56, protein content from 22-33, it is also rich in calcium and phosphorous. It has the potential of being one the major foreign exchange earning products for Nigeria (El Khier *et al*., 2008). The effects of compaction on growth and yield of crops have been extensively studied by researchers all over the world (Ohu *et al*.,1989; Dauda, 2011; Lipiec and Hatano; 2003 Lipiec *et.al*.,1991; Hamza and Anderson, 2005). The degree to which a soil can be compacted varies with the water content of the soil, soil texture and the force of compaction applied to the soil (Mamman and Ohu, 1998). The objective of the study is to determine the effects of compaction on the early growth of sesame in a sandy loam soil.

2.0 Materials and Methods
The soil in this study is sandy loam soil from the University of Maiduguri. The soil was collected from the top 20cm of the soil profile. The soil sample was air dried, large clods were broken and grounded and the soil texture was then mixed to obtain a homogenous

mixture of the sample. Particle size analysis carried out on the sample revealed that the soil is made up 0f 6 º/o silt, 17 º/o clay and 77 º/o sand (Dauda, 2011).
The initial moisture content of the soil was found to be 5.7% using oven-drying method. The soil moisture content was raised to varying moisture levels of 10%, 12%, and 14% exceeding the optimum moisture content of sandy loam which is 12% moisture. Having raised the moisture content to 10% 12% and 14% it was tightly sealed in a polythene bag to avoid moisture loss and to obtain a homogenous sampleThe amount of water to be added (Q) to condition the sample to different moisture levels was determined using the following expression (kachalla 1999):

$$Q = \frac{\mathrm{A(b-a)}}{\mathrm{ax100}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where Q is the mass of water to be added in kg. A is the initial mass of sample in kg. a is the initial moisture content of the soil in % dry basis, and b is the final (desired) moisture content of the soil in º/o dry basis.

Each sample was subjected to five levels of compaction energy using 0,5,10,15,20 blows of a standard proctor hammer in cylindrical cores of 17cm in height and 10cm diameter in accordance with the standard proctor compaction procedure (Lambe, 1951). The above hammer blows correspond to static equivalent pressure of 66.7Kpa, 177Kpa, 288Kpa, 399Kpa and 510Kpa as obtained from Raghavan and Ohu (1985). The compacted cores were covered with polythene bags fastened with rubber bands to avoid moisture loss and left for 24 hours in the laboratory. No compaction (0 hammer blow) was used as a control. The dry bulk density and penetration resistance of the soil were determined following the method described by Lambe (1951). The penetration resistance of the soil was also measured using a Standard cone penetrometer having a cone base of 15mm and cone angle of 30 degrees operating at 1829mm per minute following the ASAE standard (1982). Eighty milliliters of water was applied to each core from planting date till 15days after planting when the first trifoliate leaves appeared on daily basis to take care of evapotranspiration need of the seedlings as suggested by (Trouse, 1971). Thereafter water was applied to the cores at the rate of 80ml every day morning and evening until the 40th day after planting when the crop was harvested. To provide normal heat requirement for seed germination molds with planted seeds were kept in a place where they received maximum sunshine every day and taken back to the laboratory at night for normal heat supply for emerging seedlings and photosynthesis of emerged ones. Head count of seedling emergence was carried out on the 3rd and 5th day after planting at the appearance of first true leaves. The seedlings were tinned to a maximum of five (5) per core at 15 days after planting. The height (cm) and diameter (mm) of the seedling were taken with a ruler and Vernier caliper respectively, at 5-days interval from 15 days after planting to 40 days after planting. The crops were harvested 40 days after planting. The wet and dry matter weight of shoot and root were determined.

3.0 Results and Discussion

3.1 Soil Bulk Density and Penetration resistance

Mean values of bulk density and penetration resistance at different compaction levels are presented in Tables 1. The effect of number of hammer blows on soil bulk density and penetration resistance was significant ($P<0.05$). The bulk density and penetration resistance increased with increasing level of compaction. The highest bulk density was recorded for the highest pressure of 510 Kpa while the least values were recorded for zero blows, in all the three different moisture content used. Also the highest values of penetration resistance were recorded for the highest pressure of 510Kpa while the least values were recorded for the least pressure of 177Kpa. These results are in agreement with that of Kachalla, 1999; Ohu *et al*.,1994; Ohu *et al*., 2006; Sweeney,2006)

Table 1: Mean Values of Bulk density (g/cm^3) and penetration resistance (Mpa) as a function of compactive efforts.

Compaction Effort (Hammer Blows)	Static Equivalent Pressure of Proctor Compaction Blows(kPa)	Dry Bulk Density (g/cm^3)	Preparation Resistance (MPa)
0	66.70	0.094a	1.32a
5	177.00	0.125b	1.53b
10	288.00	0.132c	2.38c
15	399.00	0.136c	2.79c
20	510.00	0.150d	3.04d

Values followed by the same letter down the column do not differ significantly at P=0.05 using Duncan's multiple range analysis.

3.2 Seedling Emergence

The emergence of the seedling started after 3 days of planting in which all the compactive efforts show cracks and emerging seedling except the zero compaction which emergence were late until the 5th day of planting. This is lack of soil and seed contact which is an advantage of compaction.

3.3. Growth Parameters

3.3.1 Plant Height

Figure 1 shows the average height of seedling from 10 to 40 days after planting. It can be observed from the Figure that at 10% moisture content the highest height of the seedling is in molds with moderate (5 and 10) compaction apart from the control (0 blow) between 10 - 40 days after planting. The difference between the height of the 5 and 10 blows (moderate) compaction at 10% moisture content was 1.84cm, and 5 blows has the highest height 21.7cm. The lowest seedling height at 10% MC (17.22cm), 12% MC (14.88cm) and 14% MC (16.71cm) was recorded in molds with high compactive effort which is equivalent to pressure of 510Kpa this is due to high compactive efforts that restrict root penetration and retard growth. This finding is in agreement with the reported results by Shafiq and Ahmed (1994).

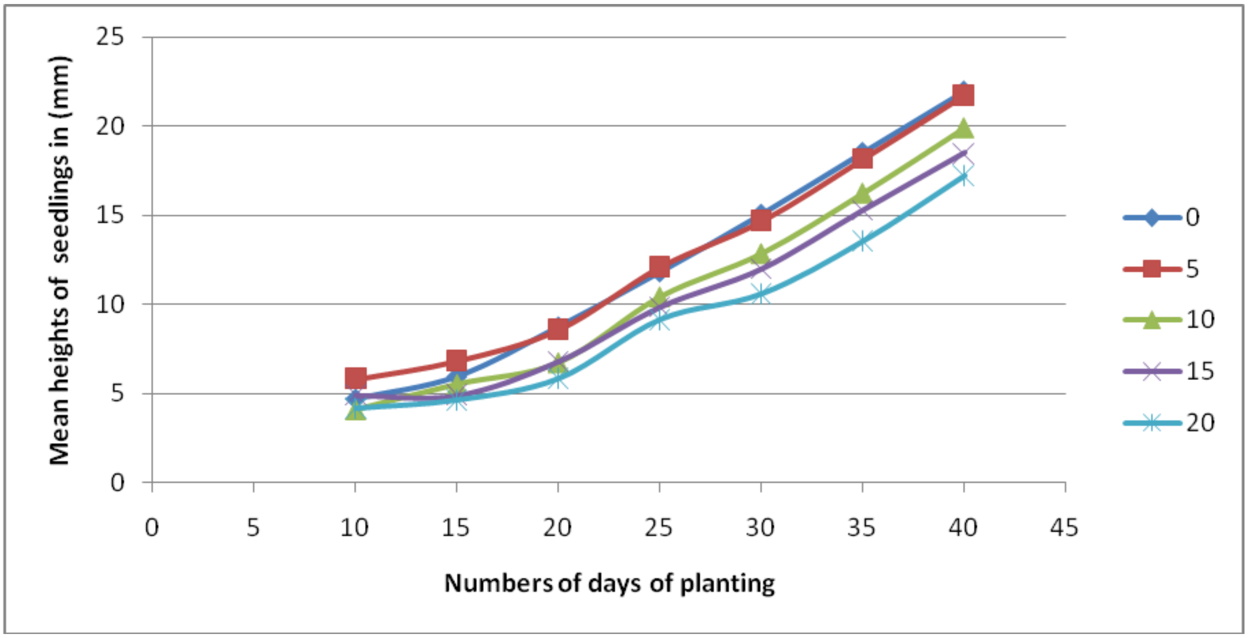

Fig. 1: Mean Height of Seedling at the Hammer Blows

3.3.2 Wet and Dry Matter Yield of Shoots and Roots

Figures 2 and 3 show wet and dry matter yield of shoots. It could be clearly seen that the wet and dry matter weight of shoots decreases as the level compactive efforts increases. The low yield at 20 blows when the pressure was 510Kpa was due to high penetration resistance and bulk density restricting the roots.

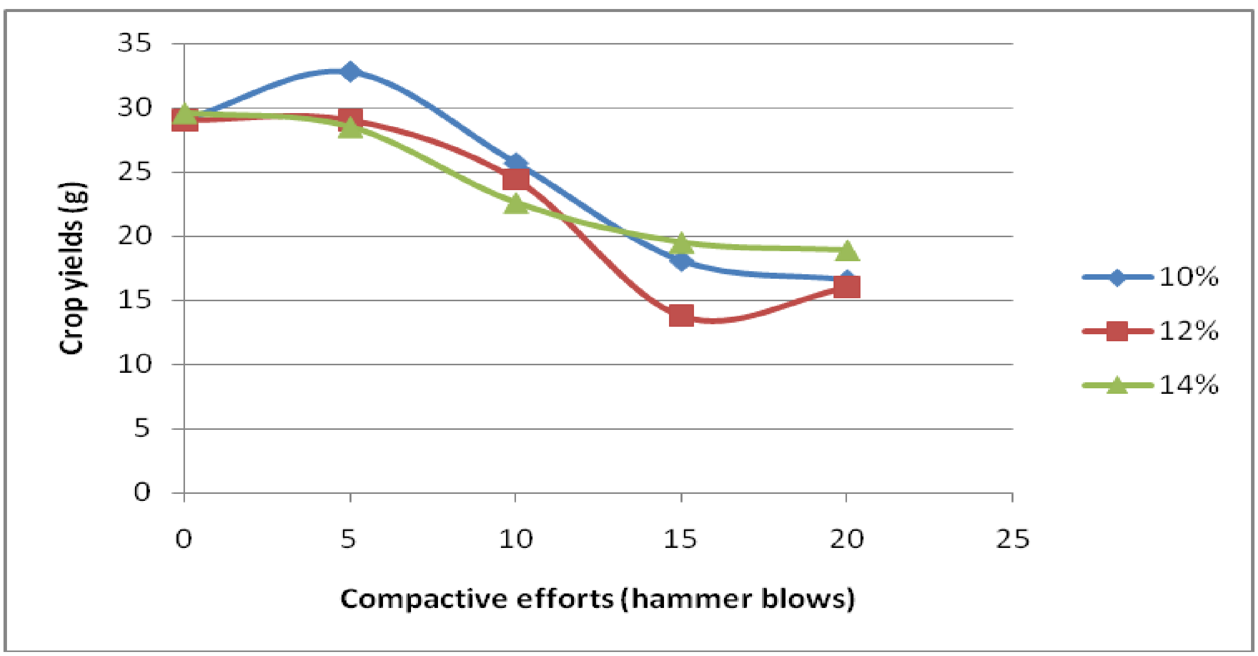

Fig. 2: Wet Shoot weight at the three moisture content (10%, 12%, and 14%).

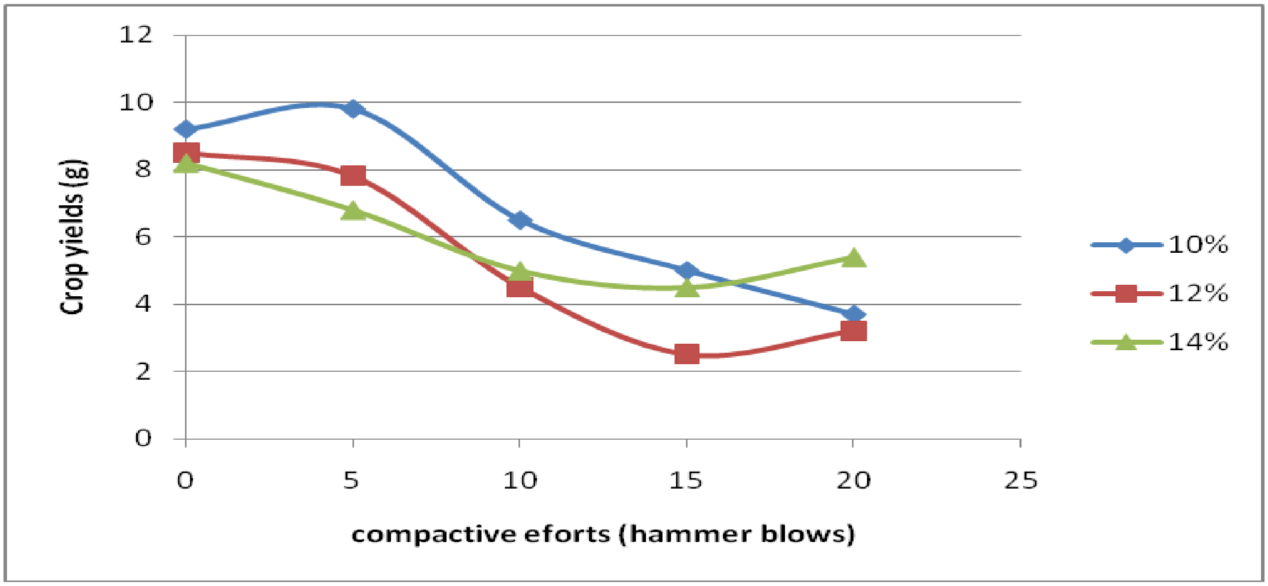

Fig. 3: Dry Shoot weight at the three moisture contents (10%, 12%, and 14%).

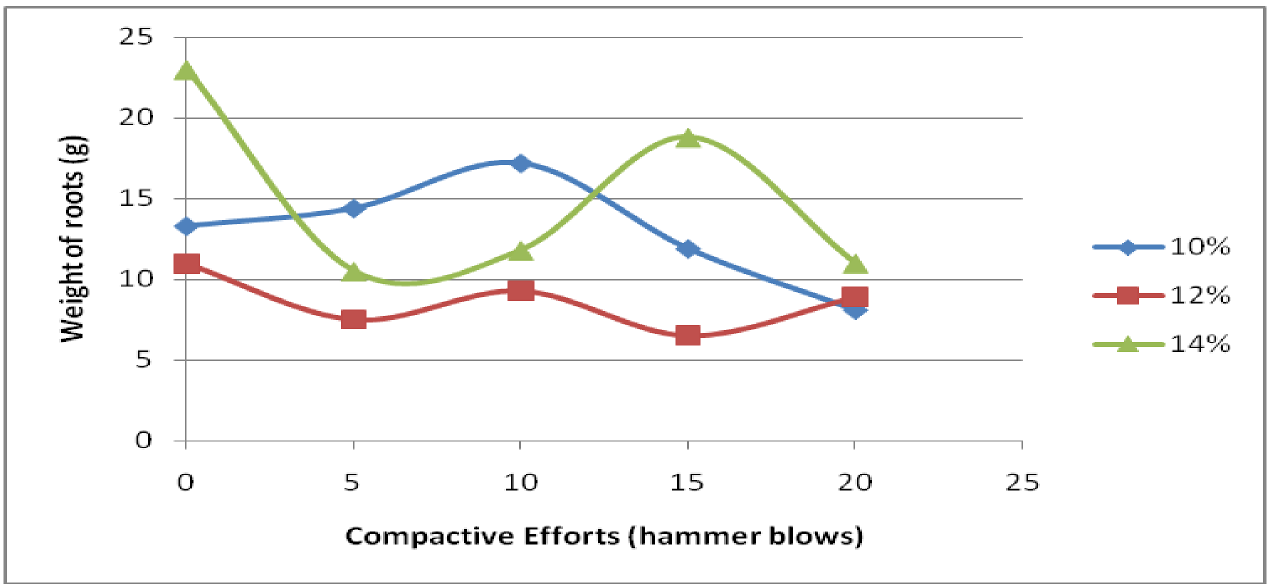

Fig. 4: Wet weight of roots at the three moisture contents

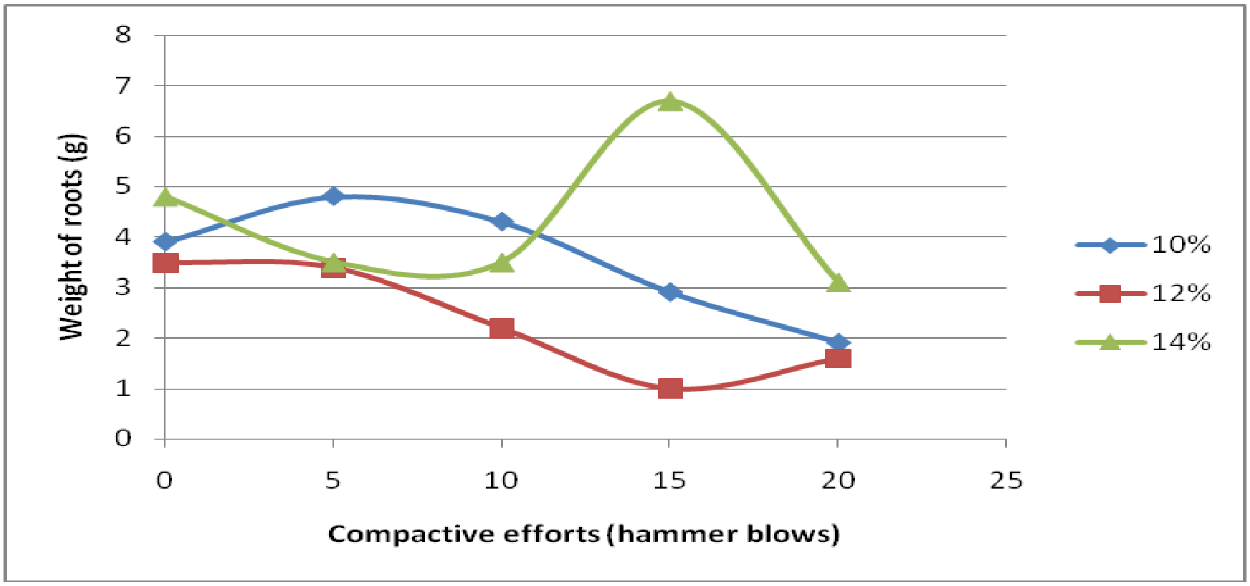

Fig. 5: Dry weight of roots at the three moisture contents

4.0 Conclusion and Recommendation

Results obtained from the study show that as compactive efforts significantly affect plant growth and development. It also shows that as compactive effort increases, the soil bulk density and penetration also increases. The effect of number of hammer blows on soil bulk density and penetration resistance was significant($P<0.05$). To achieve high seedling emergence, the soil condition should neither be too loose nor too compact. A little compaction effort is desirable to give maximum percentage seedling emergence because it promotes good contact between the seed and soil. Moderate soil compaction has beneficial effect. This is due to greater water retention. In general, it appears that there is a great potential in growing sesame on sandy loam soil, if the level of compaction is maintained at moderate level, which does not impede root development and other plant requirements.

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