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Influence of organic mulch on some biodiesel plants growth and some physical properties of semi-desert soil

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Abstract
Semi-desert soil from Mai'adua (a Local Government area bordering Niger Republic in Katsina State) was treated by applying plants residue as a surface soil treatment (organic mulches) in 0cm 3cm, 6cm and 9cm after the seedlings of the biodiesel viz; *Jatropha curcas*, *Moringa oleifera* and *Ricinus communis* fully established. The growth responses of the plants showed that at 3cm mulches thickness, *J. curcas* and *M. oleifera* showed no significant increase (P>0.05) in height but *R. communis* significantly increased by 2.4cm in compared to unmulched soil. Under 6cm and 9cm mulches, all plants had shown significant increase (P<0.05) in growth (*J. curcas* increased in 6cm mulch by 3.7cm, *M. oleifera* 4.4cm and *R. communis* 6.8cm) but *J. curcas* and *M. oleifera* growth increase by height was nearly similar under both treatments (6cm and 9cm). The growth response of *R. communis* was most triggered by 9cm mulch layer thickness (9.9cm). Regarding the soil properties, significant increase (P<0.05) had been observed in the soil moisture content. As the mulch layer thickness increased, the mean daily soil temperature significantly reduced because the mulches found to disallow the soil temperature to elevate high during the day and not very low over night. Therefore, optimum mulch rate for *Jatropha curcas* and *Moringa oleifera* in this soil is 6cm to 9cm above these range there is high tendency of the suffocation of root system which will eventually lead to the death of the plants. The optimum mulches rate for *Ricinus communis* was not established from the research findings.

Keywords: Biodiesel plants, moisture retention, organic mulching

Introduction
There is world concern on biodiesel plants as potential "green" renewable energy alternative to fossil fuel. Every aspect of plant growth and yield was affected by soil quality because it is essential for every stage of plant growth from seed germination up to plant maturation (Raza *et al*., 2012). Mulching is the practice of covering the soil surface to make favorable conditions for plant growth and development. Application of plants residue (organic mulches) as a surface soil treatment has been reported by Duiker and Lal (1999) [1]; Saroa and Lal, (2003) [15] as the most important farming technique for improving soil fertility for better plant growth and performance. Mulches help keep moisture in the soil, increases soil organic matter content, help moderate soil temperatures, help control weeds and reduce storm-water runoff and erosion. An organic material such as pine straw, wood chips, leaves and grass clippings break down and increases the texture of the soil Lukman, and Rattan (2008) [6]. The effect of crop residue on soil organic matter (SOM) content is highly related to the amount and only weakly to the type of residue applied. Organic mulches at the soil surface shade the soil serve as a vapor barrier against moisture losses from the soil, slow surface runoff and increase infiltration (Ji and Unger, 2001, Lukman and Rattan 2008 [6]. Rathore *et al.* (1998) [11] observed that more water was conserved in the soil profile during the early growth period with mulch than without it. Subsequent uptake of conserved soil moisture moderated plant water status, soil temperature and soil mechanical resistance, leading to better root growth and higher grain yields (Rathore *et al.*, 1998, Findeling *et al.*, 2003; Rees *et al.*, 2002) [11, 3, 12]. Soil aggregation, which is important to crop establishment, water infiltration and resistance to erosion and compaction, is influenced by organic mulching (Wright and Hons, 2005) [16]. The beneficial effects of mulching are known, there are instances when its availability is limited (Jolivet *et al*., 2003; Rovira and Olieveira, *et al*. 2002) [4, 14]. However, costs are incurred in its application and these increase with mulch level. Therefore, it is necessary that an optimum mulch application rate be established for

site-specific soil and environmental conditions to enhance or maintain high soil quality in a cost effective manner Lukman and Rattan (2008) [6]. Rees *et al.,* (2002) [12] ones observed two problems associated with organic mulching treatment. The first problem is "some is good more is better syndrome" for decorative and physical effective, mulch needs to be no deeper than 75mm, any deeper can course problem. Secondly, failure to understand the properties of organic materials leading to a range of problems including nitrogen drown down potassium toxicity in native, excessively reach conditions or the opposite, poor badly resulting in suffocation of root system.

Methodology

Soil Sampling and Mulch Application

Using Midwest Laboratories, Inc. 2015 (MLI) soil samples were collected from 0 – 10 cm depth with a 10cm diameter core in upper, middle and low line places at bordering site of Mai'dua Local Government (N 13º 873'0.8 and E 7º 032'3.7) to Niger Republic and transferred to Biological Garden Umaru Musa Yar'adua University, Katsina, Katsina State. The soils were filled into clay pots by equal amount of 2kg. Four seeds of the plants (*J. curcus, M. oelifera* and *R. cumunis*) were sown separately into the pots with five replicates respectively. After fourteen days, the emerged seedlings were mulched with organic lither from plant's leaves and chips in the layer thickness of 0cm, 3cm, 6cm and 9cm respectively.

Measurement of Plants Height

The increased plants height was measured in centimeters under control and mulches treatments.

Determination of Soil Moisture Retention and Temperature

Soil moisture retention was obtained by collecting soil from the root zone and measured as prescribed by Midwest Laboratories, Inc. (2015) and calculated as:

$$\mathrm{MR}t = \frac{\mathrm{W2\text{-}\ W3}}{\mathrm{W4\text{-}W1}} \times 100$$

(Where, W1 is the weight of pulverized soil, W2 is the weight of soil and corer, W3 is weight of soil, corer and aluminum foil and W4 is the weight after oven dry at 110c for 48hrs).

While the soil temperature was measured from the root zone at equal depth using field thermometer. The analysis of variance (ANOVA) was computed to study how mulching influence the plant growth soil moisture retention and temperature. The least square difference was computed to separate means when differences were significant at P = 0.05 level. The significant result of the ANOVA was then tested again with DUNNETT Multiple "T" test to study the differences between control group and experimental groups (soil mulching). DUNCAN analysis was computed to differentiate between the sample's mean that were similarly significant Lukman and Rattan, (2008) [6].

Results

The analysis of variance (Alpha = 0.05) by increased height of the plants (*J. curcus, M. oliefera and R. communis)* under mulching treatment indicated that there is significant increase in plants height under different mulch layers since, the level of significance in all species was less than 0.05 (P value < 0.05). The Dunnett multiple comparisons "T" test (Alpha = 0.05) (Table1) shown that there is no significance difference between control and the first mulching treatment (3cm mulch layer) by increase in height of *J. curcus* and *M. oliefera* but, there is significant difference observed between the unmulched and 6cm as well as 9cm mulching thickness in both of the plants. The comparison "T" test indicated the increased height of *R. communis* have significant differences between the first group (unmulched) and all the mulching treatments (3cm, 6cm and 9cm mulching). The Duncan analysis for *J. curcus* increased height by the mulching treatment in the soil, have indicated that control (unmulched) and first mulching treatment (3cm) group are of similar group while third (6cm mulching) and fourth (9cm mulching) were having of similar category as well. This means that the height of *J. curcus* in unmulched and 3cm mulched are similar but different from second group which consist of 6cm and 9cm. Duncan analysis has categories the increased height for *M. oliefera* under mulching of the soil into three groups. First group (control group) is different from second group (3cm mulched group) and third group, which, consists of 6cm mulching and 9cm, is different from the other groups. For *R. communis* increased height according Duncan analysis is been categories into three group. First group (unmulched) is consisted of control and 3cm mulching which different from second group for 6cm mulching and third is for 9cm mulching. These groupings by Duncan are portraying sameness of group means in relation to the influence in increasing the plants height.

The results by the analysis of variance (ANOVA), showed that there is significant difference in the moisture retention of the soil and mean daily soil temperatures under organic mulching treatments because the significant value of the computed data was found less than 0.05 (P value < 0.05) at 95% level of confidence. However, according to Dunnett T test (Table 2) there is no significant difference in the soil moisture content between unmulched and 3cm mulch thickness but there is significant difference between unmulched and 6cm as well as 9cm mulch layer thickness. Duncan analysis also proved that 0cm and 3cm having similar almost soil moisture content. It has been observed that there decrease in daily temperature of the soil but not significant between unmulched and 3cm mulch but significant to other mulches thickness. Similar results have been found according to Duncan analysis.

Table 1: Dennett multiple comparisons "t" test (alpha = 0.05) for *J. curcus, M. oliefera* and *R. communis* by increased height centimeter (cm) under mulch treatment

Dependent Variable Species		(I) Increased height in mulched soil (cm)	(J) Increased height in un- mulched (cm)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval
							Lower Bound
J. curcus	Dunnettt (>control)[a]	3	0	.53333	.71259	.441	-1.1886
		6	0	3.66667*	.71259	.001	1.9447
		9	0	3.76667*	.71259	.001	2.0447

M. oliefera	Dunettt (>control)[a]	3	0	1.36667	.49329	.030	.1747
		6	0	4.36667*	.49329	.000	3.1747
		9	0	4.46667*	.49329	.000	3.2747
R. communis	Dunnettt (>control)[a]	3	0	1.40000*	.65744	.076	-.1887
		6	0	6.80000*	.65744	.000	5.2113
		9	0	9.90000*	.65744	.000	8.3113

* The mean difference is significant at the 0.05 level.

a. Dunnett t-tests treat one group as a control, and compare all other groups against it.

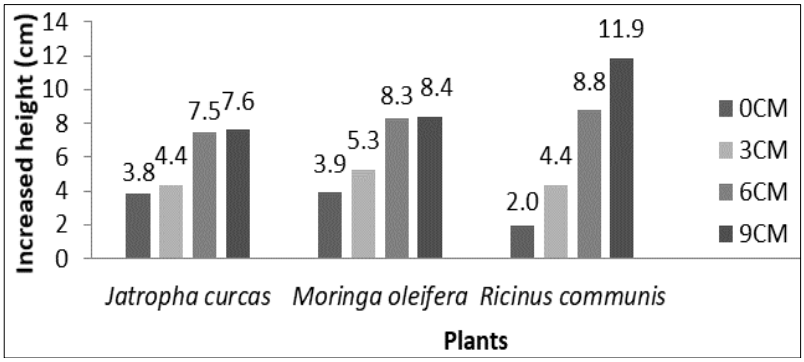

Fig 1: Shows growth response of the plants under organic mulches

Table 2: Dunnett multiple comparisons "t" test (alpha = 0.05) by soil moisture under mulches treatment

Dependent Variable Soil Sample	(I)Soil Moisture	(J)Soil Moisture	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval
						Lower Bound
Dunnettt (>control)[a]	3.00	0.00	1.18000	.87793	.227	-.9415
	6.00	0.00	4.17333*	.87793	.002	2.0519
	9.00	0.00	7.91000*	.87793	.000	5.7885

*. The mean difference is significant at the 0.05 level.

Dunnett t-tests treat one group as a control, and compare all other groups against it.

Table 3: Dunnett multiple comparisons "t" test (alpha = 0.05) by mean daily soil temperature under mulching treatment.

Dependent Variable Soil Samples	(I) Mulched Soil	(J) unmlched Soil	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval
						Lower Bound
Dunnettt (>control)[a]	3.00	0.00	.-66667	.81650	.413	-1.3064
	6.00	0.00	-7.66667*	.81650	.000	3.6936
	9.00	0.00	-8.33333*	.81650	.000	6.3603

*. The mean difference is significant at the 0.05 level.

a. Dunnett t-tests treat one group as a control, and compare all other groups against it.

Discussion

A plants biochemical and physiological activities is determined by the soil quality. By measuring some of these components and determining how they respond to management in an agricultural context, a foundation for assessing the health of the soil can be established. Among various soil management practices, an important strategy is mulching. The significance difference on the growth responds of the biodiesel plants reflects the positive influence of mulches on the soil properties but differences in growth of the plants accounts for relationship between the each species and mulch layer thickness. Mulching above 3cm thickness influenced *J. curcus* growth by increased in height and above 6cm no significant increase observed because at 6cm and 9cm it had shown almost equal height. However, significant differences have been recorded interns of the soil moisture and temperature. By this we can easily suggest that the soil moisture content between 7.50% and 11.65%, and soil temperature between 29c^{o} and 32c^{o} are suitable for optimum growth performance of *J. curcus.* This result is in line with the findings of Obi, (2010) [9] they reported that plants growth influenced by specific moisture content as well as soil temperature range. The growth responds by increase in height of *M. oliefera* in 3cm mulches thickness had no significant difference with unmulch. However, results by Dunnett tests conveyed significant differences on *M. oliefera* growth responds between unmulched and 6cm as well as 9cm mulch thickness. But according to Duncan test, its increased height in unmulched is different from 3cm mulch while in 6cm and 9cm is same or almost equal. This means that growth of *M. oliefera* increased as mulch layer thickness increased but above 6cm thickness growth increased by height was slow. This finding also is in contrast with the findings of Rehman and Basra. (2010) [13] they reported that growth and performance of *M. oleifera* is affected by high moisture content and low soil temperature regime. The growth increase of *R. communis* is been significantly increased as the mulch layer thickness increased by Dunnett test and this was found similar by Duncan test. Therefore, its increase is highly dependent on the available moisture content in the soil regardless of low soil temperature. These findings had been reported similar by Duke, (2001) [2]. It had come to noticed that organic mulching maintained the soil moisture content thereby increasing the soil moisture retention compared to unmulch soil and is determined by mulch layer thickness. This means that the higher the mulch layer thickness the more water retained by the soil. Moreover, it

has been observed that soil temperature is going very high in the day and becoming lower in the evening and very low in the morning hours under unmulched soil. Unlike under mulched soil, the soil temperature is been maintained almost equally every time but it varies according to mulch layer thickness. Similar findings have been reported earlier by Lukman and Rattan (2008) [6].

Conclusion

Non-conventional farming technique by partially covering the surface soil with crop residue (organic mulch) had played a significant positive influence on some biodiesel plants growth performance as well as soil moisture content and temperature. The optimum mulch layer thickness for better growth of *J. curcus* and *M. oliefera* in Mai'dua soil is 6 to 9cm thickness above this significant growth be found and tendency is very high for root system suffocation which will eventually leads to death of the plants. The growth response of *R. communis* was triggered most by 9cm mulch layer thickness therefore, the maximum optimum mulch rate not recognized. The organic mulch however, observed maintaining the soil moisture content but the moisture quantity is largely determined by the mulch layer thickness. The temperature is been optimized by organic mulching but, similarly varies according to mulch layer thickness.

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