Growth and performance of *Glycine max* L. (Merrill) grown in crude oil contaminated soil augmented with cow dung

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Abstract

In an effort to enhance crop production in crude oil contaminated soils, the effect of the addition of cow dung on the growth and performance of *Glycine max* grown in soil contaminated with various concentrations of crude oil were investigated in this study. There was a general improvement on the growth, dry weight, chlorophyll content, leaf area and pod production of the crop by the addition of cow dung to crude oil polluted soil. The performance of the crop also improved as the period of study increased suggesting that the toxicity of crude oil to the crop reduced as the period of study increased. Statistical differences ($P < 0.05$) were noticed among the days of sampling for some of the growth and performance indices measured suggesting that the period of study affected the performance of such indices. The findings of this study show that addition of cow dung to crude oil contaminated soil makes such contaminated soils useful for agricultural activities. [Life Science Journal. 2008; 5(3): 89 – 93] (ISSN: 1097 – 8135).

Keywords: crude oil; cow dung; *Glycine max*; augmentation; performance

1 Introduction

Various activities in crude oil exploration, exploitation, storage and transportation lead to spillage of oil to the environment (Nicolloti and Eglis, 1998). The spilled oil pollutes soils and the soils to be less useful for agricultural activities with soil dependent organisms being adversely affected (Baker, 1970; Mackay, 1991; Gelowitz, 1995; Siddiqui and Adams, 2002; Lundstedt, 2003). The effects of crude oil on the growth and performance of plants have been reported in many researches. These effects have been observed to occur due to the interference of the plant uptake of nutrients by crude oil and the unfavourable soil conditions due to pollution with crude oil (Plice, 1948; Gudin and Syratt, 1975; McGill and Rowell, 1977). It has been reported that plants and soil microbes compete for the little nutrient available in soils that are not rich like that polluted with crude oil thereby suppressing the growth of plants in such soils. However it is generally known that when soils not suitable for plant growth are augmented with manure, growth and performance of plants in such soil are enhanced. Merkl *et al* (2005) reported that addition of inorganic fertilizer in a crude oil polluted soil enhances the growth and performance of *Brachiaria brizantha* in crude oil polluted soil. Although, the performance of plants as reported by Merkl and co-workers can be enhanced in crude oil polluted soil with fertilizer, it also increases the cost of crop production in crude oil polluted soil. It is therefore necessary to investigate the impact organic manure like cow dung can make the growth of crops in crude oil polluted soil. This is because such manure is cheaper and is more affordable to farmers than the inorganic fertilizers. This study was therefore carried out to investigate whether addition of cow dung to crude oil polluted soil will enhance the growth and performance of *Glycine max* (*G. max*) in such soil. The information obtained will serve as a good reference for using cow dung to augment soils contaminated crude oil so as to use such soils for crop production.

2 Subjects and Methods

2.1 Sources of seeds and crude oil

The seeds of the *Glycine max* (TGX 1440-1E) used in this study were obtained from the Gene Bank Section of IITA Ibadan, Nigeria. The crude oil used for the studies

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was the well-head medium. This was obtained from the Shell Petroleum Development Company's Health Safety and Environment Laboratory, Port Harcourt, Nigeria. The manure used was cow dung obtained from the Oremeji cattle market, Ifako Gbagada, Lagos, Nigeria.

2.2 Pollution of soil and addition of manure

This was done by adding 0 g, 25 g, 50 g, and 75 g of crude oil in pots containing 4000 g of sandy loam soil. Each quantity of crude oil was added to six pots and was thoroughly mixed with the soil using hand trowel. Each quantity of crude oil served as a treatment with the 0 g treatment serving as the control. 100 g of the partially decomposed cow dung were added to three of the six pots having same quantity of crude oil. The remaining three pots were left to serve as control for each treatment. The manure was properly mixed with the polluted soil using hand trowel.

2.3 Planting of seeds and germination studies

This was done following the modified version of the method described by Vavrek and Campbell (2002). Seven seeds of the *G. max* were sown in sandy-loam soil treated with different concentrations of crude oil (25 g, 50 g, and 75 g) and the control treatment. The number of seeds that germinated from each pot was summed up after ten days. The percentage germination in each treatment was calculated using the following formula.

Percentage of germination = (number of seeds that germinated / number of seeds sown) × 100%.

2.4 Growth and performance studies

2.4.1 Crop samples collection. The crops were collected by carefully uprooting a crop from each pot to avoid loosing the root tips. The collection of the crop samples was done once every 21 days for 105 days. The collected crops samples were properly labeled to show the treatments.

2.4.2 Growth and performance of *G. max.* These were determined by measuring the plant height, biomass, leaf area, chlorophyll content and the number of pods produced by *G. max* in each treatment. The plant heights were measured with meter rule while the biomass of the plant was determined by measuring the dry matter content of the plant after oven drying the plant in an oven at 60 ºC to a constant weight using a weighing balance (Merkl, *et al*, 2004). The leaf areas of the plants were measured following the method described by O'Neal *et al* (2002) and the chlorophyll content was measured as was described by Saupe (2004).

The growth and performance of *G. max* in crude oil polluted soil were compared with those of the crop grown the contaminated soils and that were augmented with cow dung.

2.5 Statistical analysis

The data obtained were statistically analysed using LSD at 5% level of significance after analysis of variance test with SPSS 13.0 software.

3 Results and Discussion

The influence of cow dung on the height of *G. max* (TGX 1440-1E) grown in soil contaminated with crude oil (well-head medium) is shown in Figure 1. The heights of *G. max* in soils contaminated and augmented cow dung were greater than those of *G. max* in contaminated soils that had no cow dung. However, on day 42, the height of *G. max* in soil with contaminated with 50 g crude oil (50.17 cm) was greater than the height of *G. max* in soil contaminated with 50 g crude oil and that had cow dung (43.67 cm). However, the addition of cow dung did not produce any significant difference on the crops ($P > 0.05$).

The plants grown in the soil without crude oil contamination grew better than those from the contaminated soil irrespective whether cow dung was added to soil or not. This shows that crude oil contamination inhibits plant growth and it is similar to the findings of Baker (1970), Akinola *et al* (2004), Merkl *et al* (2004) and Agbogidi *et al* (2006; 2007). However, the greater plant height for plants from soils treated with 25 g crude oil observed on day 105 as against the height of the plants from the uncontaminated soil may be due to exhaustion of nutrients from the sandy-loam soil used in this study by the plants from the uncontaminated soil and the increased addition of organic carbon by the degrading crude oil (Osuji and Onokaje, 2004; Okolo *et al*, 2005).

The addition of cow dung to soils contaminated with crude oil led to increase of the dry matter content of the *G. max* grown in such soils (Figure 2). Thus the dry weights of the *G. max* from soils that were contaminated with crude oil and had cow dung added to them were greater than those from crude oil contaminated soils that had no cow dung added to. The addition of cow dung to the crude oil contaminated soil had much influence on the dry matter content of plant grown in soil with 25 g crude oil that the dry matter content of plants from soil with 25 g crude oil and cow dung was greater than that of the plant from the uncontaminated soil. However, the dry matter content of *G. max* from soils with crude oil alone did not show

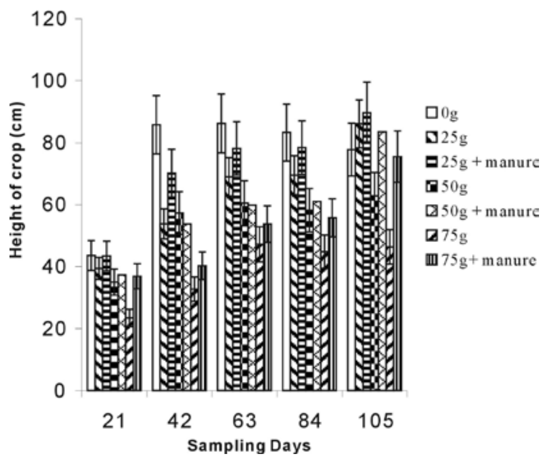

Figure 1. The effect of manure on the height of *G. max* grown in soils contaminated with varying concentrations of crude oil (well-head medium). The values are means ± S.E. of three replicate determinations. The errors bars show the difference in the level of response of the plants to the treatments in replicate buckets. 0 g = control, 25 g = soil with 25g crude oil and no cow dung, 25 g+manure = soil with 25g cow dung and cow dung, 50 g = soil with 50 g crude oil and no cow dung, 50 g + manure = soil with 50 g crude oil and cow dung, 75 g = soil with 75 g crude oil and no cow dung, 75 g + manure = soil with 75 g crude oil and cow dung.

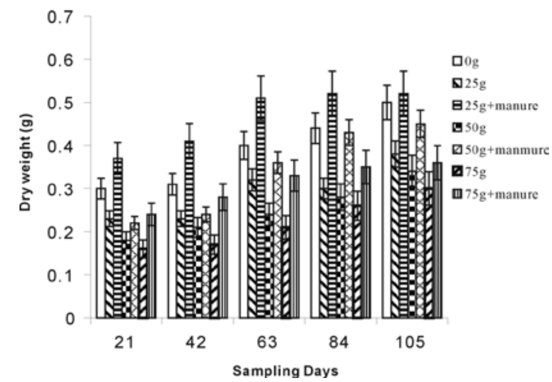

Figure 2. The influence of manure on the dry weight of *G. max* grown in soil polluted with varying concentrations of crude oil (well-head medium). Values are means ± S.E. of three replicate determinations. The errors bars show the difference in the level of response of the plants to the treatments in replicate buckets. 0 g = control, 25 g = soil with 25 g crude oil and no cow dung, 25 g + manure = soil with 25 g cow dung and cow dung, 50 g = soil with 50 g crude oil and no cow dung, 50 g + manure = soil with 50 g crude oil and cow dung, 75 g = soil with 75 g crude oil and no cow dung, 75 g + manure = soil with 75 g crude oil and cow dung.

any significant difference from those of *G. max* from soil with crude oil and cow dung ($P > 0.05$). This is similar to the findings of Merkl *et al* (2005) who did not observe any significant difference on the influence of fertilizers on the shoot biomass of tropical pasture grass (*Brachiaria brizantha*). The difference between the dry matter content of *G. max* from soil with crude oil alone and soil with crude oil and manure was highest between *G. max* from soils with 25 g crude oil and least between *G. max* from soils with 50 g crude oil. The increased in the dry matter content observed in this study could be attributed to continuous growth of the plant which was shown the earlier section of this report.

The leaf areas of *G. max* from soils with crude oil and cow dung were higher than those from soils with crude oil alone (Figure 3). Although the addition of cow dung led to increase in the leaf areas, there was no significant difference between the leaf areas of *G. max* from soils with crude oil alone and those of *G. max* from soils with crude oil and cow dung ($P > 0.05$). Therefore we can infer that addition of cow dung to crude oil contaminated does not have any effect on the leaf area. The noticed increase in the leaf area could be due to the general better growth of the plants grown in contaminated soils that had cow dung added to it. Although the addition of cow dung did not affect the leaf area of the plant significantly, there were significant effects of the days of sampling on the leaf area of the plant ($P < 0.05$).

The total chlorophyll content of *G. max* from crude oil contaminated soils mixed with cow dung like the growth and the dry matter content of the crop was generally higher than that of *G. max* from soils with crude oil alone (Figure 4). Although the addition of cow dung to the contaminated soil increased the total chlorophyll production, the means of total chlorophyll of *G. max* from contaminated soils alone and those of *G. max* from contaminated soils mixed with cow dung did not show any statistical differences ($P > 0.05$). This suggests that the difference in the chlorophyll content of the plants from contaminated soils with cow dung and those from soils without cow dung may only be due to improved soil condition by the cow dung application. In addition to the chlorophyll content being higher in plants from contaminated soils that had cow dung being higher than those from soils that had no cow dung, plants collected from contaminated soils that had cow dung on days 21 and 105 had more chlorophyll than the plants from the uncontaminated soil. The increase of the chlorophyll content of the plant after day 63 could be an indication of the plant recovery from the toxicity of crude oil.

The influence of cow dung on the production of pod by *G. max* grown in crude oil polluted soil is shown in

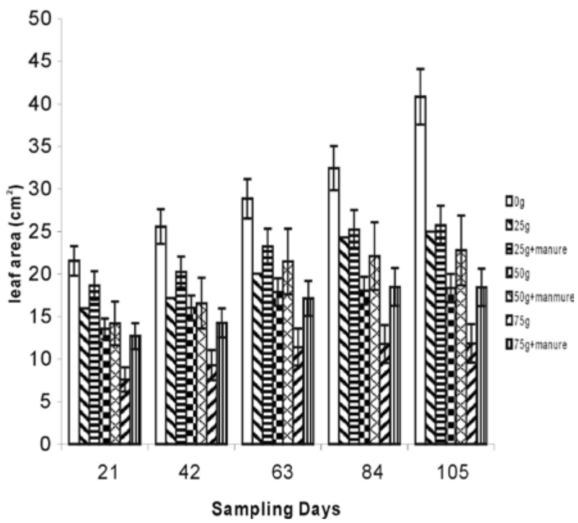

Figure 3. The effect of manure on the leaf area of *G. max* grown in soil contaminated with varying concentrations of crude oil (well-head medium). The values are means ± S.E. of three replicate determinations. The errors bars show the difference in the level of response of the plants to the treatments in replicate buckets. 0 g = control, 25 g = soil with 25 g crude oil and no cow dung, 25 g + manure = soil with 25 g cow dung and cow dung, 50 g = soil with 50 g crude oil and no cow dung, 50 g + manure = soil with 50 g crude oil and cow dung, 75 g = soil with 75 g crude oil and no cow dung, 75 g + manure = soil with 75 g crude oil and cow dung.

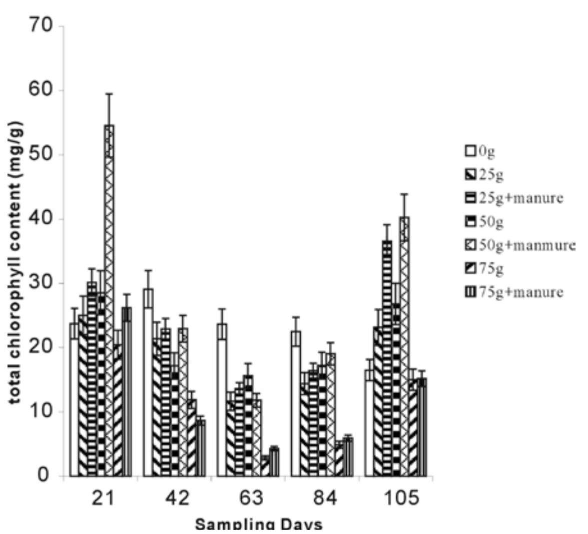

Figure 4. The influence of cow dung on the total chlorophyll content of *G. max* grown in soil contaminated with crude oil (well-head medium). The values are means ± S.E. of three replicate determinations. The errors bars show the difference in the level of response of the plants to the treatments in replicate buckets. 0 g = control, 25 g = soil with 25 g crude oil and no cow dung, 25 g = soil with 25 g crude oil and cow dung, 50 g = soil with 50 g crude oil and no cow dung, 50 g + manure = soil with 50 g crude oil and cow dung, 75 g = soil with 75 g crude oil and no cow dung, 75g + manure = soil with 75 g crude oil and cow dung.

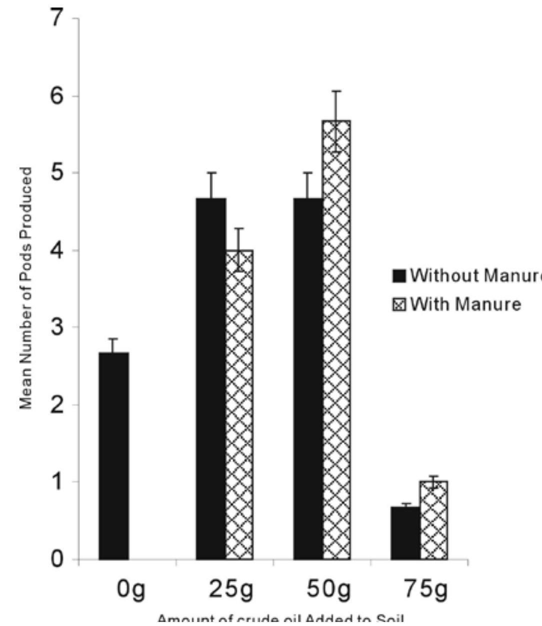

Figure 5. Influence of cow dung on pod production of *G. max* in crude oil polluted soil. The errors bars show the difference in the level of response of the plants to the treatments in replicate buckets.

Figure 5. Plants from contaminated soil mixed with cow dung produced higher number of pods than *G. max* from crude oil polluted soil without cow dung when the concentration of crude oil was high. However, there was no statistical difference between the number of pods produced by *G. max* grown in contaminated soils mixed with cow dung and those without cow dung ($P > 0.05$).

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