Influence of different vermicompost levels on growth, yield and quality of forage Sorghum (Sorghum bicolor L. Moench)

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Abstract. The objective of this study was to determine the effect of vermicompost fertilizer level on growth, dry matter yield and quality of sorghum (Sorghum bicolor (L.) Moench)). This study was arranged using a split-plot in time trial design with the main plot of each main harvest and the level of application of vermicompost fertilizer as subplots. The vermicompost fertilizer were: P₀ = 0 kg vermicompost/ha (0 kg N/ha, 0 kg P₂O₅/ha, 0 kg K₂O/ha); P₁ = 5.000 kg vermicompost/ha (30.5 kg N/ha, 11 kg P₂O₅/ha, 41 kg K₂O/ha); P₂ = 10.000 kg vermicompost/ha (61 kg N/ha, 22 kg P₂O₅/ha, 82 kg K₂O/ha); P₃ = 15.000 kg vermicompost/ha (91.50 kg N/ha, 33 kg P₂O₅/ha, 123 kg K₂O/ha), respectively. The variables in this study included the plant height, dry matter yield, crude protein, crude fiber, NDF and ADF. The results showed that if the vermicompost fertilizer dosage was increased the plant height, dry matter yield and crude protein would increase, but did not affect the crude fiber, NDF and ADF. Regrowth (ratoon) influences plant height and dry matter yield, while crude protein and crude fiber and ADF do not affect. It can be concluded that applying vermicompost fertilizer significantly increased growth, dry matter yield and significantly affected crude protein, while regrowth resulted in lower growth and dry matter yield.

1. Introduction
Sorghum [Sorghum bicolor L. (Moench)] is a cereal plant with multi uses, considered as one of the most important plants for the production of grains for humans consumption and animal feed [1-3]. Sorghum ranks fifth among the most important plants in the world [4] and has been a staple crop in the semiarid tropics of Africa and Asia for centuries [5]. Sorghum is crop mainstay of dry land farmers in semi-arid tropics owing to assured grains and fodder [6]. It is adaptive to vast environmental condition and provides palatable nutritious fodder to the animals [7]. Sorghum is more resistant than corn in drought conditions and thus grows in stress-prone semi-arid areas not suitable for corn [8]. Because of its tolerance to drought, sorghum has the potential to produce large amounts of nutritious forage during the summer [9]. In generally, conventional sorghum varieties produce higher forage but are some what lower in forage quality compared to BMR varieties [10]. Sorghum can produce ratoon plants after crop harvest. Ratoon sorghum has high production stability both below and above the average annual rainfall in semi-arid conditions [11]. Production and quality of ratoon plants is lower than that of main crops [12]. To increase the dry matter yield and quality of forage feed, it is very important to determine...
fertilizer requirements. Vermicompost is an organic fertilizer in the form of worm dung dried. Vermicompost is produced through the interaction of earthworms with microorganisms that results in the degradation of organic material [13]. The value of vermicompost as an organic manure has been well recognized for utilizing in agriculture as it contains valuable nutrients, inorganic form besides being a very effective soil ameliorant [14]. Therefore, this study was conducted to study the effect of different levels of vermicompost fertilizer on growth, dry matter yield and quality of sorghum [Sorghum bicolor L. (Moench)] Super-1 varieties.

2. Materials and methods

2.1. Experimental design
This research was arranged using a split plot in-time trial design consisting of two harvest times (main crop and ratoon) and four levels of vermicompost fertilizer application as plot: P0 = 0 kg vermicompost/ha (0 kg N/ha, 0 kg P2O5/ha, 0 kg K2O/ha); P1 = 5.000 kg vermicompost/ha (30.5 kg N/ha, 11 kg P2O5/ha, 41 kg K2O/ha); P2 =10.000 kg vermicompost/ha (61 kg N/ha, 22 kg P2O5/ha, 82 kg K2O/ha); P3 = 15.000 kg vermicompost/ha (91.50 kg N/ha, 33 kg P2O5/ha, 123 kg K2O/ha). Each treatment consisted of four replications. Each treatment used 1.50 x 2.00 meters plot of land. In one plot 12 holes were made with a distance of 0.50 meters each. Each hole is planted with 5 sorghum bowels. After the plants grow, the uniformity is done by uniforming the number of plants in each hole, which leaves two plants that have uniform growth. Fertilization is done after uniformity. Maintenance of plants until they reach physiological maturity then harvest to get data on the main crop. Harvested crop are allowed to grow back until they reach physiological maturity, then are harvested again to obtain data on ratoon.

2.2. Parameters
The parameters measured were plant height, dry matter yield, crude protein content, crude fiber, NDF and ADF. Crude protein was determined according to the method of Association of Official Analytical Chemist [15]. Neutral detergent fiber (NDF), acid detergent fiber (ADF) by the methods by [16].

2.3. Data analysis
The data were analyzed using two-way ANOVA (Analysis of Variance) technique. Post-hoc tests were used to analyze further data. Differences among the treatment means were determined by Duncan’s Multiple Range Test [17].

3. Results and discussion

3.1. Plant height
The effects of vermicompost fertilization and harvest time on plant height presented in Table 1 and table 2. Plant height were significantly (p<0.05) affected by vermicompost fertilization and harvest time. There was no interaction between the fertilization and harvest time. The height of plants with P1, P2 and P3 fertilizer application (p<0.05) was higher than that of P0 (control). The increase in plant height given vermicompost fertilizer caused by the influence of nutrients contained by vermicompost fertilizer such as nitrogen. The results of this study are in accordance with the findings of [18] in Brassia (Brassica rapa var. chinensis), that vermicompost fertilizer application can increase plant height. The height of main crop was significantly (p<0.05) higher than that plant height ratoon. According to [12] that the height plant of the sorghum ratoon is influenced by the type of sorghum.

3.2. Dry matter yield
The effects of vermicompost fertilization and harvest time on dry matter yield presented in table 1 and table 2. Dry matter yield were significantly (p<0.05) affected by vermicompost fertilization and harvest time. There was no interaction between the fertilization and harvest time. The dry matter yield was
significantly influenced by the vermicompost fertilized \((p<0.05)\). Significant differences in the dry matter yield of application vermicompost fertilized have also been reported by [19] in African Marigold plants \((Tagetes erecta)\). The use of vermicompost has a positive effect on dry matter yield [20]. Dry matter yield of main sorghum was significantly higher \((p<0.05)\) compared to ratoon. The results are consistent with reports [12] that the yield of main sorghum dry matter was higher \((22.87 \text{ tons/ha})\) compared to the yield of ratoon dry matter \((8.47 \text{ tons/ha})\).

**Table 1.** The effect of the level of vermicompost fertilizer on growth, production and quality of sorghum.

| Parameters                | P\(_0\)          | P\(_1\)          | P\(_2\)          | P\(_3\)          |
|---------------------------|------------------|------------------|------------------|------------------|
| Plant Height (cm)         | 142.33±0.35\(^d\) | 169.83±37\(^c\)  | 202.59±32\(^b\)  | 220.33±29\(^a\)  |
| Dry matter yield (tons/ha)| 2.83±1.72\(^a\)  | 3.67±1.21\(^b\)  | 4.17±0.98\(^c\)  | 4.67±1.25\(^d\)  |
| Crude protein (%)         | 7.66±0.51\(^a\)  | 7.67±0.52\(^b\)  | 8.66±0.52\(^c\)  | 9.33±0.51\(^d\)  |
| Crude Fiber (%)           | 31.33±1.21\(^a\) | 30.55±1.37\(^b\) | 30.00±0.89\(^c\) | 30.00±0.89\(^d\) |
| NDF (%)                   | 67.67±0.52\(^a\) | 67.00±0.89\(^b\) | 66.17±0.40\(^c\) | 66.00±0.89\(^d\) |
| ADF (%)                   | 43.68±1.03\(^a\) | 43.50±0.84\(^b\) | 43.17±0.75\(^c\) | 42.67±0.52\(^d\) |

\(^{a,b,c}:\) The different superscripts within the column indicate differences \((p<0.05)\).

**Table 2.** The effect of harvest time on growth, dry matter yield and quality of sorghum.

| Parameters                | Main crop | Ratoon |
|---------------------------|-----------|--------|
| Plant height (cm)         | 214.08±29\(^a\) | 153.42±34\(^b\) |
| Dry matter yield (tons/ha)| 4.92±0.67\(^a\)  | 2.75±1.06\(^b\)  |
| Crude protein (%)         | 8.42±0.99\(^a\)  | 8.25±0.75\(^b\)  |
| Crude fiber (%)           | 30.83±1.34\(^a\) | 30.17±0.94\(^b\) |
| NDF (%)                   | 66.75±0.97\(^a\) | 66.67±0.96\(^b\) |
| ADF (%)                   | 43.42±0.90\(^a\) | 43.08±0.79\(^b\) |

\(^{a,b,c}:\) The different superscripts within the column indicate differences \((p<0.05)\).

### 3.3. Crude protein

The effect of vermicompost fertilization and harvest time on the crude protein content of Sorghum presented in table 1 and table 2. The crude protein content was greatly influenced \((p<0.05)\) by vermicompost levels and harvest time, not significant effect. There was no interaction between vermicompost fertilization and harvest time. An increase in crude protein content in the application of vermicompost fertilizers was reported by [21,22]. The nitrogen content of sorghum ratoon is lower \((p>0.05)\) compared to the nitrogen content of the main plant. The results of this study are in accordance with that reported by that the main plant sorghum contains more nitrogen \((2.56\%)\) higher than the nitrogen content of ratoon \((2.40\%)\).

### 3.4. Crude fiber

The effects of vermicompost fertilization and harvest time on crude fiber presented in table 1 and table 2. There was no significant effect of vermicompost fertilizer and main-crop and ratoon on the crude fiber content of sorghum plants. The interaction between fertilization and harvest time (main-crop and ratoon) had no significant effect. Although there was no effect of applying vermicompost fertilizer, there was a tendency for the decrease in crude fiber from P\(_0\) \((31.33\%)\) to \((30.00\%)\) at P\(_3\) level. Likewise in the main crop \((30.83\%)\) fell to \((30.17\%)\) in ratoon.

### 3.5. Neutral detergent fiber (NDF)

The effects of vermicompost fertilization and harvest time on NDF content presented in table 1 and table 2. There was no interaction between the fertilization and harvest time. The NDF content was...
greatly influenced \((p<0.05)\) by vermicompost levels and harvest time not significant effect. The NDF content was significantly \((p<0.05)\) influenced by vermicompost fertilization. The NDF content was significantly decreased \((p<0.05)\) in P2 and P3 treatments. The NDF content was significantly decreased \((p<0.05)\) in P2 and P3 treatments. The decrease in NDF due to fertilization is probably caused by an increase in Brix content which is calculated as cell contents \([23]\).

3.6. Acid detergent fiber (ADF)

The effects of vermicompost fertilization and harvest time on ADF presented in Table 1 and Table 2. There was no significant effect of vermicompost fertilizer and main-crop and ratoon on ADF content of sorghum plants. The interaction between fertilization and harvest time (main-crop and ratoon) had no significant effect. Although there was no effect of applying vermicompost fertilizer, there was a tendency for the decrease in ADF from P0 (43.68\%) to (42.67\%) at P3 level. Likewise in the main crop (43.42\%) fell to (43.08\%) in ratoon.

Table 3. The effect of the level of vermicompost fertilizer on growth, production and quality of sorghum.

| Parameters                | Vermicompost levels |
|---------------------------|---------------------|
|                           | P0                  |
| Plant Height (cm)         | 142.33±0.35d        |
| Dry matter yield (tons/ha)| 2.83±1.72c          |
| Crude protein (%)         | 7.66±0.51c          |
| Crude Fiber (%)           | 31.33±1.21a         |
| NDF (%)                   | 67.67±0.52b         |
| ADF (%)                   | 43.68±1.03a         |
|                           | P1                  |
| Plant Height (cm)         | 169.83±37c          |
| Dry matter yield (tons/ha)| 3.67±1.21b          |
| Crude protein (%)         | 7.67±0.52c          |
| Crude Fiber (%)           | 30.55±1.37a         |
| NDF (%)                   | 67.00±0.89b         |
| ADF (%)                   | 43.50±0.98b         |
|                           | P2                  |
| Plant Height (cm)         | 202.59±32b          |
| Dry matter yield (tons/ha)| 4.17±0.98b          |
| Crude protein (%)         | 8.66±0.52b          |
| Crude Fiber (%)           | 30.00±0.89a         |
| NDF (%)                   | 66.00±0.89a         |
| ADF (%)                   | 43.17±0.75a         |
|                           | P3                  |
| Plant Height (cm)         | 220.33±29a          |
| Dry matter yield (tons/ha)| 4.67±1.25a          |
| Crude protein (%)         | 9.33±0.51a          |
| Crude Fiber (%)           | 30.00±0.89a         |
| NDF (%)                   | 66.00±0.89a         |
| ADF (%)                   | 42.67±0.52a         |

\(a,b,c\): The different superscripts within the column indicate differences \((p<0.05)\).

Table 4. The effect of harvest time on growth, dry matter yield and quality of sorghum.

| Parameters                  | Main crop       | Ratoon       |
|-----------------------------|-----------------|--------------|
| Plant height (cm)           | 214.08±29a      | 153.42±34b   |
| Dry matter yield (tons/ha)  | 4.92±0.67b      | 2.75±1.06b   |
| Crude protein (%)           | 8.42±0.99a      | 8.25±0.75a   |
| Crude fiber (%)             | 30.83±1.34a     | 30.17±0.94a  |
| NDF (%)                     | 66.75±0.97a     | 66.67±0.96a  |
| ADF (%)                     | 43.42±0.90b     | 43.08±0.79a  |

\(a,b,c\): The different superscripts within the column indicate differences \((p<0.05)\).

4. Conclusion

It can be concluded that applying vermicompost fertilizer significantly increased growth, dry matter yield and significantly affected crude protein, while regrowth resulted in lower growth and dry matter yield.

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