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Effect of three types of compost on agromorphological parameters of field-grown sesame

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Abstract

Sesame (*Sesamum indicum* L.) is one of the world's most important oilseed crops. It is highly valued for its food and therapeutic uses. In order to promote the fertilization method(s) that can improve sesame productivity, a trial was conducted in Saaba, in the central region of Burkina Faso. The trial involved a completely randomized block design consisting of three blocks and four treatments for each block. These treatments were T0: control; T1: Plant t treated with cow dung-based compost; T2: Plant treated with straw, ash and manure-based compost; T3: Plant treated with rice husk-based bokashi compost. The number of leaves per plant, plant height, collar diameter, number of branches, number of capsules per plant, dry weight of capsules per plant, dry weight of grains per plant, dry weight of above-ground and below-ground biomass were measured. The results show that some growth parameters and plant yield were significantly influenced by the treatments at the 5% threshold. The grain yields per plant were 10.8g, 7.14g, 6.55g and 3.13g depending on the treatment. The anaerobic straw, manure and ash compost (T2) performed best compared to the rice husk bokashi (T3) and cow dung compost (T1).

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Introduction

Sesame (*Sesamum indicum* L.) is an oilseed crop cultivated in almost all tropical and subtropical countries of Asia and Africa for its highly nutritional value (Iwo *and al*., 2002). Unfortunately, the poverty of most of the soil handicaps its optimal production. Conventional mineral fertilisation should be an effective solution to ensure better productivity of sesame. However, conventional mineral fertilisation has polluting effects (Bockman *et al*., 1990) and is expensive and inaccessible to small-scale producers (Useni *et al*., 2013). This is a real constraint to improving agricultural production, which must necessarily involve improving soil fertility.

Several field and greenhouse studies have shown that local residue-based composts applied to poor, acidic tropical soils can provide the necessary nutrients for plant growth and development to increase crop yields (Kochi *et al*., 2010; Nyembo *et al*., 2014). However, organic fertilisation should be an alternative to restore soil fertility to improve agricultural production especially through diversification of local compost sources.

The aim of this study was to evaluate the effects of three types of compost on the morphological and agronomic parameters of field-grown sesame. The specific objectives were:

i) To estimate plant growth (height, collar diameter, number of leaves) for each treatment;

ii) To estimate the biomass production and the number of branches per plant for each of the treatments;

iii) To estimate the yield, i.e. the number of capsules per plant, the dry weight of grains and capsules per plant for each treatment.

Material and methods

Study site

The study site is located in Saaba, Kadiogo province, in the central region of Burkina Faso. With an area of 446 km², the commune of Saaba is one of the six rural communes of the Central region. It has 23 administrative villages and is bordered to the West by the commune of Ouagadougou, to the South and Southwest by Koubri, to the East by the commune of Nagreongo and to the North by the communes of Loumbila and Ziniaré (Dah, 2013). Saaba is located about 10 km from the town of Ouagadougou and has the following geographical coordinates: latitude: 12.3769, longitude: -1.42083 12° 22' 37'' North, 1° 25' 15'' West, and an altitude of 302m.

Material

Plant material

The plant material used in this study is a sesame variety of Indian origin called Jaalgon 128, introduced in Burkina Faso under the code S42 (Nongana, 1996). S42 is a variety adapted to the climatic conditions of Burkina Faso. This variety is little branched and has a vegetative cycle of 80 to 90 days (Rongead, 2013) with an agronomic potential of 1,000 to 1,500 kg/ha on the experimental station (Miningou *et al.,* (2018).

It has white, often purplish flowers. These dehiscent capsules are composed of 4 chambers containing white seeds. The seeds come from the National Institute for the Environment and Agricultural Research (INERA) in Kamboinsin (Ouagadougou). Its agronomic characteristics are presented in Table 1.

Soil physico-chemical characteristics

Samples soil were analysed by the National Soil Bureau (BUNASOL). The results of this analysis showed that the essay soil has a sandy-silty texture (45.1% of sand). The details of its physico-chemical characteristics are presented in Table 2.

Table 1. Agronomic characteristics of the sesame variety S42.

Origin	India
Cycle (days)	88 - 90
Flowering date (DAS)	36
Potential yield (kg/ha)	1000 - 1500
Average yield of the best producers (kg/ha)	420 - 580 (max 980)
Weight of 1000 seeds (kg)	2,6 - 2,9
Oil content (%)	52 - 58
Colour of the seed	White

Source: Miningou *et al.* (2018)

Table 2. Physico-chemical characteristics of the soil in the study area.

Elements analysed	Content
Clay (%)	13.73
Total silt (%)	41.17
Total sand (%)	45.1
Total OM (%)	1,195
Total carbon (%)	0.693
Total nitrogen (%)	0.056
C/N	12
Total phosphorus (ppm)	91.00
Assimilable phosphorus (ppm)	6.73
Total potassium (ppm)	771.17
Available potassium (ppm)	44.57
PHwater	5.82
Exchange capacity (T) meq/100g	5,54
Saturation rate (S/T)	59

Methods

Experimental design

The trial was set up in a completely randomized block design with three blocks or replications and four treatments (T0, T1, T2, T3) for each block. These treatments are:

T0: Control plot.

T1: Plot treated with cow dung based compost;

T2: Plot treated with straw, ash and manure based compost;

T3: Plot treated with rice husk based bokashi compost;

The trial consisted of four plots per block, 12 plots in total. Treatments were randomly assigned in each block

Cultural operations

Ploughing was carried out on 29 July using a ploughshare under animal traction. Seeds were sown on 30 July with picks and weeding was carried out twice. The first weeding took place at 13 days after sowing (DAS) and the second at 28 DAS;

Each plot was fertilized or treated twice, once on 14 days and once 15 days after the first fertilization. Weeding was carried out after each fertilization by broadcasting. The phytosanitary treatment consisted to: treated the plants with nem extract on 10 September after the appearance of flower buds to minimize the effects of sesame pests;

Supplementary watering was carried out on three times compensate the lack of rainfall at the end of the season (late September to mid-October).

Measurement and parameters recording

The parameters observed in this study are as follows:

- The size or height of the plants was measured with a tape; four plants were randomly selected for the different measurements;
- The number of branches and the number of leaves were determined by counting;
- The diameter at the collar of the stems was measured with a digital caliper;
- The dry biomass (above and below ground) was determined after carefully digging up four plants in the four plots of each block and separating each part and drying first in the sun and then in the laboratory in an oven at 85°C for 24 hours;
- The number of capsules per plant was determined by progressive harvesting of the capsules;
- the dry weight of the capsules and the dry weight of the seeds per plant by weighing with a DENVER electronic balance;

The number of leaves, the collar diameter and the plant height were measured every 15 days at 26, 41 and 56 days after the sesame sowing.

Data analysis

Data were tested for normality and homogeneity of variance before being submitted an analysis of variance (ANOVA) using GENSTAT. The LSD tests (smallest significant difference at the 5% level) were used to compare the different treatments.

Result and discussion

Result

Growth parameters

Number of branches

Fig. 1 shows that cow dung-based compost had the best effect on the number of branches per plant. It is followed by rice husk-based bokashi compost, manure, ash and straw-based compost. The analysis of variance indicates that the addition of the three types of compost had no significant effect on the number of branches ($p > 0.05$).

Plant heights

Table 3 shows that the application of the different compost types had highly significant effects ($p < 0.001$) on plant height in the first phase (26 days).

In the second phase (41 days), there were significant differences (p =0,029) in plant height between the three compost types. In the 56 days of the third phase, there was a highly significant difference (p<0.001) in plant size.

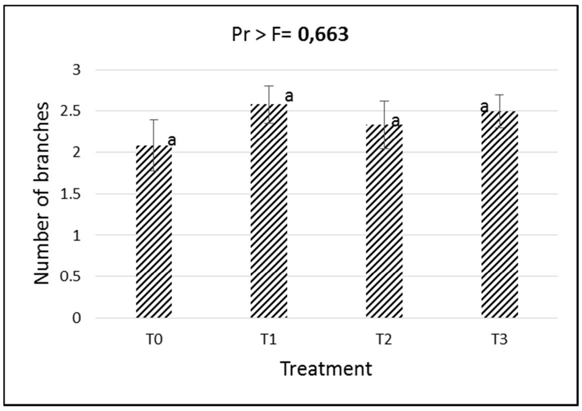

Fig. 1. Effect of three types of compost on the number of branches of S42 sesame grown in the field. T0: Control; T1: Cow dung-based compost; T2: Manure, ash and straw-based compost; T3: Rice husk-based bokashi compost

Collar diameter

On 26 days, the three compost types had no significant differences (p = 0,143) on collar diameter compared to the control plots. For 41 and 56 JAS these inputs had very highly significant effects (p = 0,001; p = 0,002) on collar diameters. There was no significant difference on this parameter between treatments T1, T2 and T3. The T2 treatment recorded the largest diameter for both times while the control plot recorded the smallest. All these results are shown in Table 4.

Number of leaves

Table 5 shows that the addition of all three types of compost had no significant effect (p = 0.37) on the number of leaves in the first phase (26 days); whereas it had highly significant effects (p=0,127 and p= 0.001) on the number of leaves in the second and third phase (41 and 56 days).

The difference between these three inputs was not significant. During the 56 days, the T2 treatment recorded the highest number of leaves and the control the lowest. The number of leaves increased only at 56 days after the application.

Table 3. Influence of the three types of compost on plant height of S42 sesame grown in the field.

DAS / Treatment	26	41	56
T0	6,25±0,54a	16±2,96a	65±4,71a
T1	7,58±0,51b	20±0,74ab	77±0,82b
T2	8,42±1,30b	21±1,24b	81±2,21b
T3	8±0,74b	22±0,82b	79±0,89b
Probability	<0,001	0,029	<0,001

DAS=days after sowing; T0: Control; T1: Cow dung-based compost;T2: Manure, ash and straw-based compost;T3: Rice husk-based bokashi compost

Table 4. Influence of the three types of compost on the collar diameters (cm) of S42 sesame grown in the field.

DAS / Treatment	26	41	56
T0	2,09±0,14a	3,76±0,55a	6,11±0,38a
T1	2,20±0,21a	5,47±0,98b	7,83±0,05b
T2	2,66±0,38 a	5,81±0,73b	8,00±0,47b
T3	2,38±0,07a	5.60±0.62b	8,11±0,44b
Probability	0,143	0,001	0,002

DAS=days after sowing; T0: Control; T1: Cow dung-based compost; T2: Manure, ash and straw-based compost; T3: Rice husk-based bokashi compost

Table 5. Influence of the three types of compost on leaf numbers of S42 sesame grown in the field.

DAS / Treatment	26	41	56
T0	5,23±0,35a	11,00± 1,00a	55,16±4,48a
T1	6,55±0.44a	12,66±0,94a	79,33±5,84b
T2	6,78±0.58a	14,00±0,00a	85,83±11,90b
T3	6,72±0.51a	12,75±0,20a	84,50±5,66b
Probability	0,370	0,127	0,001

DAS=days after sowing; T0: Control; T1: Cow dung-based compost; T2: Manure, ash and straw-based compost; T3: Rice husk-based bokashi compost.

Dry weight of biomass

Dry weight of below-ground biomass

The average root weight of sesame root was 0,37±0,06 g, 0,34±0,11 g, 0,30±0,11 g and 0,29±0,09 g respectively for treatments T1 T2 T0 and T3 (Fig.2). The use of the three treatment increase significantly the dry weight of below-ground biomass of sesame compared to the control. However, there are no significant differences between each treatment.

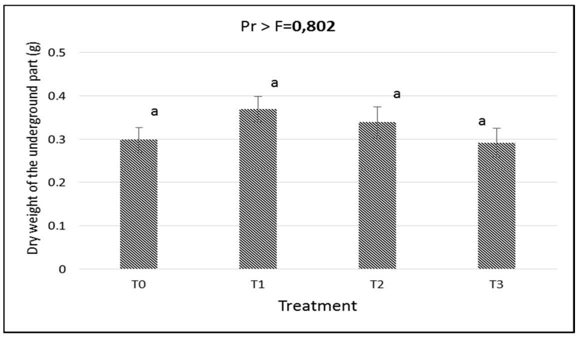

Fig. 2. Effect of three types of compost on the below-ground biomass of S42 sesame grown in the field.
To: Control; T1: Cow dung compost; T2: Manure, straw and ash compost; T3: Rice husk bokashi compost.

Dry weight of above-ground biomass

The fig. 3 shows the dry weight of the biomass according to the treatments. Treatment T1 recorded the highest weight (2,11±0,50 g), followed by T2 (2,00 ±0,66g) and T3 (1,68±0,64 g). The lowest weights were obtained with the control plot To (1,61±0,54 g). The ANOVA shows that the addition of all three types of compost had no significant effects (p = 0,412) on above-ground biomass weight;

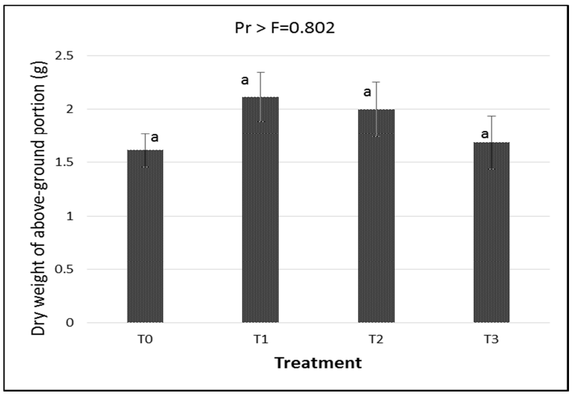

Fig. 3. Effect of three types of compost on above-ground biomass of S42 sesame grown in the field.
To: Control; T1: Cow dung-based compost; T2: Manure, straw and ash-based compost; T3: Rice husk-based bokashi compost.

Yield parameters

Number of capsules per plant

Fig. 4 shows the average number of capsules per plant for the treatment factor. The highest numbers of capsules per plant were obtained in the plots treated with treatment T2 (70±5c). The lowest average number of capsules was recorded with the control plot (22±2c). The number of capsules was also high in the plots treated with treatment T3 (45±5,49c) and treatment T1 (46±6,52c). The analysis of variance indicates that all three compost types had highly significant effects (p < 0,001) on capsules numbers.

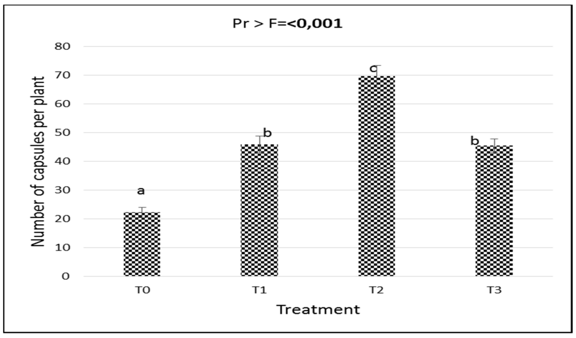

Fig. 4. Effect of three types of compost on the number of capsules per plant of S42 sesame grown in the field.
To: Control; T1: Cow dung-based compost; T2: Manure, straw and ash-based compost; T3: Rice husk-based bokashi compost.

Dry weight of capsules per plant

Fig. 5 shows the average dry weight of the capsules per plant according to the different treatments. This fig. shows that the capsules obtained through the treatment of the plots with anaerobic compost have the highest weight (28.08g). The control plot recorded the lowest average weight (7.85g). The plots treated with bokashi and cow dung compost recorded high weights (bokashi: 18.25g and cow dung: 16.55g). The analysis of variance indicates that all three types of composts had highly significant effects (p < 0.001) on boll weight per plant.

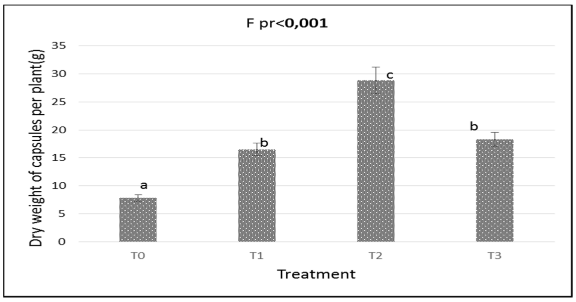

Fig. 5. Effect of the three types of compost on the dry weight of capsules per plant of S42 sesame grown in the field.
To: Control; T1: Cow dung-based compost; T2: Manure, straw and ash-based compost; T3: Rice husk-based bokashi compost.

Dry weight of grain per plant

Fig. 6 shows the overall results for grain dry weight. Fig. 6 shows the average grain weight per plant generated by the bokashi, cow dung compost, and anaerobic compost treatments. The best effects were recorded with treatment T2 (10.85g) followed by treatment T1 (7.13g) and treatment T3 (6.55g). The lowest weight was recorded by the T0 control (3.13g). The analysis of variance shows that all three compost types had highly significant effects (p=0,004) on grain weight.

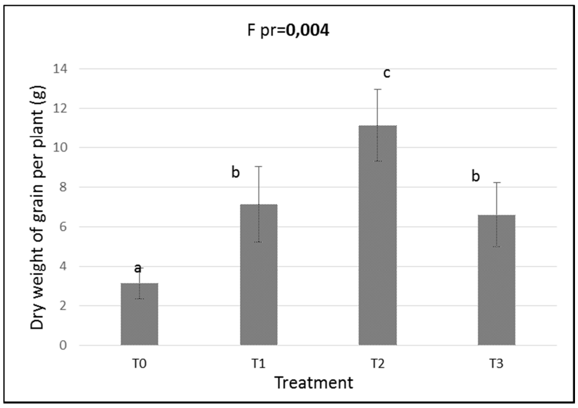

Fig. 6. Effect of three types of compost on grain weight per plant of S42 sesame grown in the field.
T0: Control; T1: Cow dung-based compost; T2: Manure, straw and ash-based compost; T3: Rice husk-based bokashi compost.

Discussion

The results obtained during this study indicate that the three treatments (T1: cow dung-based compost; T2: straw, ash and manure-based compost; T3: rice husk-based bokashi compost) had a significant influence on the growth of sesame, namely height, diameter at the collar and number of leaves. These treatments had an significant effect on yield, particularly on the number of capsules per plant, the weight of capsules per plant and the dry weight of grains per plant compared to the unfertilized control plots. These effects can be attributed to the nature of the compost and certain physical and physicochemical characteristics that make up the compost.

Indeed, organic manures do not have the same nutrient values in terms of fertilizing elements (Siboukeur, 2013). These results can also be explained by the mineralized nitrogen content of the composts and their availability as well as the assimilation capacity of Sesame plants; this could be the result of an improvement in the chemical properties of the soil through better retention of nutrients for plant feeding.

Anaerobic compost gave the best effects in terms of number of leaves and height compared to other types of composts because of its high content or richness of necessary nitrogen or plant available phosphorus. For most composts 0-50% of the nitrogen is available in the first year (Jobin and Petit, 2004). In fact, a sufficient amount of nitrogen and phosphorus ensures growth and an increase in the number of leaves per plant. These results are in agreement with those of Okpara *et al.*, (2007) who demonstrated through their work that phosphorus or nitrogen ensures the increase in the number of leaves and branches per plant and the growth of sesame plants. The difference between the treatments regarding the number of leaves only appears at 56 days before harvest. This result is explained by the fact that the number of leaves is dependent on the number of nodes. The number of branches per plant depends on the variety. According to RONGEAD (2013), S42 is a low-branching variety, which justifies the fact that the results obtained on this parameter were not significantly different from one treatment to another.

The sesame plants that recorded significant height in this study were the plants that also recorded the highest number of capsules. Our results corroborate those of Djigma (1983) who showed that sesame yield is positively correlated with the height of the main stem (number of reproductive nodes).

The various organic fertilizers influenced sesame biomass yields differently. Of the three composts, anaerobic compost had the best effect on biomass production. The high nitrogen content of the anaerobic compost confirms the results obtained previously. This corroborates the observations made by Amadji *et al.,* (2009) after using compost enriched with poultry droppings for cabbage production on sandy soil. Indeed, nitrogen is an important element for plant growth and yield determination (Sikora and Szmidt, 2001; Douglas *et al.*, 2003).

The difference between these three composts can be explained by the source of fertilization and the fertilization capacity if we refer to the work of Boufares (2012). This study shows that plots with high root and above-ground biomass are those with the highest yields. This suggests a positive correlation between yield and biomass: above-ground and root biomass improve yield. These results corroborate those of Banziger *et al.*, 2000. In addition, an increase in root mass leads to high yields under water stress (Yandav *et al.*, 1997). Okpara *et al.* (2007) demonstrated that a combination of nitrogen and phosphorus improves sesame yield. According to Turcot (1999) the increase in soil structural stability (better aeration, better water retention, etc.) may play a significant role in the higher yields observed in maize plants treated with green waste compost. During the crop cycle, a rainfall break of 18 days was observed in September. This drought coincided with the casualization phase. During this period, sesame needs a significant amount of water, which had a negative impact on plant productivity. This explains the low yields observed in the untreated control plants.

Conclusion

This study showed that anaerobic compost made from straw, manure and ash had the best effects on plant growth, biomass and yield compared to the other two types of compost, namely rice husk-based bokashi and cow dung-based compost. The results showed that the use of this type of compost significantly improves the number of bolls and the weight of the grains, and consequently the productivity or yield of sesame.

Recommendation(S)

We can recommend that farmers use anaerobic compost made from straw, manure and ash for sustainable improvement of soil fertility and good sesame yield.

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