Growth and Productivity of *Sorghum Bicolor* (L.) Moench in Merapi Eruption Soil with Organic Fertilizer Addition

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ABSTRACT: The aimed of this study was to determine the growth and the productivity of sorghum planted in Merapi eruption soil which was affected by addition with various levels of organic fertilizer. The treatments given was an organic fertilizer 5 and 10 ton/ha. Analysis was conducted on the production, chemical composition, and *In vitro* digestibility. Data was analyzed using anova analysis on Completely Randomized Design (CRD) and the difference between means was continued with Least Significant Difference (LSD) test. The result showed that plant height, dry matter production, *In vitro* digestibility dry matter affected ($P<0.05$) by addiction of organic fertilizer in Merapi eruption soil. Plant height increase for 87.55 cm to 118.12 - 126.00 cm, dry matter production for 2.82 ton/ha to 5.20 - 5.68 ton/ha, and *In vitro* digestibility dry matter for 65.39% to 66.37 - 69.20%. Based on the result of study, addition an organic fertilizers 5 and 10 ton/ha on Merapi eruption soil increased the growth and the productivity of sorghum.

Keywords: Merapi Eruption Soil, Organic Fertilizer, *Sorghum Bicolor* (L.) Moench, Proximate Analyzed, *In vitro* Digestibilty

INTRODUCTION

Continuous availability and quality of forage will become major variable to support the success in increasing the productivity of ruminants. However, the availability of land which can be used to grow forage increasingly limited. Therefore, necessary to develop marginal land such as sandy soil to improve the availability of feed ingredients, especially forage (Suwignyo *et al*., 2010). Merapi eruption land is wide-spreading, potential as a pasture land for ruminants. However, the soil of former Merapi eruption containing volcanic ash, sand and rocks that have physical properties that are less good, especially the carrying capacity of the soil moisture availability to plants. Volcanic ash soil were given additional organic fertilizer or animal manure condition will get better (Yunaidi, 1997). Buckman and Brandy (1982) stated that organic fertilizers boosted soil water holding capacity and enhance the amount of water available for plant life. Suwignyo *et al*. (2010), stated that farmers in the sandy soil add some organic fertilizer to increase the quality of the soil before planting. One of the plants that can be utilized in the land of the former Merapi eruption is sorghum. Wahida *et al*. (2013) stated that sorghum has a feature that is easily cultivated to yield high enough, little need of water, the risk of failure is small, adaptability spacious well planted in monoculture or multiple cropping, can experience re-growth, and hold drought with low productivity.

MATERIAL AND METHODS

Materials and tools

The materials were used in the study is the soil of former Merapi eruption, topsoil from the area Jambusari, Kepuharjo, Sleman, Yogyakarta. Land regosol of farm forage fodder Faculty of Animal Science (Karangmalang), organic fertilizer (compost manure) comes from control study Lusuba (2013), grain sorghum varieties Numbu, SP36 (36% P_2O_5), and urea (46% N), chemicals for proximate analysis and measurement of digestibility *In vitro* method Tilley and Terry 2 stages, as well as rumen fluid from cows PO fistula.

The tools were used is equipment for polybag, oven 55 °C and 105 °C, ruler size 30 cm, digital scales brand Idealife capacity of 5 kg sensitivity 1 g, equipment for proximate analysis and measurement of digestibility *In vitro* method Tilley and Terry, autoclave, brand Sartorius analytical balance 0.0001 g sensitivity. Wiley mill with a diameter of 1 mm sieve to grind samples.

Preparation of planting medium

There were 4 kinds of soil from the planting medium are Karangmalang as external control, soil eruption of Merapi without addition of organic fertilizer as an internal control, Merapi eruption soil with the addition of organic fertilizers 5 ton / ha and 10 ton / ha. Soil included approximately ¾ polybag capacity (size 0.08 x 30 / 15x 30 cm) and replication 6 polybags as a growing medium without sifting process. SP36 with a dose of 150 kg / ha (2.25 g / polybag) given as basal fertilizer with organic fertilizer, blended at the top (topsoil), then allowed to stand for 7 days.

Planting and fertilizing

Seeds planted by making a hole in the middle polybag depth of approximately 5 cm, 1 grain sorghum each hole and then covered with soil. Urea 100 kg / ha (3 g) given at the time the plant ages 4 and 7 weeks. Watering is done every other day in the morning about 500 mL. Tilling the soil is done every week along with observations of plant height and number of leaves. To prevent stinky pests by spraying insecticide Dacron® (0.5 ml / liter of water).

Harvesting and preparation of samples

Plants were harvested at milk stage. Plants were cut 10 cm from the soil surface. Plants in each polybag counted and weighed and then put in the paper bag that had been dried oven 55ºC and already weighed. Paper bag containing dried plant samples in an oven temperature of 55ºC approximately 2 days. The dried samples were weighed, then ground using a Wiley mill with a 1 mm sieve screen, later in the proximate analysis (AOAC, 2005).

Variables observed

The variables measured were growth (germination, leaf number, plant height and flowering time); productivity (dry matter production; production of organic matter; the chemical composition; digestibility of dry matter and organic matter digestibility *In vitro*) sorghum. *In vitro* digestibility test carried out according to the method of Tilley and Terry (1963) 2 stages with modifications according Utomo (2010) the reduction of the substrate (sample) and rumen fluid, artificial saliva (fluid McDougall) to half (50%), namely 0.25 grams of sample material feed, using 25 mL of rumen fluid mixture with artificial saliva (1: 4), 3 ml of HCl 20% (v / v), and 1 mL of pepsin 5% (w / v), incubated using a 50 ml test tube volume.

Data analysis

Data were analyzed by a completely randomized design using SPSS 16.0 unidirectional pattern continued test of Least Significant Different (LSD) (Gomez and Gomez, 1984)

RESULTS AND DISCUSSION

Fertilizers and Soil Quality

The quality of organic fertilizer and soil were used in this study can be seen in Table 1.

Table 1. Quality of organic fertilizers and soil were used in this research

Kind	C (%)	BO (%)	N (%)	P (%)	K (%)	C / N
Organic fertilizer**)	38.17	65.81	1.35	0.44	1.48	34.01
Karangmalang soil *)	3.45	5.95	0.26	18.75	1.26	13.27
Merapi eruption soil *)	0.31	0.54	0.03	3.24	0.03	10. 33

*) Analysis of the samples in the Laboratory of Soil Science, Faculty of Agriculture
**) (Lusuba, 2013)

Plant Growth

Data growth of sorghum as germination, plant height, leaf number and flowering time are presented in Table 2.

Table 2. Data observation, growth of sorghum

Variabel	Treatment			
	External control	0 tonnes / ha	5 tonnes / ha	10 tonnes / ha
Germination (days)	1.17±0.41^{p}	2.33±0.52^{q}	1.67±0.52^{p}	1.17±0.41^{p}
Plant height (cm)	155.98±21.14^{r}	87.55±20.48^{p}	118.12±19.60^{q}	126.00±22.99^{q}
Number of leaves (pieces)	9.83±1.94	7.67±1.75	8.50±2.17	9.50±1.38
Flowering time (days)	71.50±4.18^{p}	90.33±4.08^{r}	82.50±7.94^{q}	78.00±7.69^{pq}

Germination plant height (cm), number of leaves (pieces), and the flowering time (days)
pqr different superscripts in the same column indicate significant differences (P <0.05)

Germination. Addition of organic fertilizers 10 tons / ha was able to compensate for the speed of germination of external controls (1.17 days). Factors affecting the speed of germination according to Rao (2010) that is the decomposition of organic matter due to the addition of organic fertilizers.

Plant height. The height of plants was produced in this study was lower than the literature of Cereal Crops Research Institute (2013), which was higher sorghum varieties Numbu ± 187 cm. The growth of plants according to Samanhoedi (2010), influenced by the soil moisture content. That's because high accretion process plant begins with the formation of buds is a process of cell division and enlargement. Both of these processes are affected by cell turgor. The process of cell division and enlargement will happen when the cells undergo turgiditas whose main element is the availability of water.

Crop Production

The average production of sorghum plants grown in soil eruption of Merapi with the addition of organic fertilizers can be seen in Table 3.

Table 3. Production of dry and organic matter (tonnes / ha) sorghum (% DM)

Production (ton / ha)	Treatment			
	External control	0 tonnes / ha	5 ton / ha	10 tonnes / ha
Dry matter	3.39 ± 0.26 ^{q}	1.24 ± 0.92 ^{p}	1.31 ± 0.46 ^{p}	1.44 ± 0.55 ^{p}
Organic matter	3.09 ± 0.24 ^{q}	1.14 ± 0.85 ^{p}	1.21 ± 0.43 ^{p}	1.31 ± 0.50 ^{p}

pq: different superscripts in the same row indicate significant differences (P <0.05)

Dry matter production. Production of sorghum dry matter in this study was lower than the result Wijayanti (2009) 3.19 tonnes / ha. Dry matter production of the plant can be increased by fertilizing the plant gets bigger as additional nutrients essential for growth, development, and production.

Production of organic materials. Production of organic material in this study is lower when compared with the research Wijayanti (2009) which is 2,76 t / ha. The big difference in the production of organic materials was affected by the ash content of plants. The ash content of plants varies depending on the plant species and the intensity of the light that hits.

Chemical composition

The average yield analysis of the chemical composition can be seen in Table 4 below:

Table 4. The chemical composition of sorghum plant (% in DM)

Variables measured	Treatment			
	Control	0 tonnes / ha	5 ton / ha	10 tonnes / ha
Dry matter (%)	24.50 ± 1.08 ^{p}	38.90 ± 0.68 ^{q}	22.24 ± 0.31 ^{p}	22.43 ± 2.54 ^{p}
Organic matter (%) ^{ns}	91.15 ± 0.22	91.86 ± 1.74	92.59 ± 0.27	91.21 ± 0.74

Crude protein (%)	10.09 ± 0.22 p	15.59 ± 2.19 q	12.28 ± 0.14 p	11.27 ± 0.66 p
Crude fiber (%)	22.35 ± 0.67 p	24.09 ± 0.53 p	31.98 ± 2.06 q	33.05 ± 2.08 q
Ether extract (%) ns	2.43 ± 0.11	2.75 ± 0.46	2.30 ± 0.02	2.36 ± 0.43
EMWN (%)	55.52 ± 1.15 q	49.43 ± 4.93 pq	46.02 ± 2.16 p	44.53 ± 3.91 p
Calculate TDN (%) ns	70.85 ± 0.93 q	69.26 ± 2.05 q	58.87 ± 2.35 p	56.15 ± 2.20 p

ns indicates non-significant
pq different superscripts in the same row indicate significant differences (P <0.05)

Dry matter content. The percentage of dry matter content of sorghum plants grown seedless according Praptiwi *et al*. (2013) 30.42%. Susetyo *et al*. (1969), states that if the water content of the plant increases, there will be a decrease in dry matter content.

Crude protein levels. The percentage of crude protein of sorghum crops planted on the ground clay geluhan and urea (100 kg / ha) by Koten (2013), namely (4.45%). When compared with the percentage of the study, the percentage of research is above such literature. This can be caused by differences in soil and fertilizing.

Crude fiber content. The percentage of crude fiber sorghum crops planted on the ground clay geluhan and urea (100 kg / ha) by Koten (2013), ie 33.14%. Thus treatment with the addition of organic fertilizers 5 and 10 ton / ha in the range of literature.

Extract materials without nitrogen. Value of EMWN according Hartadi *et al*. (2005), the sorghum plants grown without seeds (41.1%) and seeds (69.2%) the levels EMWN research results are among the percentage of literature. According to Tillman *et al*. (1998), the levels of plant EMWN is determined by the magnitude of the levels of the other factions are not different then EMWN levels are no different, and vice versa.

In vitro Digestibility

In vitro digestibility of dry matter and organic matter sorghum can be seen in Table 6.

Table 6. *In vitro* digestibility of dry matter and organic matter of sorghum plant

Digestibility	Treatment			
	External control	0 tonnes/ha	5 ton/ha	10 tonnes/ha
Dry matter (%)	71.03q±0.48	65.39p±1.53	66.37p±1.75	69.20q±1.04
Organic matter (%)	71.07q±1.25	64.64p±0.85	66.23p±2.04	69.70q±1.67

pq different superscripts in the same row indicate significant differences (P <0.05)
In vitro digestibility values pangola grass dry matter (52.44%) and organic matter (52.31%)

Dry matter digestibility

Praptiwi *et al*. (2013) stated, dry matter digestibility of sorghum plants grown without seeds, namely 40.96%. If literature is compared to the results of the study are above, this is because the research is part of the plant as a whole not just the leaves.

Organic matter digestibility

Praptiwi *et al*. (2013) stated, organic matter digestibility sorghum crops grown seedless ie 40.60%. If literature is compared to the results of the study were above the literature, this is because the research is part of the plant as a whole not just the leaves. Although sorghum is more drought resistant, but for production with optimum results need adequate water, especially in the phase of bunting to seed filling (Sungkono *et al*., 2009).

CONCLUSION

The addition of 5 and 10 ton / ha organic fertilizer for sorghum plant planted in the soil of the Merapi eruption could increase the growth and production of sorghum, although not the same as the land of Karangmalang.

SUGGESTION

The addition of organic fertilizers 10 tons / ha in the soil Merapi eruption could increase the growth and productivity of sorghum. Furthermore, variety of forage and crops, variations in the type of organic fertilizer, further analysis of neutral detergent fiber (NDF) and acid detergent fiber

(ADF).

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