Response of sorghum variety growth in the first ratoon with liquid organic fertilizer application

Eka Nurmala Sari[1], *Puji* Harsono[2,*], and *Supriyono*[2]

[1] Department of Agronomy, Graduate School, Universitas Sebelas Maret (UNS), Jl. Ir. Sutami 36A, Kentingan, Surakarta, 57126, Central Java, Indonesia
[2] Department of Agrotechnology, Faculty of Agriculture, Universitas Sebelas Maret (UNS), Jl. Ir. Sutami 36A, Kentingan, Surakarta, 57126, Central Java, Indonesia

Abstract. The advantages of ratoon system are short harvesting time, minimum irrigation needed, and lower farming cost compared with the first plant of seed. Liquid organic fertilizer (LOF) application is selected to increase nutrition absorption and as an attempt of supporting sustainable agriculture program. The objective of research is to study the effect of first-ratoon sorghum variety and LOF dose on sorghum growth. This research used completely randomized block design factorial. The first factor is sorghum variety consisting of Numbu, Kawali, and Suri 3. The second treatment of LOF dose consisted of 0 $L.ha^{-1}$, 3 $L.ha^{-1}$, 6 $L.ha^{-1}$, and 9 $L.ha^{-1}$. Data analysis was conducted variance analysis of 5% followed with least significant different test 5% and polynomial regression test. The result of research shows that Numbu with the optimum dose of LOF 3,8 $L.ha^{-1}$ produced the highest leaf area and LAI of 2570 cm^2 and 2,56 compared to other varieties. Suri 3 and Numbu yield higher fresh stove weight than Kawali. This means that Numbu and Suri 3 can be used as a source of animal feed.

1 Introduction

Food diversification is an attempt of anticipating the food crisis. Sorghum (*Sorghum bicolor* L.) belongs to cereal crops needing development and cultivation as food material, animal feed and alternative energy. This plant can grow on marginal land in Indonesia [1], meaning that it can grow in dry or puddle condition and can adapt well to different types of soil and even in high soil humidity and saline soil [2]. Sorghum uses water very efficiently and it needs water only about 2,5-36 mm/day and can yield 5-6 ton/ha [3]. Sorghum forage is more promising than other plants as the production of dry sorghum material is better, drought tolerant, and pest- and disease-resistant [4].

Generally, the harvested sorghum will be left. Meanwhile, sorghum is able to grow again into ratoon. Ratoon is the shoot resulting from the cutting of stem following the harvesting of first plant to be grown again [5]. Sorghum is suitable as ratoon because it has a root system that has developed so that it has a stronger, wider and deeper character to get water and nutrients, so it can support plant growth and development up to the third ratoon [6]. The

* Corresponding author: pharsono61@gmail.com

advantages of ratoon system are shorter harvesting time, more efficient water use, and lower farming cost [7].

Ratoon's production ability is about 48,9-65,7% of the first plant production [8]. The solution to maintain ratoon production yield is to administer adequate nutrition. The liquid organic fertilizer (LOF) application can give good nutrition to the plant as it contains complete nutrition that can be absorbed easily by the plant. The advantages of LOF - supplying nutrition according to the plant's need, absorbable nutrition, and easier and more even application [9] – are also factors supporting the sustainable agriculture.

This research aims to study the effect of sorghum variety in the first ratoon with LOF dose on sorghum growth. The result of experiment is expected to identify the sorghum variety in the first ratoon with optimum LOF dose to be cultivated as alternative source of forage. This information can be used as the reference to improve sorghum production for fulfilling the need for forage.

2 Material and method

2.1 Research Design

This research was conducted in February-December 2021 in Cabeyan Village, Bendosari Sub District, Sukoharjo Regency, Central Java. This village is located at 116 m altitude with grumusol soil type. Such soil type contains 0,06-4,5% organic material, low nutrition and pH 7,5-8,5 [10]. The climate condition in research location was entering rainy season during the research period with average rainfall of 336,75 mm, weather temperature 27℃-35 ℃ and average annual weather humidity of 77% [11].

This research used a completely randomized block design factorial. The first factor was sorghum varieties including V1=Numbu, V2=Kawali, and V3=Suri 3, while the second factor is LOF dose consisting of 4 (four) levels: P0=0 $L.ha^{-1}$, P1=3 $L.ha^{-1}$, P2=6 $L.ha^{-1}$, and P3=9 $L.ha^{-1}$. The sample was selected randomly using random sampling technique, with 3 plant samples respectively from 36 experiment compartments, so that there were totally 108 plant samples. Growth parameters observed are plant height, leaf width, leaf area index, and fresh stove weight per plant.

2.2 Sorghum Ratoon

Ratoon is made after the first sorghum planted from the seed has been harvested through cutting the first internode of sorghum stem about 10 cm from the soil surface. The shoot selected is the one growing from the base stem, consisting of 2 shoots.

2.3 Liquid Organic Fertilizer (LOF)

The nutrient content of LOF used includes, among others: 4,15% (10,38 mL) N, 4,45% (11,13 mL) P_2O_5, 5,66 % (14,15 mL) K_2O, 9,69 % (24,9 mL) organic C, 505,5 ppm (0,5 mL/L) Fe, 1931,1 ppm (1,93 mL/L) Mn, 1179,8 ppm (1,18 mL/L) Cu, 1986,1 ppm (1,98 mL/L) Zn, and pH 5,61. In addition, LOF also contains humic acid, fulvic acid, and growth regulator (gibberellin, cytokine, and auxin) [12]. LOF application is conducted by spraying it using knapsack electric sprayer. LOF dose is 20-60 ml with water solvent of 10-30 L for 100 m^2 area. This dose becomes a reference in determining the dose of LOF treatment.

2.4 Data Analysis

The data of research was analyzed using variance analysis (ANOVA) of 5%. If there is a significant difference, it is followed with least significant different test (LSD) of 5% and

polynomial regression test. Data analysis was conducted using SPSS version 26 and Microsoft Excel 2016 software.

3 Result and discussion

3.1 Plant height (cm)

Plant height is the important character contributing to growth and yield [13]. Plant height is also used to measure the effect of environment or treatment applied.

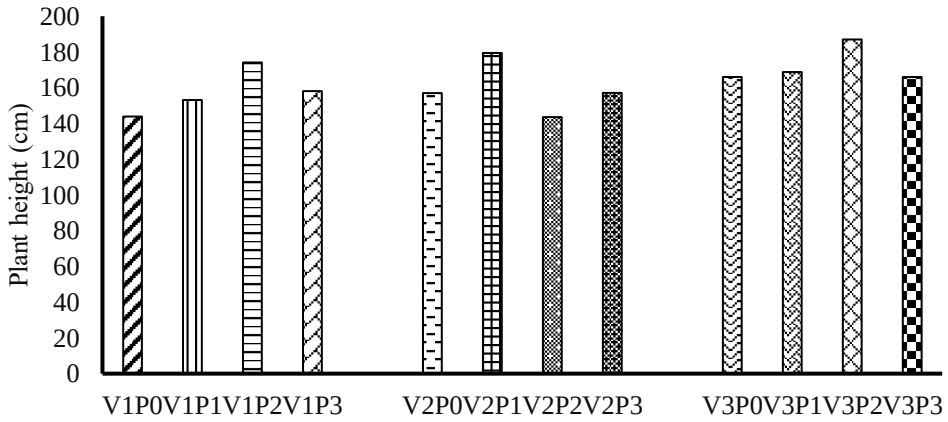

Fig. 1. Plant height of several sorghum varieties in the first ratoon at day-63 after cutting with LOF dose treatment

Considering the result of variance analysis, it can be seen that the treatment of sorghum variety in the first ratoon at day-63 after cutting with LOF does not affect plant height (Figure 1). It is because the effect of climate condition entering rainy season during the research period, in which the high rainfall results in nutrient washing in the leaf before it is absorbed by the plant. Considering the data of observation on the rainfall [11] in the research location, the average monthly rainfall in January-April is about 336.75 mm and belongs to high category. It is in line with previous study [14] finding that the high rainfall can make fertilizer washed easily before it is absorbed completely, and thus it does not affect the plant growth. Varying morphologies of leaf, can affect nutrient absorbability, in which the leaf with glossy and hairy leaf and having sharp corner will be wet difficultly and take longer time to absorb nutrient.

3.2 Leaf width (cm^2)

Leaf width is an indicator in the analysis of plant growth and is a parameter to observe photosynthesis rate. Leaf has an ability of producing photosynthate; thus, the wider the leaf, the higher is the growth rate of plant [15].

Considering the result of polynomial regression test (Figure 2), the optimum dose can be obtained in Numbu, 3.8 $L.ha^{-1}$, providing the widest leaf. Coefficient of correlation (r) = 0,77 means that there is a close relationship between sorghum variety in the first ratoon and LOF dose. The results of research [16] state that leaf formation in plants is influenced by the availability of nutrients, both nitrogen, phosphorus and potassium elements. These nutrients play a role in the formation of cell and as a constituent of organic compounds. The increasing leaf areas show the higher the ability of the leaves to receive and absorb sunlight so that the

results of photosynthesis are also high. The LOF used contains complete nutrition such as macronutrient, micronutrient, growth regulator, and other nutrients like humic acid and fulvic acid. The characteristics of sorghum with high forage source are having thin or flat leaf morphology and wider size of leaf [17]. Numbu is a variety of sorghum with higher forage source, compared with other varieties, and thereby can be used as alternative source of forage.

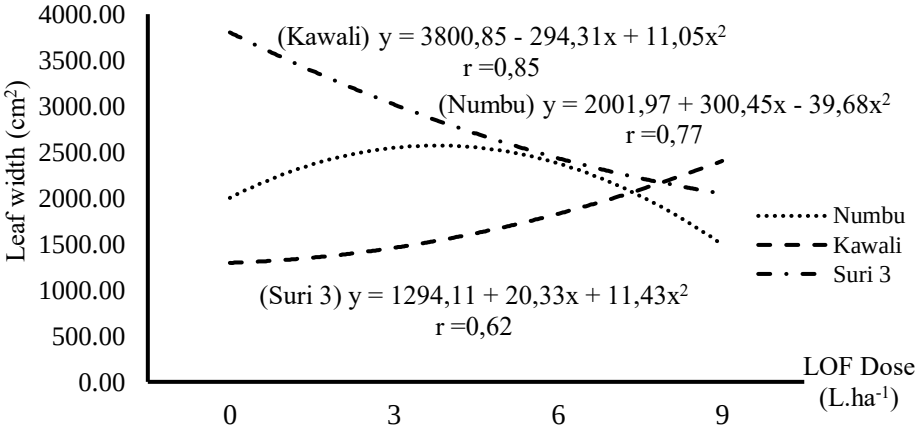

Fig. 2. The effect of LOF dose on leaf width in several sorghum varieties in the first ratoon at day-63 after cutting

3.3 Leaf Area Index (LAI)

Leaf observation needs to be done as a measure in growth analysis and to yield supporting data to explain the growth process occurring in the plant. Leaf as a photosynthesis organ is closely related to LAI. LAI is used as an indicator of canopy density and an estimator of plant productivity [18].

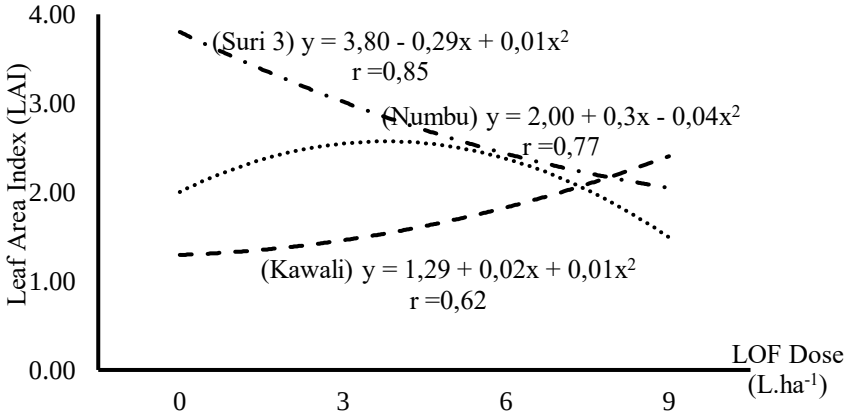

Fig. 3. The effect of LOF dose on LAI in several sorghum varieties in the first ratoon at day-63 after cutting.

Considering the result of polynomial regression test (Figure 3), the optimum dose is obtained in Numbu, 3.8 L.ha^{-1}, providing the highest LAI. The Coefficient of Correlation (r) = 0.77 can be interpreted that there is a close relationship between sorghum variety in the first ratoon and LOF dose. LOF contains complete nutrition needed for the plant growth. LOF application, according to [16], can spur vegetative growth, particularly in the leaf width of

sorghum plant, in which the leaf width affects LAI value significantly. The complete nutrient content of LOF, including nitrogen, can improve chlorophyll content and photosynthesis rate. LAI is an indicator to find out the sunlight interception correlating to photosynthesis and yielding photosynthate. The higher photosynthate production will contribute to the development of plant organs like leaf number and leaf width and then will result in larger biomass production. In this research, Numbu variety has the highest LAI and high biomass yield.

3.4 Fresh Stove Weight per plant (g)

The fresh stove weight or total biomass of plant is a parameter often used to study the plant growth. The fresh stove weight is an indicator of water and nutrition absorption rate by the plant for metabolism process [18] and an indicator of the development and the increase of network tissues like plant height and leaf width [19]. It is also supported by [13] stating that the fresh stove weight represents the net return of harvest yield. If the fresh stove weight increases, the plant production yield will increase as well.

Table 1. Result of Least Significant Different test 5% in several sorghum varieties in the first ratoon on fresh stove weight per plant

Sorghum variety	Fresh Stove Weight (g)
Numbu	301,86 b
Kawali	228,11 a
Suri 3	304,40 b

Note: Figure followed by the same letter indicates the not significantly different result in the least significant different test 5%

The result of variance analysis shows that sorghum variety affects the fresh stove weight per plant. It was then followed with the least significant different test 5% (Table 1). The result of analysis shows that Suri 3 variety provides the heaviest weight, Suri 3 is heavier (76.29 g) than Kawali and Numbu is heavier (73,75) than Kawali. However, Suri 3 and Numbu varieties provide similar fresh stove weight. It is in line with [20] finding that Suri 3 has fairly high fresh stove weight compared with other varieties, but still below Suri 4. Suri 3 can potentially be forage due to its high biomass production. The increase in the fresh stove weight of plant is due to the absorption of nutrient and water in a large quantity [1]. The fresh stove weight has correlation with photosynthesis and nutrition assimilation [21].

4 Conclusions

Numbu with optimum dose of LOF 3,8 $L.ha^{-1}$ produced the highest leaf area and LAI of 2570 cm^2 and 2,56 compared to other varieties. Suri 3 and Numbu indicate higher fresh stove weight than Kawali. It means that Numbu and Suri 3 can be utilized as the alternative to forage.

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