Growth and productivity of cassava given organic fertilizer and potential waste as a source of animal feed

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Abstract. The research was conducted to determine the growth and productivity of cassava plants that are given organic fertilizers and their potential waste as ruminant animal feed. The research was conducted at Kerthi Winangun Farmers Group, Bukti village, Kubutambahan District, Buleleng Regency. The experiment was arranged in a completely randomized design with three fertilization treatments and twelve replications. The fertilizer given were: cow dung 5 kg/plant (UK1), compost 5 kg/plant (UK2) and cow dung 5 kg/plant + bio urine 300 ml/plant (UK3). The Parameters observed were (1) plant growth (height, Number of leaves and tubers), (2) tuber production, (3) waste (leaf and peel) production and (4) carrying capacity. The result shows that application of 5 kg compost /plant yielded the highest tuber, leaf and peel production was respectively 1789,25±475,50, 667 ± 104 and 416,61±18 g/plant. Production of this peel can be used to feed 1.29-1.52 cattle/ha/year or 10.73-12,68 goat/ha/year. In conclusion, the cassava that was given with 5 kg compost per plant has the highest production to be used as a source of feed for ruminants.

1 Introduction

Cassava (*Manihot esculenta* Crantz) have high starch content (up to 90% of the dry matter) [1]. Indonesian has high cassava exporting counties with total cassava production 19 million tonnes [2]. The tuberous roots of cassava used as a staple food in several locations in Indonesia. Consumption of rice as a staple food causes cassava tubers and leaves to be rarely consumed and more widely used as for compounding livestock feeds. Cassava tuber may be processed into a variety of products, including chips, flakes, cubes, peeler, starch and flour, pellets etc, which are highly demanded in the export market [3].

Cassava peels had received greater attention by researchers because it is the most abundant and contributes more to environmental degradation compared to the other solid wastes [4,5]. On the other hand, the development of ruminant livestock, especially cattle and goats in Bali province, is experiencing problems with limited land area. The potential

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of this cassava peels needs to be calculated as a source of animal feed. This will be used as a reference to increase the population of ruminants in the future

Cassava is inherent tolerance to various adapt climatic stresses [6], cassava is usually grown on severely depleted soils, often with little or no inputs of fertilizers and pesticides [7] and hence with very low yields. Cassava is generally cultivated by farmers on dry land side by side with ruminant livestock cultivation. To save expenses, farmers use livestock manure as organic fertilizer for cassava plants. In addition, in spite of using fresh manure, farmers also use fermented manure and bio urine for fertilizing plants. Organic fertilizer contains organic compounds as a source of macro and micronutrients and have a high-water retention capacity [8]. When applied to substrates, they promote improvements in chemical, physical, and biological characteristics [9] and can supply the nutritional demand for plants.

Based on this, innovation of fermentation technology is needed to support the application of organic fertilizers to increase the productivity of cassava plants. Therefore, the objective of this study was to investigate the effects of organic fertilizer on growth and productivity of cassava plants and their potential waste product as a source of ruminant feed and important effects for cattle carrying capacity in dry land area of Bali province.

2 Materials and methods

This research was conducted in nine month in the Kerthi Winangun Farmers Group, Bukti village, Kubutambahan District, Buleleng Regency, Bali Province Indonesia from October 2019 to June 2020. Whereas the cassava that used in this study was local cassava (ubi ketan) with planting space 1 m x 1 m. This study was arranged in a completely randomized design with three fertilization treatments and twelve replications. The fertilizer given were: cow dung 5 kg/plant (UK1), compost 5 kg/plant (UK2) and cow dung 5 kg/plant + bio urine 300 ml/plant (UK3).

Compost derived from cow dung that has been fermented with Rumino Bacillus inoculant (RB) for ± 2 weeks. Bio urine comes from cows urine which is fermented with RB and Azotobacter (AZBA) for 7 days with a ratio of 1,000 l of urine: 1 l of RB and 1 l of AZBA. The application of solid organic fertilizer (cow dung and compost) was carried out together with tillage or 2 weeks before planting with sowing according to the treatments. Bio urine was given when the plant was 3 month. Bio urine was mixed with water in a ratio of 1: 3 prior to application to the plant.

The Parameters observed were (1) plant growth (height, Number of leaves and tubers), (2) tuber production, (3) waste (leaf and tuber skin) production and (4) carrying capacity. To determined the growth of cassava, the plant height was measured every 3 months. Cassava leaves, tubers and peel were weighed then sample was taken after that dried in the sunrays for 2 days. This sample then place in the oven which an electric oven at 70^0 C for 24 hours to determine the dry weight (DW). The determination of dry matter (DM) and organic matter (OM) was carried out based on the Association of Official Analytic Chemist method. Analysis of the nutritional content of the ration consisting of dry matter (DM), organic matter (OM), crude protein (CP), crude fibre (CF), ether extract (EE) and gross energy used the AOAC [10] method. Determination of carrying capacity was carried out by estimating consumption (fresh weight/dry matter) divided by livestock unit/day. The data obtained from this study were analyzed by analysis of variance with an error rate of 1-5%. The differences between three treatments were tested further by Duncan's Multiple Range Test.

3 Results and discussion

3.1 Cassava growth

The data showed organic fertilizer treatment was significantly affected plant height and the number of tubers produced (Table 1). The highest number of leaves was found in UK2 treatment, which was 144.55 ^{b} ± 12.80 significantly higher (P<0.05) than UK1 and UK3 treatments. The highest number of leaves in UK2 treatment was probably due to the higher nutrient content in compost compared to cow dung alone or with the addition of bio urinee. In addition, the composting process will break down organic compounds into compounds that are more easily absorbed by plants. More nutrients that are available and can be utilized will lead to better plant growth, especially the number of leaves.

The high number of leaves causes the better photosynthesis process compare to the less number of leaves. Photosynthesis proses produce sufficient materials to form complex organic compounds such as carbohydrates, protein and fat [11]. This might affect to the production and quantity number of cassava tubers. Cassava tubers are a place to temporarily store photosynthetic products that are not used for plant vegetative growth.

Table 1. Cassava growth

Parameter	UK1	UK2	UK3
Plant height (cm)	214.67^{a}±15.01	210 ^{a} ±5,66	197,33 ^{a} ±5,03
Number of leaves	91.69 ^{a} ±23,30	144.55 ^{b} ±12.80	71.44 ^{a} ±14.56
Number of tubers	6.00 ^{a} ±1.41	6.50 ^{a} ±0.71	5.49 ^{a} ±1.06

3.2 Cassava productivity

Application of compost resulted the highest fresh tuber production, which was 1789.25 g/plant, this was significantly higher (P <0.05) compared to treatment UK1 but not significantly different (P> 0.05) compared to treatment UK3 (Table 2). The average production of cassava is 1,373.52 kg/plant or higher than the data obtained by Dinata et al. [12] which is 1,188 kg/plant. The high production of these tubers leads to the inreasing of fresh peel production at 416.61 g/plant, that was significantly higher (P <0.05) compared to UK1 treatment but not significantly different (P> 0.05) compared to UK3 treatment.

Table 2. Cassava productivity

Parameter (g/plant)	UK1	UK2	UK3
Fresh			
- Leaves	446 ^{a} ±120	667 ^{a} ±104	298 ^{a} ±70
- Tuber	1113 ^{a} ±59.52	1789.25 ^{b} ±45.50	1218.3 ^{ab} ±47.14
- Peel	135.98 ^{a} ±61.14	416.61 ^{b} ±109.37	402.04 ^{b} ±150.86
Dry mater (DM)			
- Leaves	108.78 ^{a} ±29.15	162.68 ^{a} ±25.29	72.68 ^{a} ±44.24
- Tuber	126.44 ^{a} ±57.88	225.38 ^{b} ±54.02	138.40 ^{a} ±51.93
- Peel	37.83 ^{a} ±17.24	117.48 ^{b} ±30.84	114.5 ^{b} ±42.54

In line within the fresh weight and the dry matter of cassava leaves, data showed tubers and cassava peels in UK2 treatment was the highest from all treatment. The high production of cassava peels has the high potential to be used as a feeds source for ruminants' production. Cassava peels contains 6.38% crude protein, 0.48% crude fat, 15.91% crude

fiber and a gross energy content about 3,007.8 kcal/kg. The highest productivity of cassava plants in UK2 treatment was probably due to the higher nutrient content in compost compared to cow dung alone or with the addition of bio urine. According to Utami and Dinata [13], goat manure fermented with RB contain with P_2O_5 about 0.99 (%), N total about 1.91%, and C/N ratio 22 and bio urine treated with RB and Azotobacter showed P_2O_5 about 56.37 ppm, N total about 0.1%, and C/N ratio 17.5. The nitrogen content of fermented manure was 1.57% or higher rather than in bio urine (0.06%) which was related to leaf development.

In Addition, compost has more undissolved nutrient that causes the availability longer in the soil. Slow release nutrients have optimal responses to the production of cassava plants that have a relatively long harvest life. Solid organic fertilizer (compost) was able to improved the physical properties and fertility of soil but has a low nutrient content available [14].

3.3 Carrying capacity cassava tuber peel for cattle and goat

Carrying capacity is the ability of a land to produce animal feeds for accommodates livestock per hectare. Cassava peels can be used as concentrate feedstock. The average conversion result of fresh and dry cassava peel production of all treatments into an area of ha was 3,189.53 and 899.45 kg / hectare, respectively.

Table 3. Carrying Capacity of the cassava peel for cattle and goat/ha/year

Parameters	**UK1**	**UK2**	**UK3**
Fresh cassava peel			
- cattle	0.49	1.52	1.48
- goat	4.08	12.68	12.36
Dried cassava peel (DM)			
- cattle	0.41	1.29	1.26
- goat	3.45	10.73	10.46

Notes:

- The number of plants per ha are 10.000 plants with harvests 1 times a year
- Assuming that cattle weight is 250 kg and goats weigh is 30 kg
- Livestock need fresh feed as concentrate as much as 3% of body weight
- Livestock need dried feed as concentrate as much as 1% of body weight

The average production of fresh cassava peels can accommodate 1.17 cattle's or 9.71 goats/ha/year; meanwhile dried cassava peels can accommodate 0.99 cattle's or 8.21 goats/ha/year (Table 3). If it was converted to into harvest area means of 5,514 ha of cassava plants in Bali [15], the use of fresh cassava peels as a source of concentrate feeds will be able to accommodate 6,425 cows or 53,538 goats. Meanwhile, the dry cassava peels will be able to accommodate as many as 5,435 cows or 45,293 goats.

4 Conclusions

Application of compost significantly increased cassava yield. With the cassava productivity of 1789.25 kg tuber /plant and 416.61 kg peel/plant could support cattle and goat's population, respectively 1.29-1.52 and 10.73-12.68 heads/ha/year.

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