Research Article

The Potential of Sorghum as a Staple Food Grown Using Fermented Organic Fertilizers and Different Plant Spacings in East Timor

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Abstract | Sorghum (Sorghum bicolor L. Moench), is a strategic commodity as a staple food, feed and industrial raw materials. Even with good nutritional content, sorghum can replace rice. However, in Timor-Leste, planting has not been as intensive as staple food crops such as rice, corn and other popular food sources. Many technological innovations to produce high sorghum crop productivity have been produced such as using fertilizer and planting distance set. The research aims to investigate production potency of sorghum which cultivated with vary of level fermented organic fertilizer (FOF) and planting distance. The research was conducted at Titilari Lospalos Village, Lautem, East-Timor, starting from June to October 2022. The study was designed with a completely randomized design (CRD) factorial with 2 factors: Factor A was FOF consisting of 0 (A0), 6000(A1), 7000(A2), 9000(A3) kg/ha. The second factor was distance planting consisting of B1 (50x25), B2 (60x25), B3 (70x25), B4 (80x25) cm; there was 3 replications. The observed variables were: total leaves, height plant, biomass and seed production of sorghum. The results showed that the highest total leaves at A3 (72,87 leaves/plant) and significantly different (P<0,05) to A0, A1 A2. The highest height was at A3 (94,72 cm) significantly different with A0, A1, and A2. The highest biomass production was A3 (1,70 kg/plant) not different (P>0,05) with A2 but significantly different with A0 and A1. The highest seed production was A3 (0,60 kg/plant) no different to A2 but had significantly different to A0 and A1. Effect of planting distance showed that all variables had no significantly different. To conclude that effect of A3 had the highest values on total leaves, height plant, biomass and seed production. The biomass and seed production, was equivalent to 23,78 and 8,37 tons/ha therefore, sorghum has potency as staple food in East Timor.

Keywords | Fermented organic fertilizer, Planting distance, Sorghum production

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INTRODUCTION

Demand of basic food increasing as population increasingly rapidly in East Timor Timor-Leste, which nowadays still depending on 80-90 % to import sustain demand of food. Government of Timor-Leste attempted and focus on reduce import and raised livestock and cultivated crops directly by Timorese. Raised and cultivate crops in East-Timor is restricted mostly due to climate, limitation land, seed and management of cultivation properly. During dry season food is limited resulting on perform of animal decrease or low and lack of food (calf mortality high, thin, need a long time to reach saleable age, malnutrition, etc.). Therefore, necessary to find a plant multi-functional which can be uses for both feed and food such as sorghum.

Sorghum (Sorghum bicolor L. Moench), as grass species which has good quality and high production where can be a source of food (Andriani and Isnaeini, 2016) which suitable to develop in East Timor due to sorghum due to can be survive on dry soil. Moreover, the sorghum risk of failure is low, nutrition content is high, resistant to pests and plant diseases, cost of production is low and cheap. Additionally, sorghum plant has other functions such its branch/stem, leaves and seed can be used as feed and food for people. Sorghum can substitute corn on chicken feed due to its quality is similar to corn. Thus, development sorghum on livestock area which can be used a substitution on ration formula in the future, while sorghum leaves can use as ruminant feeding. Nutrition composition of sorghum seed is of 100% dry matter; protein 10,26%, crude fiber 2,72%, fat 2,70, Ca 0,9% and P 0,38% (Rumambi, 2013). Composition of sorghum's leaves is similar to elephant grass (Pennisetum purpureum) and tofu especially its protein is 7.8%, 6.0% and 5.0 percent respectively. According Tarigan et al. (2015) in 100 gram of sorghum, content 73 g carbohydrate and 332 Kcal other nutritious such as protein, fat, calcium, phosphor ferro and vitamin B1 and water.

Although sorghum can grow and perform on good production in dry and marginal soil; however, it is important to pay attention to cultivate technic with using fertilizer such as fermented organic fertilizer (FOF) or appropriate element nutrient to the plant, in order to reach a production maximum of sorghum is required element nutrient with quantity sufficiently or equilibrium to sustain growth and high productivity of the sorghum. Fertilization is a method to provide nutrient for plant therefore can sustain the growth of the plant. One of the fertilizer types is FOF made of animal feces. The fertilizer function is to increase microorganism species and to stop development of pathogenic microorganism in the soil (Susanto, 2002). The FOF made of cattle feces is an alternative on agriculture technology whereas friendly environment and sustainable due to the fertilizer can provide nutritional elements macro and micro as well, fertilize the soil and improve soil structure therefore sorghum easy to absorb water and nutrient elements. Composition nutrient of FOF made by cattle feces according to Hartatik and Widowati (2010) as: N (0,7-1,3%), P_2O_5 (1,5-2,0%), K_2O_5 (0,5-0,8%), C-organic (10,0-11,0%), MgO (0,5-0,7%) and C/N ratio (14,0-18,0). The FOF can be made by feces animal, rice straw, coffee skin and sawdust with EM-4 (effective microorganism-4) (Goa et al., 2012).

Cultivation distance density of plant in an area is important as plant production depends to distance planting of the plant, which must consider type, texture, structure and soil fertility (Prihatman, 2000). Cultivation distance which close spacing produced plant production high while spacing that is too small will cause competition for water, nutrients and sunlight, so that the growth and yield of sorghum is not optimal. Using a spacing that is too narrow between fellow leaves covering each other so that plant growth will be tall and elongated because they compete for sunlight so that it will inhibit the photosynthesis process and plant production is not optimal (Laili et al., 2010). Therefore, the use of sorghum spacing is deemed necessary, because to get uniform growth, even distribution of nutrients, effectiveness of land use, ease of maintenance, suppression of pest and disease development as well as to find out how many seeds are needed at the time of planting. In Timor-Leste not much research has been done on how to cultivate sorghum with using FOF and set plating distance, therefore, why this research was carried out.

RESEARCH METHODS

Location and time of research

This research was conducted in Titilari Lospalos Village, Lautem East Timor, starting from June to October 2022.

Research material

The materials used are sorghum seeds of sorghum (Sorghum bicolor L Moench) variety, land, plastic bags and large envelopes, Bali cattle feces, EM-4, granulated sugar, water, sawdust, rice bran and rice bran.

Research equipment

The equipment used is a digital scale with a capacity of 200 g with the smallest scale of 0.01 g for weighing fertilizer, and a spring scale with a capacity of 50 kg with a sensitivity of 0.5 g for weighing biomass and seeds, a drying oven.

Preparation of Fermented Organic Fertilizer with cattle Feces

Prepared materials before making FOF such as EM-4, sugar and water. Then mixed until homogeneous. The EM-4 is a type of bacteria that is made to assist in the decomposition of manure so that it can be utilized in the composting process. Compost produced by this method is environmentally friendly, in contrast to inorganic compost derived from chemical substances. Prepared the feces of Bali cattle, rice bran, rice bran, sawdust and mix until homogeneous. After that, spread it on the floor and flush with the prepared EM-4 solution. The material watered is not too wet. Then, covered tightly with plastic until an anaerobic condition occurs. Kept control over the temperature of the fertilizer material after 5-6 hours. If the temperature reaches 50°C, the plastic must be opened so that air can enter after the normal temperature is closed again. The FOF used after 14 days, with characteristic brownish color, soft texture not crushed, not hot and does not smell rancid or rotten.

Research Procedure

The study experimental method designed was a completely randomized design (CRD) factorial with 2 factors with

4 treatments and 3 replications, namely: Factor A dosage of FOF as: A0 = without fertilizer (control), A1 = 5000 kg FOF/ha, A2 = 7000 kg FOF/ha, A3 = 9000 kg FOF/ha. Fertilizer according to the treatment was given 1 time, which was given when the plants were one month old. These fertilizers are given by immersing them at a distance of +5 cm from the planting hole. Watering the plants is done every day. Factor B was planting distance with the respective spacing: B1 = 50 x 25 cm, B2 = 60 x 25 cm, B3 = 70 x 25 cm, B4 = 80 x 25 cm. The total treatments were 16 with 3 repetitions, thus a total of 48 units treatment.

Land preparation includes: dismantling and demolishing the soil, making beds with size of 3.2 x 1 m, in total 48 units of beds. The beds are left for 7 days to remove weeds before planting the sorghum seeds. The sorghum seeds are planted in the prepared holes as many as 3-4 seeds per hole, then after 14 selections are made of the tillers that thrive, so that only 2 plants are obtained in each hole. During the study it was controlled weeds did not grow and the use of insecticides on plants disturbed by insects.

At the time of harvest, measurement of forage production is carried out. Plant cutting is done on the stem with a distance of +5 cm from the ground. Harvesting sorghum seeds had done when the plants are ripe (brown). The biomass production and sorghum seeds obtained were put in newspaper bags of known weight and then dried in an oven at 55°C for 3 days until they reached a constant weight. The biomass samples were milled with a sieve hole diameter of 1 mm and then dry matter (DM) analysis was carried out (AOAC, 2005).

Observed variable

Variables observed included leaves production, plant height, biomass production and seed production. Total leaf production (leaves/bed) was calculated during the study, plant height (cm/plant) was measured from the land to the highest point of the plant, Biomass production (tons/ha), fresh biomass production multiplied by plant dry matter and sorghum seed production (tons/ha), calculated the total seed production multiplied by the dry matter of sorghum seed production. Mean of plant in beds cultivated of 15 plants

Data analysis

The data obtained were analyzed for variance according to the CRD factorial pattern. Duncan's test (Duncan's New Multiple Range Test) was performed on the treatment factor to show a significant effect (Kadir, 2016).

RESULTS AND DISCUSSION

Total sorghum leaves

Statistical test results showed that the FOF dosage factor had a significant effect (P < 0,05) on sorghum leaves production (Table 1), while the spacing factor had no significant effect. Data in Table 1 indicated that effect of factor A on sorghum leaves total without FOF, the leaves productions was 62,92 leaves/plant had the same result statistically with the treatments of A1 (64.02 leaves/plant), A2 (68,75 leaves/plant), respectively but the highest leaves productions was on treatment A3 (72,86 leaves/plant). The leaves production showed tend to increasing in line with the level of fertilizer increase was due to when the FOF level increases and the spacing distance is sufficient enough to provide adequate soil nutrients including nitrogen, phosphorus needed to produce plant parts such as leaves, stems and seeds. When the availability of soil nutrients is sufficient, plant production, such as leaves, will increase in number and thickness (Pandutama et al., 2003). Bullard and York (1985) found that one of the indicator variables that describes the growth of sorghum plants can be observed from plant height and number of leaves. Plant height and number of leaves are components of vegetative growth a plant. Futhermore, Ezward et al. (2019) found that the most important on planting crop is the biological properties of the soil. From results of study on using bioboost fertilzer it appears that if the volume of fertilizer treatment is getting higher, then plant height growth will also be getting better/higher. Otherwise if Bioboost fertilizer treatment volume the lower the higher the growth the plants will be farther down description. Therefore, as a crop it is very important to consider fertilizer when planting sorghum. The number of leaves of sorghum in this research was still in range of others research 7 – 40 leaves/beds Andriani and Isnaeni (2016), 6,60 leaves/beds (Slameto, 2022) depends to varieties of the sorghum.

Treatment factor B on total sorghum leaves no significantly different (P>0,05) on total leaves production. In the treatment factor different spacing produce plants with no different of total leaves. This matter indicates that there has been no competition in exploiting growth space especially light.

In Table 1, the data revealed that total sorghum leaves on B2 tend to produce leaves more compared to when on cultivated on distance wide (B3 and B4), this is caused by total plant when a distance planting wide will reduce the total plants in the area in total thus the total leaf will decrease. Even so the leaves of sorghum in total due to suitable distance plant related to opportunity of the plant to get nutrient, water light or compete to others plant which cultivated nearby (Azis and Arman, 2013). A widely dis

Table 1: Total sorghum leaves (leaves/plant)

Treatment		Fermented organic fertilizer				Average
		A0	A1	A2	A3	
Planting distance	B1	63,21	60,58	63,96	60,71	62,11[A]
	B2	61,17	65,83	72,50	80,54	70,01[A]
	B3	68,13	64,04	65,92	72,71	67,70[A]
	B4	59,17	65,63	72,63	77,50	68,73[A]
Average		62,92[a]	64,02[a]	68,75[ab]	72,86[b]	67,14

Notes: Different capital letter at the same column and different non capital letter at the same row indicate significant differences with Duncan test (P < 0,05); A (level fertilizer) ; B (planting distance): A0 (no fertilizer); A1 (6000 kg/ha); A2 (7000 kg/ha); A3 (9000 kg/ha). B1 (50 x 25 cm); B2 (60 x 25 cm); B3 (70 x 25 cm); B4 (80 x 25 cm).

Table 2: Sorghum Height (Cm)

Treatment		Fermented organic fertilizer				Average
		A0	A1	A2	A3	
Planting distance	B1	58,08	63,40	74,78	66,77	65,76[A]
	B2	67,26	92,17	102,10	100,93	90,61[B]
	B3	81,56	68,88	82,26	83,85	79,14[AB]
	B4	70,08	73,23	82,85	127,33	88,37[B]
Average		69,24a	74,42ab	85,50ab	94,72c	80,97

Notes: Different capital letter at the same column and different non capital letter at the same row indicate significant differences with Duncan test (P < 0,05); A (level fertilizer) ; B (planting distance): A0 (no fertilizer); A1 (6000 kg/ha); A2 (7000 kg/ha); A3 (9000 kg/ha). B1 (50 x 25 cm); B2 (60 x 25 cm); B3 (70 x 25 cm); B4 (80 x 25 cm).

Table 3: Sorghum Biomass (kg/plant)

Treatment		Fermented organic fertilizer				Average
		A0	A1	A2	A3	
Planting distance	B1	0,74	1,05	1,38	1,93	1,27[A]
	B2	0,91	1,06	1,37	2,03	1,34[A]
	B3	0,63	1,17	1,57	1,54	1,23[A]
	B4	0,96	0,95	1,38	1,28	1,14[A]
Average		0,81[a]	1,06[a]	1,42[b]	1,69[b]	

Notes: Different capital letter at the same column and different non capital letter at the same row indicate significant differences with Duncan test (P < 0,05); A (level fertilizer) ; B (planting distance): A0 (no fertilizer); A1 (6000 kg/ha); A2 (7000 kg/ha); A3 (9000 kg/ha). B1 (50 x 25 cm); B2 (60 x 25 cm); B3 (70 x 25 cm); B4 (80 x 25 cm).

Table 4: Seed Production (Kg/plant)

Treatment		Fermented organic fertilizer				Average
		A0	A1	A2	A3	
Planting distance	B1	0,51	0,29	0,55	0,50	0,46[A]
	B2	0,49	0,35	0,52	0,71	0,52[A]
	B3	0,42	0,45	0,40	0,59	0,47[A]
	B4	0,32	0,46	0,60	0,61	0,50[A]
Average		0,44[a]	0,39[a]	0,52[ab]	0,60[b]	

Notes: Different capital letter at the same column and different non capital letter at the same row indicate significant differences with Duncan test (P < 0,05); A (level fertilizer) ; B (planting distance): A0 (no fertilizer); A1 (6000 kg/ha); A2 (7000 kg/ha); A3 (9000 kg/ha). B1 (50 x 25 cm); B2 (60 x 25 cm); B3 (70 x 25 cm); B4 (80 x 25 cm).

tance of cultivated resulting on opportunity of the plant to absorb nutrient, furthermore nitrogen abundant to use its root respiration than plant cultivated nearby (Prihatman 2000). Slameto et al. (2022) revealed that the results of the study on a different sorghum cropping system is the zigzag cropping system and conventional cropping systems showed no significant differences in the growth components of variable plant height and number of sorghum leaves both at plant vegetative age and plant height plants and number of leaves at sorghum harvest. The results of this study are in line with the research of Liu et al. (2004) which shows that the variation in distance planting had no significant effect on the number of leaves, plant height, leaf number index, but significantly affected the production per hectare of the crop.

Sorghum Height

Results of analysis of variance showed that the A factor and planting distance had a significant effect ($P < 0,05$) on sorghum height (Table 2). Effect of treatment factor A on sorghum height at A3 (94,72 cm/plant) higher than others treatments. Treatment A2 where produced to 85,50 cm similar to A1 (74,42 cm/plant) however different to A0 (69,25 cm) which the lowest number of sorghum height when the sorghum not fertilized (A0). The sorghum height which cultivated using fermented organic fertilize higher when the application of fertilizer is increasing, due to its content of nutrient such as N, P, K to the soil will provoke growth of the plant therefore the height is increasing (Marzuki et al., 2013).

Treatment of factor B presented that the treatments had effect on height sorghum which the highest plant was on B2 (90.62 cm), although statistically it similar ($P>0,05$) to B3 and B4 nevertheless different to the shortest was at B1. The data indicated that when the cultivation distance narrow do not give opportunity to the sorghum growth properly due to less opportunity to have nutrient including oxygen as they compete to others plants on the contrary when the space widely the plant have more opportunity to absorb more nutrient and get oxygen maximum from the soil (Marzuki et al., 2013). Spacing used for sorghum cultivation, namely more than 75 x 25 cm (B2, B3, B4); so that it can take advantage of growing space as sunlight hits all parts plants better and also allows plants to absorb optimal nutrition and oxygen. The Sorghum height in this study is lower than finding by Andriani and Isnaini (2016) where revealed that the sorghum height vary around 200 – 400 cm, depends to the varieties of the sorghum, therefore the plants structure is ideal to deconvolve as feed and source of sugar production (FAO, 2000). The chemical composition (crude protein and crude fiber content) of sweet sorghum leaves is equivalent to that of elephant grass and sugarcane shoots, respectively 7.82% and 28.94%; 6% and 34.25%; 5.33% and 35.48% (Directorate General of Plantation, 1995). The data informed that when sorghum cultivated with planting distance widely and level organic fermented fertilizer added resulting on the height of the sorghum increasingly due to the plant has opportunity to explore and utilize nutrient maximum in wide space as Haryanto and Sasmita (2019) explained that cultivation distance configuration has effect on population and plant height where offers competition opportunity to get nutrient, using energy as sunlight and spacing to live of the plant.

Biomass Production

Effect of fermented organic fertilized (factor A) and cultivation distance (factor B) as presented in Table 3. The Treatment of factor A shown a significant effect ($P<0,05$) on biomass production however, factor B had no effect significantly ($P >0,05$) on the biomass production. The effect of FOF on biomass production statistically A3 and A2 were higher compared to treatment A0 and A1, while A0 and A1 was not different. The treatment A3 revealed that biomass production was 1,70 kg/plant, when the sorghum does not offered fertilizer the biomass production was 0,81 kg/plant which informed that product biomass needed fermented organic fertilizer therefore plant necessary can sufficient to live well. Dahlan and Kaharuddin (2007) explained that plant production is affected by soil aeration, soil structure and soil nutrition and another important factor was using fertilizer.

Data on Table 3 shown that biomass production reached till 1,69 kg/plant hence could be an alternative to support raising animal especial ruminant whereas in East Timor facing immense problem at dry season and also the land to plant forage is limited. Yuliaty et al. (2013) reported that problem on livestock growing in East Timor on dry season such as limitation feed, soil nutrition less of nitrogen and phosphorus and farmer's time and ability to rare their animal is limited. Mostly farmers in East Timor only offer additional feeding whenever forage available around their village. The condition needs intervene how to prepare animal feed quality such as biomass of sorghum. Sorgum is one of the food crop commodities that has important potential as a source of animal feed (Khaidir et al., 2021). In addition, sorghum has the advantage of being resistant to environmental stress when compared to other cereal crops, for example on dry land (Irwan et al., 2004), therefore, it is suitable to be developed in East Timor.

Sorghum can harvest three time per cultivation, the biomass production in this study in the first collection was produced to 1,69 kg/plant or equivalent to 7,93 ton/ha or 23,78 ton/ha per cultivation period. The result similar to Shoemaker et al. (2010) found that biomass sorghum was 20-50 ton/ha and can be reached till 40-5- ton/ha (Slameto, 2022). It was further reported that several varieties of sweet sorghum were used as forage production was 149% higher than corn and 191% higher than wheat. Sorghum has the potential to be developed as a forage-producing plant, because it has a longer vegetative growth, the chemical composition (crude protein, crude fiber and HCN-hydrogen cyanide) produced is better than the quality of other forages. HCN in sorghum is still at a safe level for livestock; Purnomohadi (2006) found that level HCN in Sorghum bicolor L. Moench around 210 – 267 ppm; level HCN of up to 500 is danger to animal. Ruminant with body weight 200 kg required forage (DM base) 4 kg/d, therefore in once harvest of sorghum biomass could be feeding 4.225 cattle or 352 - 353 cattle per year. The result informed that sorghum biomass as forage could be an energy source to ruminants, by using fermented organic fertilizer 9000 kg/ha will produce maximum of the sorghum biomass. However, when the sorghum cultivated only consider on plant distance the highest biomass production was 1,34 ton/ha with the distance the best is B2 (60 x 25 cm), the finding support from study of Koten et al. (2012) and Maddonni et. al. (2006) revealed that wide distance of planting will be benefited to the plants as offers using nutrient maximal of the soil, sunlight which photosynthesis better and fertilize to the plants.

The data revealed that factor distances cultivated tend to produced less of the sorghum biomass. Also, the data figured when cultivation distance of the sorghum is enough will accommodate more plant inside the bed therefore the biomass production in total will increase as well. Biomass production produce maximum when on time period of nurse until seed production (vegetative phase to generative phase), which required nutrient supreme for supporting growing process. In order to meet the requirement process of the sorghum development required fertilizer such fermented organic fertilizer, therefore proses of photosynthesis running well and the produce more biomass (Koten et al., 2012). The same case reported by Susanto (2002) that development of plant is manifested by soil nutrient disponible to the plant requirement.

Seed Production

The effect of treatment factor A and factor B is revealed in Table 4. Treatment on factor A, revealed had significant effect on sorghum seed production (P < 0,05) however, factor B no significant effect (P >0,05) to the production of the sorghum.

Treatment factor A shown that seed production maximum is on treatment A3 while the smallest was on treatment A1 which similar to no FOF (A0). Base on the data on Table 4, indicated that the seed production of sorghum tends to small when cultivated only applied less than 6000 kg/ha of the FOF. Sorghum seed production with treatment factor A3 was 0,60 kg/plant as the highest seed production, it was same with treatment A2 (0,52 kg/plant), but higher than on factor A1 (0,44kg/plant) and on factor A0 (0,39 kg/plant). The data shown that using fertilizer when cultivation of sorghum resulting on high production of sorghum seed due the nutrient such as nitrogen, phosphorus and calcium will absorb maximum of the plant. This matter caused by the treatment of A3 by applying the volume of FOF of 9000 kg/ton able to improve soil fertility through the main duties and functions of bacteria contained therein (FOF). From the research results, the greater the volume number given, the better growth and development on sorghum plant. Soil type in Lospalos, East Timor is latosol which is known as soil types are common in the tropics where the soil content has high concentrations of iron and aluminum oxide, the acidity level of latosol soil ranges from 4.5-6.0. This type of soil has a low level of fertility and productivity, organic matter low, Al poisoning, P deficiency, and poor in other micronutrients (Sanchez and Logan, 1992). The land can be empowered by adding proper and balanced fertilizer, fertilizer that can be used in the form of fertilizer organic such as FOF, so will increase land productivity will affect production sorghum plant.

Yoku et al. (2007) described that sorghum Sudan grass when fertilized with fermented organic nitrogen fertilizer resulting on 70% higher than not fertilized. High production of sorghum seed indicated that elevated growth of the plant (Kartaatmadja and Fagi, 2000), therefore fertilization must consider including its dose should be fit and precise. According to Marzuki et al. (2013) overuse of fertilizer can damage growth of the plant resulting on not efficient. Munawar (2011) explained that using FOF can large level when soil nutrient concentration very limited so will provide enough nutrient for the plant. Ezward et al. (2019) reported that using organic fertilizer namely bioboost of 480 ml/plant produced dry seed of Sorghum bicolor (L) Moench 113/61 gr/plant equivalent to 6,05 ton/ha. Using organic fertilizer such as FOF resulting on accelerates time harvest that meets the standards of seed production. Manuhuttu et al. (2014) revealed that organic fertilizer is biofertilizers that are in it contains microorganisms very useful in the process decomposition of organic matter, e.g. *Azotobacter, Azospirillum, Bacillus* sp., *Pseudomonas* sp., and *Cytophaga* sp. In addition, organic fertilizer also contains hormones such as gibberellins, cytokinins, kinetin, zeatin, and auxin The use of FOF can suppress use of inorganic fertilizers 50% to 60% binds N free in the root zone, accelerating soil biochemical processes make P and K available to fertility-producing plants land increases . Therefore, important to find out the level of the applicable fertilizer including the FOF.

Sorghum seed production on treatment A3 was 0,60 kg/plant which equivalent to 2,79 ton/ha per harvest or 8,37 ton/ha per cultivation (3 harvest three times). According to TI (2016) seed sorghum production in Jawa Timur – Indonesia can produce till 2-3 ton/ha, in Babat 6,5 ton/ha while Slamento (2022) revealed that production of sorghum seed around 8-9 ton/ha. Ezward et al. (2019) found that giving Bioboost Fertilizer 480 ml/plant produced seed of 113.61 grams/plant equivalent to 6.05 tonnes/Ha. This is due to the application of organic fertilizers such as FOF can improve physical, chemical, and biological properties soil so aerated and better soil porosity thus giving opportunities to the roots to develop and improve activity of soil microorganisms will give organic acids to be available in the ground. Good soil biological properties resulting in the availability of nutrients which will affect growth plant development and yield. This matter in accordance with the opinion of Dwidjosepoetro (1996), which states that good plant growth as a result of the required nutrients it is sufficiently available to plants to reach a maximal seed production. Productivity is an indication of success in a cultivation. Deep precision Fertilization greatly affects the productivity of cultivated plants (Marzuki et al., 2013).

The effect of distance planting revealed that statically the same on seed production with total production around 0,46 until 0,52 kg/plant. There was a tendency a small planting distance produce high seed production. That could explain that planting distance fine will allow has a larger population with a larger population it is more capable of providing maximum production per hectare. Maddonni et al. (2006) stated that a narrower spacing would increase the population in order to provide greater production per hectare. The spacing appropriate in such a way that the plant density does not interfere with the absorption of sunlight needed in the photosynthesis process. In addition, the implementation of the distance planting properly is relatively easy, does not require complex technology and special skills (Slameto, 2022) thus sorghum can apply planting distance with minimal distance at 15 x 25 Cm and the widest is 80 x 25 cm. Kartaatmadja and Fagi (2000) researched spacing in rice found that spacing will affect the existing population will affect it later its production. Apart from the spacing, fertilization is also required the right way to get maximum productivity.

East Timor is a small country which has area land about 15.000 km^2, the potential for up farming is about 274,000 ha, however only about 80,000ha is currently being cultivated (Laohamutuk, 2017). Thus, available about 194.000 ha land area could be cultivated sorghum and can be produced 1.623.780 ton/ha. Based on the results of seed production in this study it can be used as food substitution to basic food such corn and rice in East Timor which recently the stable food mostly imported from Indonesia. WFP (2020) shown that total rice imported only sufficient to 1,8% (541 ton/ha) of the Timor-Leste national total requirement (30.000 ton/ha). The result found on treatment A3 which produced 8,37 ton/ha can provide food needs of about 1000 people. Expectation from the research the sorghum can substitute corn and rice and also can considered to government institution which required food domestic (food source to member of Police National Timor Lorosae (PNTL), member of The Timor Leste Defence Force (F-FDTL), Hospital, school feeding (Merenda escolar), etc.) therefore, can reduce imported basic food. The program of planting sorghum to be a staple food also can support to National Development Plan Strategic of Timor-Leste year 2011 – 2030 that East Timor should independent on domestic basic food to reach one of the Sustainable Development Goals (SDGs) which has mentioned of The Prime Minister of Timor-Leste declared SDG2 "zero hunger" a top priority in the country (Laohamutuk, 2017).

According to the result of this study showed that FOF on level 9000 kg/ha and planting distance minimal of 50 x 25 cm suitable to apply when cultivate sorghum in East Timor. Therefore, appropriate level fermented organic fertilizer and planting distance will offer high benefit to farmer where have limitation land.

CONCLUSIONS

To conclude that treatment of FOF had significant effect on total leaf, sorghum height, biomass production and seed production with the best treatment was A3 (FOF 9000 kg/ha) with the highest total leaf was 72,86 leaf/plant; highest sorghum was A3 (72,87) cm, biomass production was A3 (1,69 kg/plant) and seed production was A3 (0,60 kg/plant), while treatment of planting distance had significant effect only on height sorghum was B2 (90,61 cm). The biomass production was 1,69 kg/plant equivalent to 23,78 ton/ha, while seed production was at 0,64 kg/plant or equivalent to 8,37 ton/ha. Sorghum is potential to be a staple food replacer on rice and corn; its biomass can be a feed for ruminants.

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CONFLICT OF INTEREST

There are no conflict of interest.

NOVELTY STATEMENT

Sorghum can be as a staple food in East Timor, using fermented organic fertilizer of 9000 kg/ha produced high biomass and seed production of sorghum in East Timor.

AUTHORS CONTRIBUTION

Yuliaty carried out organized the manuscript draft and coordinated the entire article writing. Brigida A. Correia carried out the research and data collection, participated in the sequence alignment. Ligia T. Correia participated in the design of the study and performed the statistical analysis. Joa Americo conceived of the study, and participated in its design and coordination and helped to draft the manuscript. Mateus da Cruz de Carvalho carried out and helped on statistical analysis. Joana da C. Freitas participated in data collection, rechecked the manuscript draft. All authors read and approved the final manuscript.

REFERENCES

AOAC. (2005). Official Methods of Analysis of the Association of Official Analytical Chemists. Association of Official Analytical Chemists Publ. Maryland.

Andriani A, M,Isnaini (2016). Morfologi dan Fase Pertumbuhan Sorgum. Jakarta: Balai Penelitian Tanaman Serealia.

Azis A, H Arman. (2013). Respon Jarak Tanam dan Dosis Pupuk Organik Granul yang Berbeda Terhadap Pertumbuhan dan Produksi Tanaman Jagung Manis. J. Agrisistem. Vol 9 No. 1. Hal: 16-23

Bullard R.W, J.O. York (1985). Breeding for bird resistance in sorghum and maize. In Russel, G.E. (Eds.Plant breeding progress reviews. Butterworth, Surrey. (1): 193 – 222. https://doi.org/10.1016/B978-0-407-00780-2.50012-6

Ezward C. A. Haitami, E.Indrawanis (2019). Efforts to Increase Sorghum (Sorghum bicolor (L. Moench)) Productivity through Bioboost Fertilizer. Agricult. Scient. J. 16 (1): 46-53. https://doi.org/10.31849/jip.v16i1.2344

Dahlan FH; Khairudin (2007). The Effect of Using Cow Manure Bokashi Fertilizer on Growth and Production of Corn Plants. J. Agribisnis: 3(1).

Directorate General of Plantations, (1995). Sweet Sorghum Commodity of Hope in the Provinces of Eastern Indonesia. Balitkabi Special Edition: 4: 6–12.

Dwidjoseputro D. (1996). Introduction to Plant Physiology. Gramedia. Jakarta.

FAO. (2000). Food and Agriculture Organization. Sweet Sorgum in China. China: Spotlight.

Goa MJ; Li J, X Zhang (2012). Resposes of Soil Fauna Structure and lLeaves Litter Decomposition to Effective Microorganism Treatments in Dahiggan Mountains. Chinese Geograph. Sci. 22 (6): 647 - 658. https://doi.org/10.1007/s11769-012-0573-6

Hartatik L.R., Widowati. (2010). Pupuk Organik dan Pupuk Hayati. http://www.balittanah.litbang.deptan.go.id. Diakses 20 April 2023.

Haryanto D, ER Sasmita (2019). The Effect of Planting Distance and Types of MAnure on the Growth and Biomass of Indogofera. Agrivet. 25 (70-77). https://doi.org/10.31315/agrivet.v25i2.4284

Irwan A.W, Wahyudin A, Susilawati R., Nurmala T. (2004). Interaction of plant spacing and type of manure on yield components and flour content of sorghum (Sorghum bicolor L. Moench) in Inceptisols in Jatinangor. J. Budidaya Tanaman., 4: 128-136.

Kadir (2016). Applied Statistics. Concepts, Examples and Data Analysis with the SPSS Lisrel Program in Research. PT. Raga Grafindo Persada. Jakarta.

Kartaatmadja S., F Fagi (2000). Pengelolaan Tanaman Terpadu: Konsep dan Penerapan. Jakarta: Penebar Swadaya.

Khaidir, Usnawiyah, Hendrival, Hafifah E. S., Dewi M. Yusuf, Z. Wirda. (2021). Sorghum as an Bioenergy and Food Self-Sufficiency. Global Science Society : J. Ilmiah Pengabdian Kepada Masyarakat. GSS: 3(2) 151 – 160. https://doi.org/10.33059/gss.v3i2.3729

Koten BB; R, D Soetrisno, N Ngadiyono, B Suwigniyo (2012). Production of Shorgum Plant (Shorgum Bicolor (L) Moench) of Rote Local Variety as Forage for Ruminant Feed at Different of Harvest Timor and Urea Level. Bulletin Peternakan: 36(3) 150 - 155. https://doi.org/10.21059/buletinpeternak.v36i3.1622

Laili N., T. Mukaihara;, H Matsui, M. Yamamoto, Y. Noutoshi, K. Toyoda, Y. Ichinose. (2021). Role of Trehalose Synthesis in Ralstonia syzygii subsp. indonesiensis PW1001 in Inducing Hypersensitive Response on Eggplant (Solanum melongena cv. Senryo-nigou). Plant Pathol. J. 37(6): 566–579. https://doi.org/10.5423/PPJ.OA.06.2021.0087

Laohamutuk.org.Agri (2017).AgriculturePolicy.pdf.https://www.laohamutuk.org/Agri/2017AgriculturePolicy4Jul2017en.pdf. Accessed March 2023

Liu W, M. Tollenaar, G. Stewart, W. Deen. (2004). Within – Row Plat Spacing Variability Does Not Effect Corn Yield. Agron. J. 96 : 275 – 280. https://doi.org/10.2134/agronj2004.2750

Maddonni G. A, A. G. Cirilo, M. E. Otegui. (2006). Row Width and Maize Grain Yield. Agron. J: 98:1532-1543. https://doi.org/10.2134/agronj2006.0038

Manuhuttu. A.P, H. Rehatta dan J. J. G. Kailola. (2014). Effect of Concentration of Bioboost Fertilizer on Increasing Lettuce Production (*Lactuca sativa*. L). Agrologia Jurnal Ilmu Budidaya Tanaman. Volume 3. Nomor 1.

Marzuki, Murniati, Ardian (2013). The Effect of Planting Spacing and Fertilizer Doses on the Growth and Production of Paddy Rice (*Oryza sativa* L) with the Sri Method. Riau: Fakultas Pertanian Universitas Riau.

Munawar A. (2011). Kesuburan Tanah dan Nutrisi Tanaman. Bogor. IPB Press.

Pandutama M.H., A. Mudjiharyati, Suyono dan Wustamidin. (2003). Dasar-Dasar Ilmu Tanah. Jurusan Tanah Fakultas Pertanian Universitas Jember. Jember.

Prihatman K (2000). Budidaya Padi, Pendayagunaan dan Pemasyarakatan Ilmu Pengetahuan Teknologi. Bogor Press.

Purnomohadi M. (2006). Potensi Penggunaan Beberapa Varietas Sorgum Manis (Sorghum bicolor (L.) Moench sebagai Tanaman Pakan. Berk. Penel. Hayati.; 12 (41-44). https://doi.org/10.23869/bphjbr.12.1.20067

Rumambi (2013). Growth Characteristics of Sorghum With Different Urea Fertilization As a Nitrogen Source. Laporan Penelitian Unggulan Perguruan Tinggi (BPOTN) Universitas Sam Ratulangi, Manado.

Sanchez P.A, T. J. Logan (1992). Myths and Science about the

Chemistry and Fertility of Soils of the Tropics. Madison, USA: Soil Science Society of America. p. 36.

Shoemaker C E, DI Bransby (2010). The Role of Shorgum as bioenergy feedstock in R. Barun, D. Karlen and d. Johnson (Eds). Sustainable alternative fuel feedstock opportunities, challenges, and roadmaps (pp. 149-160). U.S. Regions: For six.

Slameto. (2022). Daya Hasil Sorgum dengan Sistem Tanam Zigzag pada Lahan Kering Masam di Wilayah Kabupaten Lampung Selatan, Provinsi Lampung. Prosiding Seminar Nasional Hasil Penelitian Agribisni: Vol. 6, No. 1: 332 - 338).

Susanto R. (2002). Penerapan Pertanian Organik, Pemasyarakatn dan Pembangunannya. Yogyakarta: Penerbit Kanisius.

Tarigan J A, E Zuhry, Nurbaiti (2015). Uji Daya Hasil Beberapa genotype sorgum manis (Sorghum bicolor (L) Moench) Koleksi Batan. J. Online Mahasiswa Faperta UNRI: 2(1): 1-15.

Times Indonesia (TI). (2016). Produktivitas Sorgum Lamongan Lampaui Produksi Nasional. https://timesindonesia.co.id/peristiwa-daerah/134892/produktivitas-sorgum-lamongan-lampaui-produksi-nasional. Accessed March 2023

WFP (2020). World Food Programme on Food Security in Eats Timor. Timor-Leste Food Security Bulletin.

Yoku O, D, Soetrisno S, A Sirads (2007). Effect of Planting Spacing and NPK Fertilization on Sudanese Grass Production (Shorgum sudanenses). Agritek. 15: 81 - 87.

Yuliaty S, Low J, Fisher G, Mcl. Dryden (2013). Energy Requirement for Maintenance and Growth of Entire Male Bali Cattle in East Timor. Anim. Prod. Sci.: 54(7) 908 - 914. https://doi.org/10.1071/AN13092.