Evaluation of plant distance and composition of goat manure in okra (*Abelmoschus esculentus* l.) plant in supporting food security

A Nurmas\(^1\), T C Rakian\(^2\), N P E R Asdari\(^3\), M Tufaila\(^4\), A Rahman\(^5\) and N E Dungga\(^6\)

\(^1\)Department of Agrotechnology, Concentration on Agronomy, Faculty of Agriculture, Halu Oleo University
\(^2\)Department of Agrotechnology, Concentration of Weed Science, Faculty of Agriculture, Halu Oleo University
\(^3\)Bachelor of Agriculture, Department of Agrotechnology, Faculty of Agriculture, Halu Oleo University
\(^4\)Department of Soil Science, Faculty of Agriculture, Halu Oleo University
\(^5\)Department of Plant Protection, Faculty of Agriculture, Halu Oleo University
\(^6\)Department of Agronomy, Faculty of Agriculture, Hasanuddin University, Jl. Perintis Kemerdekaan KM 10, Makassar, 90245, Indonesia

Email: nurmas_aksan@yahoo.co.id

Abstract. This study aims to evaluate the spacing and compost of goat manure at different levels to the growth and yield of okra plants in supporting food security. The study used a factorial randomized block design, with treatment spacing (60cm x 40cm; 70cm x 40cm; 80cm x 40cm) as the first factor and treatment of goat manure compost doses (0, 5, 10, 15, and 20 tons ha\(^{-1}\)) as a second factor. Variables observed were plant height, stem diameter, number of leaves, 50% flowering age, number of fruits, and fruit weight. Data were analyzed by analysis of variance followed by the BNJ test of 95%. The results showed that there was an interaction of plant spacing and compost doses of goat manure on the variable height of plants aged 14 and 28 DAP, the number of leaves 28 DAP, stem diameter 48 DAP age, and fruit weight. While plant spacing has an independent effect on the variable number of flowers, number of fruits, and fruit weight and compost dosage of goat manure on plant height variables 42 days after planting, number of leaves aged 14 and 42 days after planting, stem diameter 28 days after planting, number of fruits and fruit weights. The combination of spacing of 80cm x 40cm with compost doses of goat manure 20 (tons ha\(^{-1}\)) is the best treatment on the variable number of fruits and the weight of fruit of okra plants.

1. Introduction

Political ecology is a theoretical perspective that seeks to integrate human and physical approaches to environmental change through political, ecological, and economic analysis of marginal societies, social and cultural pressures of production on local resources, and local-global political interactions [1]. Managing the physical environment of plants by looking at the links between nutritious food, environmental strength, politics, and human cultural behavior is one of the efforts in describing food security strategies collectively to provide perspectives on nutrition intake from the individual level to the broader level of international policy by viewing individuals as part of the cultural and ecological environment [2-4].

Soil fertility with the addition of organic matter in an effort to support the growth and yield of okra plants that can provide carbohydrates, proteins, fats, minerals, and vitamins. One of the okra-producing regions, namely East Java and is developing quite well in the area. However, for the Southeast Sulawesi region, it is not well known and not widely cultivated. [5] The okra plant
(Abelmoschus esculentus L.) is a plant, including the Malvaceae family, and originates from tropical Africa. Currently, okra plants have been widely developed in various tropical and subtropical countries. Okra fruit can be used as a vegetable that can be consumed by boiling, frying, or slicing and consumed directly. In 100 g okra fruit contains 88% water, 2.1% protein, 0.2% fat, 8% carbohydrate, 1.7% fiber, and 0.2% ash [6].

In general, there has been an increase in the need for okra, but okra production in Indonesia is still low due to the availability of okra seeds and the lack of public knowledge about crop cultivation. In some tropical countries, okra production has not been able to reach optimum (2-3 tons/ha) with high quality, because soil fertility continues to decline [7], because it needs efforts to increase the production of okra through environmental management of growing plants with increased soil fertility and spacing by giving goat manure compost at various levels to support optimal growth and production.

The problem faced in the cultivation of okra plants in Southeast Sulawesi is dry land, which mostly has growth limiting factors, such as low soil fertility, acidic reactions, and solubility of Al and Fe, which can poison plants. To overcome this problem, we need to be carried out environmental protection for plant growth sites by evaluating the spacing and soil fertility. The solution offered is the provision of compost goat manure organic material which is expected to improve the ability of the soil to store water, increase infiltration capacity and drainage [8], so that the productivity of okra plant land increases and the community's need for healthy, safe and high nutritional vegetables in the era globalization towards sustainable food security and food security.

One of the strategies to increase land productivity is to regulate plant populations by adjusting plant spacing. Spacing suitable for okra plants ranges from 60-80 cm in one row with spacing between 20-30 cm [9]. Larger spacing can produce fruit with better fruit quality characteristics because of the availability of sufficient nutrients, moisture, and sunlight for plants due to low plant density. Plants with a wide distance will try to translate more photosynthate into the fruit so that the fruit produced becomes larger and heavier than those produced by plants at close range [10]. The application of manure increases nutrient uptake, reduces the use of chemical fertilizers, improves soil aggregates, increases the number of soil pores so that the wider reach of roots to absorb nutrients, and increases fertilization efficiency [11]. Goat manure is a fertilizer derived from goat manure, containing 0.7% N element; P205 0.4%; K20 0.25%, CaO 0.4%; C / N ratio of 20-25%; 31% organic matter and 64% moisture content [12].

2. Methods

2.1. Research design

This research was conducted at the Agronomy Laboratory, Faculty of Agriculture, Halu Oleo University, from March to June 2018. The study used a randomized basic design factorial pattern group, with the treatment of spacing (60cm x 40cm; 70cm x 40cm; and 80cm x 40cm) as the first factor and treatment of goat manure compost dose (0, 5, 10, 15, and 20 tons ha-1) as the second factor.

Evaluation of Growth and Yield of Okra Plants: Observed variables: plant height age 14, 28 and 42 DAP, stem age 14, 28 and 42 DAP, number of leaves (strands) age 14, 28 and 42 DAP, flowering age (50%), number of fruits (fruit) and weight of fruit (g).

2.2. Statistic analysis

Data from observations of each observation variable were analyzed based on the prints. If \( F_{count} > F_{table} \) the 95% BNJ test. The design model used for factorial design \( a \times b \) [11] is:

\[
Y_{ijk} = \mu + A_i + B_j + AB_{ij} + e_{ijk} (ij)
\]

with \( i = 1, 2, \ldots, a \)

\( j = 1, 2, \ldots, b \)

\( k = 1, 2, \ldots, n \)
Yijk = response variables k-th observation results that occur because of the joint influence of the i-th level of factor A and the j-level factor B

μ = actual average (constant value)

Ai = i-level effect A factor

Bj = j-level effect B factor

ABij = interaction effect between i-level effect A factor and j-level effect B factor

€k (ij) = the effect of the experimental unit to k in a combination of treatments (ij)

3. Results and discussion

3.1. The effect of interaction between planting distance and goat manure compost on plant height (cm)

The results of the evaluation of the effect of the interaction of plant spacing and compost on the variable height of plants aged 14 and 28 daps showed the spacing (80cm x 40cm) at a dose of 20 (t ha\(^{-1}\)) showed higher plant height growth compared to other treatments. There is an independent effect of compost dose on plant height at 42 daps, shown in tables 1, 2, and 3.

Table 1. Interaction between spacing and compost dosage of goat manure on average height (cm) of okra plants (14 days after planting).

| Planting Distance (cm) | The dose of Goat Manure (ton ha\(^{-1}\)) | BNJα0.05 |
|------------------------|----------------------------------------|-----------|
|                        | 0          | 5     | 10    | 15     | 20    |            |
| 60cmx40cm              | 4.78 a     | 6.47 a| 9.03 a| 10.18 a| 10.70 a| 3.376     |
| 70cmx40cm              | 5.42 a     | 6.77 a| 7.56 a| 8.78 a | 13.67 a| q          |
| 80cmx40cm              | 6.33 a     | 7.43 a| 7.56 a| 10.73 a| 13.67 a| r          |

Note: The numbers followed by the same letters in the same column and row are not significantly different based on the 95% BNJ test.

Table 2. Interaction between spacing and compost dosage of goat manure on average height (cm) of okra plants (28 days after planting).

| Planting Distance (cm) | Dose of Goat Manure (ton ha\(^{-1}\)) | BNJα0.05 |
|------------------------|-------------------------------------|-----------|
|                        | 0      | 5       | 10     | 15     | 20     |            |
| 60cmx40cm              | 9.62a  | 12.00a  | 14.84a | 15.40b | 17.56b | 6.798     |
| 70cmx40cm              | 9.96a  | 12.22a  | 14.70a | 15.28b | 31.91a | p          |
| 80cmx40cm              | 10.18aa| 12.43a  | 18.48a | 23.40a | 32.85a | s          |

Note: The numbers followed by the same letters in the same column and row are not significantly different based on the 95% BNJ test.

Table 3. Evaluation of the independent effect of compost doses of goat manure on average height (cm) of okra plants (42 days after planting).

| Goat Manure Compost Dose (ton ha\(^{-1}\)) | Average Height of Okra (cm) 42 DAP | BNJα0.05 |
|------------------------------------------|------------------------------------|-----------|

3
The results of the 95% BNJ test (Tables 1a, 1b, and 1c) show that there is a positive interaction between the spacing and compost doses of goat manure in stimulating growth in the height of okra plants aged 14 and 28 HST, but the compost dose has an independent effect at 42 HST. This fact is allegedly due to the availability of nitrogen nutrients from the compost of goat manure that has undergone decomposition and is available sufficient and balanced for plant height growth. According to [14] N nutrients are needed by plants and have a significant role in stimulating the vegetative growth of plants as a whole, especially the growth of stems that are able to spur growth in plant height. The results of the study [15] reported that the higher the dose of N, the higher the rate of cell division and tissue formation resulted in an increase in plant vegetative growth. This is supported by the results of the analysis of goat manure with an N value of 0.83-0.95% (very high) [16]. According to [17], that loss of N in the soil is also caused by absorption by plants or transported during harvest, washing by water, and denitrification. Compost application can increase the availability of N nutrients in the soil.

3.2. Effect of goat manure compost on number of leaves (strands)

The results of the evaluation of the independent effect of compost on the variable number of leaves aged 14 and 42 DAP and the interactions that occur between the two at 28 DAP. The 20 tons ha-1 dose treatment provided the highest number of leaves compared to other treatments at the ages of 14 and 42 dd, shown in tables 4, 5, and 6.

Table 4. Evaluation of the effect of goat manure compost on the average number of leaves (strands) of okra plants (14 days after planting).

| Goat Manure Compost Dose (ton ha⁻¹) | Average Number of Leaves (strands) 14 hst | BNJa0.05 |
|-------------------------------------|------------------------------------------|----------|
| 0                                   | 3.30c                                    | 0.735    |
| 5                                   | 4.07b                                    |          |
| 10                                  | 4.45b                                    |          |
| 15                                  | 4.69b                                    |          |
| 20                                  | 5.74a                                    |          |

Note: The numbers followed by the same letters are not significantly different based on the 95% BNJ test

Table 5. Interaction between spacing and compost dosage of goat manure on the average number of leaves (strands) of okra plants (28 days after planting).

| Planting Distance (cm) | Dose of Goat Manure (ton ha⁻¹) | BNJa0.05 |
|------------------------|-------------------------------|----------|
| 60cmx40cm              | 0                             | 3.336    |
|                        | 5                             |          |
|                        | 10                            |          |
|                        | 15                            |          |
|                        | 20                            |          |

Note: The numbers followed by the same letters are not significantly different based on the 95% BNJ test
Goat Manure Compost Dose (ton ha⁻¹)

Average Diameter of Stem (cm)  

28 hst  

BNJα0.05

| Goat Manure Compost Dose (ton ha⁻¹) | Average Diameter of Stem (cm) 28 hst | BNJα0.05 |
|----------------------------------|-------------------------------------|----------|
| 0                                | 0.24ᵇ                                | 0.206    |
| 5                                | 0.27ₐᵇ                               |          |
| 10                               | 0.37ₐᵇ                               |          |
| 15                               | 0.27ₐᵇ                               |          |
| 20                               | 0.45ᵃ                                |          |

Note: The numbers followed by the same letters are not significantly different based on the 95% BNJ test.
Table 8. Interaction of spacing and compost dosage of goat manure with average stem diameter (cm) of okra plants (42 days after planting).

| Planting Distance (cm) | Goat Manure Compost Dose (ton ha⁻¹) | BNJα0.05 |
|------------------------|--------------------------------------|----------|
|                        | 0         | 5   | 10  | 15  | 20  |
| 60cmx40cm              | 1.04a     | 1.42a | 2.03a | 2.07a | 3.14c | 0.830 |
|                        | r   | qr  | q   | q   | p   |
| 70cmx40cm              | 1.11a     | 1.53a | 2.40a | 2.31a | 4.28b |
|                        | r   | r   | q   | qr  | p   |
| 80cmx40cm              | 1.24a     | 1.49a | 2.50a | 2.66  | 5.73a |
|                        | r   | r   | q   | q   | p   |

Note: The numbers followed by the same letters in the same column and row are not significantly different based on the BNJ95% test.

BNJ 95% test results (tables 7 and 8) show that plant spacing affects okra plant populations. This is alleged because goat manure compost can increase the vegetative growth of plants. The wider the plant spacing, the less the plant population so that the stem diameter tends to be larger than the denser spacing [21]. This increase is caused by nutrients needed by plants in sufficient quantities to be absorbed by plants so that it significantly affects the diameter of the stems of okra plants [22].

3.4. The Effect of planting distance on the number of flowers (50% flowering)
The results of the evaluation of the independent effect of plant spacing on the number of flowers of okra plants show that there is a positive correlation between spacing with different populations with the number of flowers. It is shown that at wider plant spacing, the greater number of flowers is shown in table 9.

Table 9. Evaluation of the effect of plant spacing on the number of flowers (50% flowering) plants okra.

| Planting Distance  | Number of Flowers (florets) | BNJα0.05 |
|--------------------|----------------------------|----------|
| 60cmx40cm (J1)    | 10.23b                     | 0.487    |
| 70cmx40cm (J2)    | 10.82a                     |          |
| 80cmx40cm (J3)    | 10.89a                     |          |

Note: The numbers followed by the same letters are not significantly different based on the 95% BNJ test.

The results of the 95% BNJ test (Table 4) show that plant spacing has an effect on the number of flowers (50% flowering). The spacing of 70cm x 40cm and 80cm x 40cm is significantly different from the spacing of 60cm x 40cm. This is thought to be caused by different plant populations so that competition in terms of nutrient utilization, especially phosphorus, is greater, causing the number of flowers formed at 60cm x 40cm plant spacing to decrease. This is in line with the research [23] that the highest fresh weight production of broccoli is obtained at a dose (300 g plant⁻¹) with a spacing of 50cm x 60cm, and if one of the factors with a decreased dose or spacing is getting closer or both will reduce fresh production weight. The results of the study [24] showed that goat manure with a dose of 1: 2 increased the number of leaves, a dose of 1: 1, mainly increased the number of leaves and fresh weight and a dose of 1: 4 increased the fresh weight of kailan.
3.5. The effect of goat manure compost dose on the number of the fruit of okra plants

The results of the evaluation of the effect of spacing and compost dosage of goat manure on the average number of okra fruit showed that the treatment with compost dose was significantly different from control. This shows that goat manure compost affects the number of fruits per plant and per hectare, shown in tables 10 and 11.

**Table 10.** Evaluation of the effect of a dose of goat manure compost to the average number of fruits okra plants (5 times the harvest).

| Goat Manure Compost Dose (ton⁻¹) | Average Number of Fruits (plant fruit⁻¹) | BNJα0.05 |
|----------------------------------|-----------------------------------------|----------|
| 0                                | 52.10b                                  | 5.651    |
| 5                                | 58.30a                                  |          |
| 10                               | 60.98a                                  |          |
| 15                               | 59.01a                                  |          |
| 20                               | 59.39a                                  |          |

Note: The numbers followed by the same letters are not significantly different based on the 95% BNJ test.

**Table 11.** Evaluation of the effects of plant spacing and doses of goat manure compost to the average number of fruits okra plants (5 times the harvest).

| Planting Distance (cm) | Number of Fruits (fruit ha⁻¹) | BNJα0.05 |
|------------------------|-------------------------------|----------|
| 60cmx40cm              | 2,416,111.11a                 | 13,308.113|
| 70cmx40cm              | 2,135,000.00b                 |          |
| 80cmx40cm              | 1,753,125.00c                 |          |
| Goat Manure Compost Dose (ton⁻¹) | Number of Fruits (fruit ha⁻¹) | BNJα0.05 |
| 0                      | 1,885,284.39b                 | 202,224.555|
| 5                      | 2,110,416.67a                 |          |
| 10                     | 2,210,912.70a                 |          |
| 15                     | 2,143,386.24a                 |          |
| 20                     | 2,157,060.19a                 |          |

Note: The numbers followed by the same letters are not significantly different based on the 95% BNJ test.

The results of the 95% BNJ test (tables 10 and 11) showed that okra plants without compost application of goat manure were significantly different with doses of 5, 10, 15, and 20 (tons ha⁻¹) on the number of okra fruit. But there are significant differences from the three planting distances used. The results of evaluating the independent effect of goat manure compost at doses of 5, 10, 15 and 20 (ton ha⁻¹) were not significantly different, but significantly different from the controls (Table 5b), tighter spacing can lead to higher fruit numbers but lower fruit weights. This is influenced by the higher number of fruits but lower fruit weight (Table 6) both in the evaluation of spacing and compost dosage of goat manure. The results of the study [25] showed that the combination of a spacing of 50 cm x 50 cm with PPC 2 ml / l of water gave the best effect on crop yields. Research results [25] and [26] show that the use of compost can improve soil fertility and can increase crop yields.

3.6. The effect of spacing or goat manure compost dose on fruit weight (g)

The results of the evaluation of the effect of spacing or compost dosage of goat manure on the average weight of okra planting showed that the wider the spacing (80cm x 40cm), the higher the weight of the fruit compared to the spacing (70cm x 40cm) and (60cm x 40cm), also at compost dose 20 (ton ha⁻¹)
is significantly different from other treatments. There was a significant interaction between the spacing of 80cm x 40cm with a compost dose of 20 (ton ha⁻¹) shown in table 12.

**Table 12.** Evaluation of the effect of plant spacing and doses of goat manure compost to the average fruit weight (g) plant okra.

| Planting Distance (cm) | Average Fruit Weight (g) | BNJα0.05 |
|------------------------|--------------------------|-----------|
| 60cmx40cm              | 1.03c                    | 0.040     |
| 70cmx40cm              | 1.12b                    |           |
| 80cmx40cm              | 1.28a                    |           |

| Goat Manure Compost Dose (ton ha⁻¹) | Average Fruit Weight (g) | BNJα0.05 |
|-------------------------------------|--------------------------|-----------|
| 0                                   | 1.05d                    | 0.061     |
| 5                                   | 1.08cd                   |           |
| 10                                  | 1.14bc                   |           |
| 15                                  | 1.17b                    |           |
| 20                                  | 1.28a                    |           |

Note: numbers followed by the same letters are not significantly different based on the 95% BNJ test.

**Table 13.** Interaction between spacing and compost dosage of goat manure to the average weight of fruit (g) of okra plants.

| Planting Distance (cm) | Goat Manure Compost Dose (ton ha⁻¹) | BNJα0.05 |
|------------------------|-------------------------------------|----------|
| 60cmx40cm              | 28.21a                              | 6.237    |
| 70cmx40cm              | 26.06a                              | p        |
| 80cmx40cm              | 26.78a                              | q        |

Note: The numbers followed by the same letters in the same column and row are not significantly different based on the BNJ95% test.

**Table 14.** Evaluation of the effect of plant spacing and doses of goat manure compost to the average fruit weight (g) plant okra.

| Planting Distance (cm) | Average Fruit Weight (g) | BNJα0.05 |
|------------------------|--------------------------|----------|
| 60cmx40cm              | 1.08b                    | 0.068    |
| 70cmx40cm              | 1.12b                    |          |
| 80cmx40cm              | 1.29a                    |          |

| Goat Manure Compost Dose (ton ha⁻¹) | Average Fruit Weight (g) | BNJα0.05 |
|-------------------------------------|--------------------------|----------|
| 0                                   | 0.98c                    | 0.103    |
| 5                                   | 1.17b                    |          |
| 10                                  | 1.17b                    |          |
| 15                                  | 1.20ab                   |          |
| 20                                  | 1.30a                    |          |

Note: The numbers followed by the same letters in the same column and row are not significantly different based on the 95% BNJ test.
The results of the 95% BNJ test (Tables 12, 13, and 14) show that the treatment of plant spacing and goat manure has an independent and interaction effect. This is presumably due to population density due to varying plant spacing. This is in accordance with the results of the study [27] that the density of plant populations is determined by the distance in rows compared to the distance between rows.

A low population density of 50,000 plants per hectare results in the highest number of branches, the number of fruits and fruit weight per plant compared to a population density of 100,000, and 66,666 plants per hectare, but a high density gives a higher fruit weight per ha. [28] obtained the highest yield (23.99 t ha-1) at 45 x 30 cm spacing, but [29] suggested giving a broader spacing in rows up to 90 cm for the highest yield.

4. Conclusion
The results showed that there were positive interactions between plant spacing and compost doses of goat manure in the variable height of plants aged 14 and 28 DAP, the number of leaves 28 DAP, stem diameter 48 DAP, and weight of fruit. Plant spacing has an independent effect on the variable number of flowers, number of fruits, and fruit weight and compost dosage of goat manure on the height of plant age 42 DAP, number of leaves aged 14 and 42 DAP, stem diameter 28 DAP, number of fruits and fruit weight. The combination of spacing of 80cm x 40cm with compost doses of goat manure 20 tons ha-1 is the best treatment on the variable number of fruit and weight of okra fruit.

Reference
[1] Zimmerlee K S and Bassett T J 2003 Political Ecology: An Intergative Approach to Geogrhphy and Environment-Development Studises (New York: Guilford Press)
[2] Robbins P 2012 Political Ecology: A. Critical Introduction (Chichester: John Wiley & Sons)
[3] Rahmah M 2017 The protection of agricultural products under geographical indication: An alternative tool for agricultural development in Indonesia J. Intellect. Prop. Rights 22 90–103
[4] Widadie F and Agustono 2015 Comparison of integrated crop-livestock and non-integrated farming systems for financial feasibility, technical efficiency and adoption (Case of farmers in Gunung Kidul regency, Yogyakarta, Indonesia) J. Int. Soc. Southeast Asian Agric. Sci. 21 31–45
[5] Abd El-Kader A A, Shaaban S M and El-Fattah A 2010 Effect of irrigation levels and organic compost on okra plants (Abelmoschus esculentus L.) grown in sandy calcareous soil Agric. and Biol. J. of North Am. 1
[6] FAOSTAT 2009 Pertanian Organik Menuju Pertanian Alternatif dan Berkelanjutan (Jakarta: Kanisius)
[7] Akanbi W B, Togun A O, Adediran J A and Elupeju E A O 2010 Growth, dry matter and fruit yields components of okra under organic and inorganic sources of nutrients. American-Eurasian J. of Sust Agric. 4
[8] Abd El-Kader A A, Shaaban S M and El-Fattah A 2010 Effect of irrigation levels and organic compost on okra plants (Abelmoschus esculentus L.) grown in sandy calcareous soil Agric. and Biol. J. of North Am. 1
[9] Sutanto R 2002 Pertanian Organik Menuju Pertanian Alternatif dan Berkelanjutan (Yogyakarta : Kanisius)
[10] Tindall 1988 Vegetables in The Tropics (London: Macmillan Education Ltd)
[11] Maurya R P, Bailey J A and Chandler J S A 2013 Impact of plant spacing and picking interval on the growth, fruit quality and yield of okra (Abelmoschus esculentus (L.) Moench). Am J. of Agric. and Fores. 1
[12] Lingga P 1991 Jenis Kandungan Hara pada Beberapa Kotoran Ternak. Pusat Penelitian Pertanian dan Pedesaan Swadaya (P4S), Antanan, Bogor
[13] Sudjana 1991 Desain dan Analisis Eksperimen Edisi III (Bandung: Penerbit Trasito)
[14] Suryati D, Sampurno and Anom E 2015 Uji beberapa konsentrasi pupuk azolla (Azolla pinnata) pada pertumbuhan bibit kelapa sawit (Elaeis guineensis Jacq.) di pembibitan utama. JOM Faperta 2

[15] Firoz Z A 2009 Impact of nitrogen and phosphorus on the growth and yield of okra [Abelmoschus esculentus (L.) Moench] in hill slope condition Bang. J. Agril. Res. 34

[16] Effi I M 2009 Pupuk Organik, Cair dan Padat (Jakarta: Penebar Swadaya)

[17] Zulkarnain 2014 Perubahan beberapa sifat kimia tanah akibat pemberian limbah cair industry kelapa sawit dengan metode land application. J. Agrifor. 13

[18] Manyuchi M M, Kadzngura I, Phiri A and Muredzi P 2013 Effect of vermicompost, vermiwash and application time on Zea mays growth Intern. J. of Scientific Enginer.and Tech. 2

[19] Samuli S, Karimuna L and Sabaruddin L 2012 Produksi kedelai (Glicine max L.) pada berbagai dosis bokashi kotoran sapi. J. Berkala Agron. 1

[20] Hariadi Y C, Nurhayati A Y and Hariyani P 2016 Biophysical monitoring on the effect on different composition of goat and cow manure on the growth response of maize to support sustainability. Agric. and Agric. Sci. Proc. 9

[21] Shiyam J O, Binang W B and Stephen G E 2016 Effect of animal manure on soil nutrients replenishment and performance of okra (Abelmoschus esculentus L.) grown on degraded sandy soil in Calabar, Nigeria. J. of Environ. 1

[22] Raditiya J, Purbajanti E D, and Slamet W 2017 Pertumbuhan dan produksi okra (Abelmoschus esculentus L.) pada level pemupukan nitrogen dan jarak tanam yang berbeda. J. Agro Complex 1

[23] Dahang D 2018 Uji jarak tanam dan dosis pupuk organik terhadap pertumbuhan dan produksi tanaman broccoli (Brassica oleracea var. italiva L.) STEVIA 6

[24] Amrullah E R, Sutirman and Pullaila A 2013 Pengaruh pemberian pupuk organik kotoran kambing terhadap pertumbuhan dan hasil tanaman kafian (Brassica oleracea L.) Bul. IKATAN 3

[25] Ruminta, Yuvariah Y and Sabrina N 2017 Respon pertumbuhan dan hasil tanaman hanjeli (Coix lacryma-jobi L.) J. Agric. 28

[26] Tufaila M, Yusrina dan Alam S 2014 Pengaruh pupuk bokasi kotoran sapi terhadap pertumbuhan dan produksi padi sawah pada ultisol. J. Agrotek. 4

[27] Tufaila M, Dewi D L and Alam S 2014 Aplikasi kompos kotoran ayam untuk meningkatkan hasil tanaman mentimum (Cucumis sativus L.) di tanah masam J. Agroteknos 4

[28] Maurya R P, Bailey J A and Chandler J S A 2013 Impact of plant spacing and picking interval on the growth, fruit quality and yield of okra (Abelmoschus esculentus (L.) Moench). Am J. of Agric. and Fores. 1

[29] Madisa ME, Mpofu C and Oganne T A 2015 Effects of plant spacing on the growth, yield and yield components of okra (Abelmoschus esculentus L.) in Botswana. Am. J. of Exp. Agri. 6