

# Production Potential and Shelf-Life of Shallot as Affected by Inorganic Fertilizers Complemented with Organic Fertilizer and Rice Husk Charcoal in Dryland

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## ABSTRACT

Shallot (*Allium cepa* L.) is one of the important horticultural commodities with high economic value in Indonesia. The extent of planting areas in marginal land requires technological innovation for the development of shallot such as improvement and location-specific technological innovation. This research aims to observe the effect of various doses of inorganic fertilizers complemented with organic fertilizer and rice husk charcoal on the production and shelf-life of shallot. The study was conducted from March to June 2019 in East Lombok using a completely randomized block design with 1 factor and 5 levels of treatment: A1 (farmer's practices: 0 kg/ha organic fertilizer; 0 kg/ha rice husk charcoal; 300 kg/ha urea; 250 kg/ha NPK+Zn; and 100 kg/ha SP-36), A2 (10,000 kg/ha organic fertilizer; 10,000 kg/ha rice husk charcoal; 75 kg/ha urea; 62.5 kg/ha NPK+Zn; and 25 kg/ha SP-36), A3 (10,000 kg/ha organic fertilizer; 10,000 kg/ha rice husk charcoal; 150 kg/ha urea; 125 kg/ha NPK+Zn; and 50 kg/ha SP-36), A4 (10,000 kg/ha organic fertilizer; 10,000 kg/ha rice husk charcoal; 225 kg/ha urea; 187.5 kg/ha NPK+Zn; and 75 kg/ha SP-36) and A5 (10,000 kg/ha organic fertilizer; 10,000 kg/ha rice husk charcoal; 300 kg/ha urea; 250 kg/ha NPK+Zn; and 100 kg/ha SP-36). Results showed that plant height and leaf number were not significantly different in various treatments. The bulb number showed that at the age of 20 and 70 days after sowing, the highest value was shown in the A3, and the lowest value was shown in A1 and A2 treatments. Meanwhile, treatment of A5 can reduce weight loss of the prospective seeds.

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## 1. INTRODUCTION

The shallot crop (*Allium cepa* L.) is considered to be one of the most important horticultural commodities [1]. Shallot belongs to the spice vegetable crop and is usually used as food seasonings [2] as contains proteins, sugars, fatty acids, carbohydrates, and other minerals which needed by the human body [3]. In Indonesia, shallot is one of the prominent crops and is grown year-round by nearly a million of small-scale farmers [4], therefore it is categorized among the seven strategic commodities [5] as it affects farmers' lives, macro-economy, and rate of inflation [1], [6].

The Province of Nusa Tenggara Barat (NTB) is one of the major shallot production areas in Indonesia after the

provinces of Jawa Tengah (Central Java) and Jawa Timur (East Java). The average shallot productivity in NTB Province during the last 5 years (2015–2019) reached 11.04 tons/ha, this is still higher than the average productivity in East Java (8.80 tons/ha), Central Java (10.17 tons/ha), and West Java Province (10.56 tons/ha) [7]. The contribution of NTB Province to the Indonesian shallot production has reached 12.34% with the NTB's harvested area in 2019 reaching 19,341 ha and the production reaching 184,551.8 tons [7]. This productivity is categorized as low because due to the potential yield of new improved varieties such as Trisula and Bima Brebes reached 15 to 23.21 tons/ha [8]. The shallot planting areas in NTB Province are in Bima,

Sumbawa and East Lombok regencies [9]. East Lombok Regency is one of the shallot production centers in NTB with a production of 9,787.4 tons [10] and is one of the horticultural areas, especially shallot commodities [11].

Based on its use, dryland area is relatively more dominant, which reaches almost four times the area of rice fields [12]. The basic problems of dryland farming are very fast land degradation, low soil fertility, limited water resources and infrastructure support, lack of specific technological innovations and low knowledge of farmers on dryland farming which are pockets of poverty [13]. The use of dryland in Indonesia is still relatively small, while the potential for land that is considered marginal is quite large for agricultural development. Considering that as one of the Indonesian strategic commodities, shallots must be developed through some strategies, including the intensive use of marginal land [14].

To support high production for the development of shallot in dryland, improved and site-specific technological innovations are required with the application of site-specific improved technologies such as the use of adaptive varieties, fertilization as well as pest and disease control, water management and cropping patterns are expected to increase production, land productivity, farming efficiency and farmers' income as well as other environmentally friendly farming systems [15]. In agricultural cultivation systems, fertilizer is one of the important factors affecting plant growth. For optimal plant growth, the nutrients contained in the soil alone are not sufficient, however over application of inorganic fertilizers may result in decreased of land productivity. One of the ways to solve the further impacts that will arise from the excessive use of inorganic fertilizers is through the application of inorganic fertilizers with the right dose [16].

In addition, technological innovation is needed in the application of fertilizer therefore it is hoped that the effect of fertilizer application can be seen in growth and increasing shallot production. The addition of rice husk charcoal and organic matter is expected to influence increasing shallot production. Rice husk charcoal is one of the organic materials that contains various types of organic acids, besides the high silica content can be beneficial for plants because it becomes more resistant to pests and diseases due to tissue hardening [17]. Organic fertilizer contains low nutrients and has a slow response therefore it takes a long time to improve the level of soil fertility [18]. The combination use of organic and inorganic fertilizers was able to produce tomato production of 21.5 tons/ha compared to the use of inorganic fertilizers which only reached 10 tons/ha [19].

The aims of this research were to investigate the effect of various doses of inorganic fertilizers complemented with organic fertilizer and rice husk charcoal on the growth, production, and shelf-life of shallot in dryland.

## 2. MATERIALS AND METHODS

The research was conducted from March to June 2019 at the IAAT research station in East Lombok Regency, Nusa Tenggara Barat (NTB) Province, Indonesia. The research station is located at coordinates of  $-8^{\circ}30'47''$ ,  $116^{\circ}39'14''$ ,

TABLE I: DOSE OF FERTILIZATION TREATMENT ON SHALLOT CULTIVATION IN DRYLAND OF EASTERN LOMBOK IN 2019

| Fertilizers        | A1<br>(Farmers'<br>practices) | A2     | A3     | A4     | A5     |
|--------------------|-------------------------------|--------|--------|--------|--------|
| kg/ha              |                               |        |        |        |        |
| Organic fertilizer | 0                             | 10.000 | 10.000 | 10.000 | 10.000 |
| Rice husk charcoal | 0                             | 10.000 | 10.000 | 10.000 | 10.000 |
| Urea               | 300                           | 75     | 150    | 225    | 300    |
| NPK+Zn             | 250                           | 62.5   | 125    | 187.5  | 250    |
| SP-36              | 100                           | 25     | 50     | 75     | 100    |

TABLE II: THE FERTILIZATION PACKAGE PER PLOT (20 m<sup>2</sup>) APPLIED AT THE EXPERIMENTAL SITE OF EASTERN LOMBOK IN 2019

| Fertilizers        | A1 (Farmers' practices) | A2  | A3  | A4  | A5  |
|--------------------|-------------------------|-----|-----|-----|-----|
| kg/plot            |                         |     |     |     |     |
| Organic fertilizer | 0                       | 20  | 20  | 20  | 20  |
| Husk charcoal      | 0                       | 20  | 20  | 20  | 20  |
| Urea               | 3.3                     | 0.8 | 1.7 | 2.5 | 3.3 |
| NPK+Zn             | 2.8                     | 0.7 | 1.4 | 2.1 | 2.8 |
| SP-36              | 3.6                     | 20  | 1.8 | 2.7 | 3.6 |

56.4 ft at an altitude of 46.0 meters above sea level (masl). The Batu Ijo variety was planted using a 1 factor Randomized Completely Block Design (RCBD) with 5 levels of fertilization dose treatment as presented in Table I. While the fertilization package per plot is presented in Table II.

The were 7 sample plants/treatment observed with randomly selected following a zig-zag pattern. Fertilizers were applied by spreading it over the soil surface. Organic fertilizer, rice husk charcoal, and SP-36 fertilizers were applied during land cultivation, while ZA and NPK plus Zn fertilizers were applied 3 times at the age of 15, 30 and 45 days after sowing (DAS).

The implementation of the research includes clearing the land, beds making and drainage channels arranging. The application of basic fertilizers in the form of organic fertilizer as much as 10 tons/ha, SP-36 100 kg/ha and rice husk charcoal 10 tons/ha were given 7 days before sowing. While NPK+Zn 250 kg/ha and Urea 300 kg/ha were given together with rice husk charcoal, and SP-36 were distributed at the age of plants 15, 30 and 45 DAS. Before sowing, the shallot bulbs were treated by cutting off the ends 1/3 of the bulbs and sprinkled with fungicide.

Planting activities were conducted manually by planting one bulb/hole with 20 cm × 15 cm spacing. Maintaining of the plants includes weeding, which was conducted 2 times, irrigation was applied 2 times/7 days, fertilization at the plant ages of 15, 30, and 45 DAS, and controlling the pests and diseases according to the attacking level in the field.

The observed parameters included plant height, leaves, and bulbs numbers which were carried out at the age of 20 and 70 DAS. The sampling of fresh weight yield parameter was carried out at the age of 70 DAS (during harvest time), the shrinkage weight of the prospective shallot seed at the age of 30 and 60 Days After Harvest (DAH). To find out the differences between treatments, all the collected data were analyzed using ANOVA and followed by 5% level of an honest significant test.

### 3. RESULTS AND DISCUSSION

#### 3.1. General Conditions of the Experimental Site

The research was conducted at the experimental station in Labuhan Lombok Village, Subdistrict of Pringgabaya, East Lombok Regency with a flat topography with an altitude of 46.0 masl.

Based on soil analysis results prior to the experiment, it shows that soil pH of the experimental site was neutral which is an ideal condition for plant growth. In addition, total NPK nutrient content in the soil was very low, but the P and K nutrients available were very high. The detailed results of the pre-liminary soil analysis of the experimental site are presented in Table III.

Cation Exchange Capacity (CEC) at the experimental site was low with a value of 16.26 cmol/kg, however, it is still above the average CEC of sandy soils, which is usually 2–4 cmol/kg [21]. Some factors that may influence CEC are based on the amount of clay and organic matter [22].

#### 3.2. Shallot Growth Performances

The parameters of agronomic observation included plant height and leaf number. The performance of agronomic parameters is shown in Tables IV and V. Plant height was measured from the soil surface to the tip of the highest leaf (cm), and 15 sample plants in each experimental plot were measured at the age of 20 and 70 DAS. Based on the ANOVA results, it shows that plant height at the age of 20 and 70 DAS in each treatment did not differ significantly (Table IV), but the highest value was shown in the A3 treatment both at the age of 20 and 70 DAS. The lowest value from the observation of plant height was shown at the age of 20 DAS in treatment A2, but at the age of 70 DAS, namely in treatment A1. This

TABLE III: RESULTS OF PRE-LIMINARY SOIL ANALYSIS AT THE EXPERIMENTAL SITE OF EASTERN LOMBOK IN 2019

| Parameters of analysis | Unit    | Value  | Criteria*)        | Method             |
|------------------------|---------|--------|-------------------|--------------------|
| pH H <sub>2</sub> O    | –       | 8.41   | Slightly alkaline | Electrode pH-meter |
| N total                | %       | 0.11   | Very Low          | Kjeldahl           |
| P total                | %       | 0.05   | Very Low          | Spectrofotometer   |
| K total                | %       | 0.45   | Very Low          | AAS                |
| P available            | ppm     | 23.97  | Very high         | Spectrofotometer   |
| K available            | ppm     | 101.31 | Very high         | AAS                |
| CEC                    | cmol/kg | 16.26  | Low               | Percolation        |

Note: \*) based on Indonesian Soil Research Institute 2009 [20].

TABLE IV: ANALYSIS OF VARIANCE (ANOVA) OF PLANT HEIGHT DURING THE FIELD EXPERIMENT IN EASTERN LOMBOK IN 2019

| Treatments               | Plant height at 20 DAS (cm) | Std     | Plant height at 70 DAS (cm) | Std     |
|--------------------------|-----------------------------|---------|-----------------------------|---------|
| A 1 (Farmers' practices) | 43.143                      | a 3.237 | 42.143                      | a 16.41 |
| A 2                      | 42.714                      | a 5.491 | 47.143                      | a 5.08  |
| A 3                      | 46.857                      | a 4.706 | 45.143                      | a 4.22  |
| A 4                      | 45.143                      | a 5.242 | 43.143                      | a 4.22  |
| A 5                      | 45.286                      | a 5.589 | 44.571                      | a 4.721 |

Note: The average values followed by the same letters in the same column means that it is not significantly different at the 5% Tukey's Test.

TABLE V: ANALYSIS OF VARIANCE (ANOVA) NUMBER OF LEAVES OF SHALLOT AT THE EXPERIMENTAL SITE IN EASTERN LOMBOK IN 2019

| Treatments               | Number of leaves (20 DAS) | Std     | Number of leaves (70 DAS) | Std      |
|--------------------------|---------------------------|---------|---------------------------|----------|
| A 1 (Farmers' practices) | 23.86                     | a 8.63  | 17.286                    | a 7.718  |
| A 2                      | 24.43                     | a 5.62  | 17.143                    | a 7.988  |
| A 3                      | 39.29                     | a 12.76 | 29.429                    | a 8.018  |
| A 4                      | 36.29                     | a 10.87 | 19.143                    | a 7.862  |
| A 5                      | 36.43                     | a 16.96 | 22.286                    | a 10.797 |

Note: The average values followed by the same letters in the same column means that it is not significantly different at the 5% Tukey's Test 5%.

shows that the treatment dose of farmers' practices of 100% using inorganic fertilizers without the application of organic fertilizer and rice husk charcoal was not able to provide optimal growth of plant height.

It was argued that the increase in plant height occurs due to cell division and an increasing number of cells requiring energy in the form of ATP [23]. In this study, the dose of phosphorus as much as 50% of the dose of farmers has been able to provide a response to plant height. Phosphorus is a macro nutrient that plays a role in the formation of ATP (Adenosine Tri phosphate). ATP is needed by plants in every cell activity such as cell elongation, cell enlargement and cell division which affects plant height [24]. The concentration determination and fertilization dose are very important because they will have an adverse effect on growth if it does not match the needs of the plant [25].

Based on ANOVA results, the number of leaves observed in Table V showed that at the age of 20 and 70 DAS in each treatment did not show a significant difference, but the highest value was shown in the A3 treatment both at the age of 20 and 70 DAS. The lowest value from plant height observation was shown at the age of 20 DAS in treatment A1. At the age of 70 DAS, the lowest value was in treatment A2, which is the same as treatment A1. This shows that the farmers' practices dose of 100% use of inorganic fertilizers without application of organic fertilizer and rice husk charcoal was not able to provide optimal growth of the leaves.

The increase in plant height and leaf number can be caused by the addition of fertilizer given because the fertilizer will add nutrients to the soil, and the amount of additional nutrients depends on the type and dose of fertilizer used [26]. Another research also found that a 50% reduction of NPK fertilizer in soybeans could increase soybean production [27]. In addition, it was reported that organic fertilizers contained in the soil can grow microorganisms in the soil so that the soil will become more fertile [28].

#### 3.3. Bulb Numbers and Shallot Yields

Based on ANOVA results in Table VI, the number of bulbs shows that at the age of 20 and 70 DAS, the highest values shown in the A3 treatment, where the use of 50% inorganic fertilizers with the application of organic fertilizer and rice husk charcoal. The lowest values were shown in the farmer's treatment, namely A1 and A2 treatment using 25% inorganic fertilizers with the application

TABLE VI: ANALYSIS OF VARIANCE (ANOVA) NUMBER OF BULBS AND YIELDS DURING THE FIELD EXPERIMENT IN EASTERN LOMBOK IN 2019

| Treatments               | Bulbs number (20 DAS) | Std | Bulbs number (70 DAS) | Std | Yield (kg/m <sup>2</sup> ) | Std |
|--------------------------|-----------------------|-----|-----------------------|-----|----------------------------|-----|
| A 1 (Farmers' practices) | 4                     | b   | 4.286                 | b   | 2.226,7                    | ab  |
| A 2                      | 6.857                 | ab  | 4.143                 | b   | 1.955                      | b   |
| A 3                      | 7.571                 | a   | 8.286                 | a   | 2.831                      | a   |
| A 4                      | 6.714                 | ab  | 7.857                 | a   | 2.301,7                    | ab  |
| A 5                      | 4                     | b   | 5.286                 | ab  | 2.341,7                    | ab  |

Note: The average values followed by the same letters in the same column means that it is not significantly different at the 5% Tukey's Test.

of organic fertilizer and rice husk charcoal. According to [29], the more tillers number, the more bulbs produced. In addition, the availability of nutrients in plants can affect the number of tillers.

Table VI also shows that the highest yield of shallot in the treatment A3, where the use of 50% inorganic fertilizers with the application of organic fertilizer and rice husk charcoal, and the lowest in the treatment A2 where the use of 25% inorganic fertilizers with the application of organic fertilizer and rice husk charcoal. Another research [30] showed that the application of the recommended dose of NPK combined with organic fertilizer was quite prospective and good for the growth and yield of shallot. According to [31], the formation and development of shallot bulbs require a high and balanced NPK fertilization.

It was not different significantly between the control treatment and the application of organic fertilizer and rice husk charcoal; although the use of fertilizers was reduced from 50%–75%, it was not even significantly different from the treatment of giving 100% inorganic fertilizer with added organic fertilizer and husk charcoal, presumably due to the high availability of P and K in the soil. According to [32], the high availability of P-soil causes the addition of P fertilizer not to significantly increase the yield of shallot. The availability of sufficient P in the soil is very important for increasing plant growth because P is needed for the improvement of carbohydrate content and the development of plant roots. Potassium acts as an enzyme activator in photosynthetic reactions. The availability of sufficient potassium for plants will increase plant height growth. Nitrogen and Potassium will encourage plant metabolic activities and promote the growth of new cells. Other research [9] stated that potassium would increase the absorption of nutrients and play a role in respiration, transpiration of enzymes, and translocation of carbohydrates.

The availability of sufficient nutrients for plants and the power of rate of photosynthesis, so that the photosynthate produced increases. The results of [33] on shallot showed that the application of rice husk charcoal only had a significant effect on bulbs volume and the dose of rice husk charcoal gave the best effect on bulbs volume, where the application of rice husk charcoal at a dose of 20 tons/ha. According to [32], shallot is a type of plant that requires a lot of silica. Silica plays an important role in plant metabolism where it is related to several parameters that determine nutritional quality of vegetable crops. The results from other research [34] showed that rice husk charcoal has a high silica content in the form of a chemical compound silicon dioxide (SiO<sub>2</sub>), where 46.96% is needed for bulbs formation.

TABLE VII: ANALYSIS OF VARIANCE (ANOVA) WEIGHT LOSS OF PROSPECTIVE SHALLOT SEED

| Treatments              | 0 DAH  | Std | 30 DAH | Std | 60 DAH  | Std |
|-------------------------|--------|-----|--------|-----|---------|-----|
| A1 (Farmers' practices) | 2227   | ab  | 1473   | a   | 1265    | b   |
| A2                      | 1955   | b   | 1421.7 | a   | 1315    | b   |
| A3                      | 2831.7 | ab  | 1710   | a   | 1520    | ab  |
| A4                      | 2301.7 | ab  | 1738   | a   | 1601.67 | ab  |
| A5                      | 2342   | ab  | 1900   | a   | 1793.3  | a   |

Note: The average values followed by the same letters in the same column means that it is not significantly different at the 5% Tukey's Test.

### 3.4. Weight Loss of Prospective Shallot Seeds

Table VII shows that the lowest weight loss until the shallot bulbs were 60 days after harvest (DAH) was in the A5 treatment, where the application of 100% inorganic fertilizers combined with the application of organic fertilizer and rice husk charcoal as much as 10,000 kg/ha. The highest loss at the age of 60 DAH was in the A1 treatment, namely the treatment of farmers using 100% inorganic fertilizers without being combined with the application of organic fertilizer and rice husk charcoal. According to [35], large planting material indicates that the food reserves it contains are relatively large, so it is useful as a basic material for energy formation for plant growth processes. Other research also stated that organic matter is useful as a nutrient provider for plants that can increase production, and is also useful in improving the physical, chemical, and biological properties of the soil [36].

Based on [36], the application of rice husk charcoal did not affect all observed variables, it was suspected that the shallot response was less responsive to rice husk charcoal treatment.

## 4. CONCLUSION

Based on the results of this research, it can be concluded that the treatment with a reduced dose of 50% inorganic fertilizers combined with application of organic fertilizer and rice husk charcoal as much as 10,000 kg/ha was able to increase plant growth and production of shallots with a sampling yield of 2,831 kg/100 m<sup>2</sup> and this result is higher than the control treatment of farmers' practice with a dose of 100% inorganic fertilizers without application of organic fertilizer and rice husk charcoal with a yield of 2,226.7 kg/m<sup>2</sup>. Meanwhile, analysis of prospective seed losses indicated that the application of 100% inorganic fertilizers combined with the application of organic fertilizer and rice husk charcoal as much as 10,000 kg/ha could reduce the weight loss of prospective seeds.



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## AUTHORS CONTRIBUTORSHIP

BNH and TS are the main contributors of the paper (conceived and planned the experiments, carried out the experiments, contributed to the interpretation of the results, and wrote the manuscript), while MTH, MR and N are the supporting contributors (provided critical feedback and helped shape the research, analysis and manuscript).

## CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

## REFERENCES

- [1] Sugianti T, Hidayah BN. Inorganic fertilizers covered by active rice husk charcoal promote growth and yield of shallot in Dryland. *Russian J Agricul Socio-Eco Sci*. September 2021;9(117):159–166 doi: 10.18551/rjoas.2021-09.18.
- [2] Prayogi F, Islan I, Ariani E. Pertumbuhan dan hasil bawang merah (*Allium ascalonicum* L.) pada beberapa jenis medium tanam dengan teknik vertikutur. [Growth and yield of shallots (*Allium ascalonicum* L.) in several types of planting medium using verticulate techniques]. *JOM FAPERTA*. 2019;6(1):1–11. (In Indonesian).
- [3] Waluyo N, Rismawita S. Bawang merah yang dirilis oleh balai penelitian sayuran. [Shallots released by the Vegetable Research Institute]. *Iptek Tanaman Sayuran*. January 2015(004):1–5. (In Indonesian).
- [4] Adiyoga W. Seed systems in the four shallot producing areas of Java: a focus group discussion. *Int Conf Agribusiness Rur Develop (IconARD, Yogya 2020)*. *E3S Web Conf*. 2021;232:01003.
- [5] Rahmi F, Susila AD, Sulistyono E. Budidaya bawang merah (*Allium ascalonicum* L.) pada Lahan kering menggunakan irigasi sprinkler pada berbagai volume dan frekuensi. [Cultivation of shallots (*Allium ascalonicum* L.) on dry land using sprinkler irrigation at various volumes and frequencies]. *J Hort Indonesia*. April 2016;7(1):1–8. (In Indonesian).
- [6] Handayani SA. Optimalisasi pengelolaan lahan untuk sayuran unggulan nasional. [Optimizing land management for national superior vegetables]. *Tabloid Sinar Tani*. 28 April 2014. Available from: <https://tabloidsinartani.com/detail/indeks/mimbar-penyuluhan/763-optimalisasi-pengelolaan-lahan-untuk-sayuran-unggulan-nasional>. (In Indonesian).
- [7] Indonesian Central Bureau of Statistics. Indonesia in figures. In: *Centre of Statistical Bureau, Republic of Indonesia*. Jakarta:BPS Jakarta, 2020. (In Indonesian).
- [8] Moekasan TK, Prabaningrum L, Setiawati W, Prathama M, Rahayu A. Pusat Penelitian dan Pengembangan Hortikultura. In *Badan Penelitian dan Pengembangan Pertanian*. Jakarta: Kementerian Pertanian, 2016. (In Indonesian).
- [9] Hakim L. Provinsi NTB genjot produksi bawang merah dari lombok. 24 February 2020. Available from: <https://radarlombok.co.id/provinsi-ntb-genjot-produksi-bawang-merah.html>. (In Indonesian).
- [10] Indonesian Central Bureau of Statistics, Nusa Tenggara Barat. Provinsi nusa tenggara barat dalam angka. In *Badan Pusat Statistik NTB*. BPS Mataram, Katalog:1102001.52, 2018. (In Indonesian).
- [11] Adnyana IPCP, Rahayu M. Keragaan usahatani bawang merah di kabupaten lombok timur. In *Prosiding Seminar Nasional Inovasi Teknologi Pertanian*. Banjarbaru: BBP2TP Bogor, 20 July 2016, pp. 928–35. (In Indonesian).
- [12] BPS. Kabupaten lombok timur. Lombok timur dalam angka. In *Badan Pusat Statistik Kabupaten Lombok Timur dan Bappeda Kabupaten Lombok Timur*. BPS Selong, 2003. (In Indonesian).
- [13] Sudaryanto T, Rusastra IW. Kebijakan strategis usaha pertanian dalam rangka peningkatan produksi dan pengentasan kemiskinan. [Agricultural business strategic policies in the context of increasing production and alleviating poverty]. *Litbang Pertanian*. 2006;25(4):115–22. (In Indonesian).
- [14] Firmansyah MA, Mokhtar MS. *Kisah Sukses Merintis Pengembangan Bawang Merah di Kalimantan Tengah*. Jakarta: Balitbangtan; 2014. (In Indonesian).
- [15] Syafruddin, Irwan SP, Saida. Perbaikan pola tanam palawija pada lahan kering di kabupaten Parigi Moutong Sulawesi tengah. [Improvement of planting patterns for secondary crops on dry land in Parigi Moutong district, Central Sulawesi]. *Jurnal Pengkajian dan Pengembangan Teknologi Pertanian*. 2015;18(3):263–72. (In Indonesian).
- [16] Anonymous. Laporan kinerja badan penelitian and pengembangan pertanian. 2016. (In Indonesian). Available from: [http://www.litbang.pertanian.go.id/lakip/2016/lakin\\_balitbangtan\\_2016.pdf](http://www.litbang.pertanian.go.id/lakip/2016/lakin_balitbangtan_2016.pdf).
- [17] Septiani D. Pengaruh pemberian arang sekam padi terhadap pertumbuhan dan hasil tanaman cabai rawit (*Capsicum frutescens*). In *Seminar Program Studi Hortikultura, Politeknik Negeri Lampung*. Lampung: Politeknik Negeri Lampung, 2012. (In Indonesian).
- [18] Irianto. Peta potensi penghematan pupuk anorganik dan pengembangan pupuk organik pada lahan sawah Indonesia. In *Badan Penelitian Dan Pengembangan Pertanian*. Jakarta: Balitbangtan, Jakarta, 2010. (In Indonesian).
- [19] Ibrahim M, Fadni OAS. Effect of organic fertilizer application on growth, yield and quality of tomatoes in Nort Kordonfan (sandy soil) Western Sudan. *Journal Agricultural Sciences*. 2013;3(4):299–304.
- [20] Balai Penelitian Tanah. *2nd Edn Balai Penelitian Tanah*. Bogor, 2009. Available from: <http://balittanah.litbang.deptan.go.id>. (In Indonesian).
- [21] Ashari S. *Hortikultura Aspek Budidaya*. Jakarta: Universitas Indonesia; 1995. (In Indonesian).
- [22] Darlita RR, Joy B, Sudirja R. Analisis beberapa sifat kimia tanah terhadap peningkatan produksi kelapa sawit pada tanah pasir di perkebunan kelapa sawit selangkun. [Analysis of several soil chemical properties on increasing oil palm production on sandy soil in the Selangkun oil palm plantation]. *Jurnal Agrikultura*. 2017;28(1):15–20, ISSN 0853-2885. (In Indonesian).
- [23] Gardner FP, Pearce RB, Mitchell RL. *Fisiologi Tanaman Budidaya*. Translated by Susilo H. Jakarta: Universitas Indonesia Press; 1991. (In Indonesian).
- [24] Aisyah S, Hapsah H, Ariani E. Pengaruh beberapa jenis pupuk kandang dan npk terhadap pertumbuhan dan hasil bawang merah (*Allium ascalonicum* L.). [The effect of several types of manure and NPK on the growth and yield of shallots (*Allium ascalonicum* L.)]. *JOM FAPERTA*. April 2018;5(1):1–13. (In Indonesian).
- [25] Foth DH. *Dasar-Dasar Ilmu Tanah*. 6th Ed. Jakarta, 1994, Translated by Adisoemarto S. Erlangga. (In Indonesian)
- [26] Napitupulu D, Winarto L. Pengaruh pemberian pupuk N dan K terhadap pertumbuhan dan produksi bawang merah. [Effect of N and K Fertilizer Application on Shallot Growth and Production]. *Jurnal Hortikultura*. 2010;20(1):27–35. (In Indonesian).
- [27] Hasibuan R, Lumbanraja J. Soil nutrition management and predation by *cheilomenes sexmaculata* (Coleoptera: coccinellidae) impacts on aphid glycines (Homoptera: aphididae). *J HPT Tropika*. 2010;10(2):131–45, ISSN 1411-7525.
- [28] Saraswati R, Santosa E, Yuniarti E. *Organisme perombak bahan organik*. 20 October 2018. Available from: <http://balittanah.litbang.pertanian.go.id/ind/dokumentasi/buku>. (In Indonesian).
- [29] Tandi OG, Paulus J, Pinaria A. Pertumbuhan and produksi bawang merah (*Allium ascalonicum* L.) berbasis aplikasi biourine sapi. [Growth and Production of Shallots (*Allium ascalonicum* L.) Based on Cow Biourine Application]. *Eugenia*. 2015;21(3):142–50. (In Indonesian).
- [30] Suwandi S. Efektifitas pengelolaan pupuk organik, NPK, dan pupuk hayati terhadap pertumbuhan dan hasil bawang merah. [Effectiveness of Management of Organic Fertilizer, NPK, and Biological Fertilizer on the Growth and Yield of Shallots]. *Jurnal Hortikultura*. 2015;25(3):208–21. (In Indonesian).

- [31] Hidayat A, Rosliani R. Pengaruh pemupukan N, P dan K pada pertumbuhan dan produksi bawang merah kultivar Sumenep. [Effect of N, P and K Fertilization on Growth and Production of Sumenep Shallot Cultivars]. *Jurnal Hortikultura*. 2016;5(5):39–43. (In Indonesian).
- [32] Sumarni N, Achmad H. *Budidaya Bawang Merah*. Bogor: Balai Penelitian Tanaman Sayuran; 2005. (In Indonesian).
- [33] Septiani D. Pengaruh pemberian arang sekam padi terhadap pertumbuhan dan hasil tanaman cabai rawit (*Capsicum frutescens*). In *Seminar Program Studi Hortikultura, Politeknik Negeri Lampung*. Lampung: Politeknik Negeri Lampung, Lampung, Indonesia, 2012. (In Indonesian).
- [34] Pusat Penelitian Kelapa Sawit. *Kompos Bio Organik Tandan Kosong Kelapa Sawit*. Medan: Pusat Penelitian Kelapa Sawit; 2014. (In Indonesian).
- [35] Purnawanto AM. Pengaruh ukuran bibit terhadap pembentukan biomassa tanaman bawang merah pada tingkat pemberian nitrogen yang berbeda. [Effect of Seed Size on the Formation of Shallot Plant Biomass at Different Levels of Nitrogen Application]. *Agritech*. 2013;15(1):23–31. (In Indonesian).
- [36] Tarigan E. Respon pertumbuhan dan produksi bawang merah (*Allium ascalonicum* L.) terhadap pemberian abu vulkanik gunung sinabung dan arang sekam padi. In *Program studi agroekoteknologi*. USU, Medan: Fakultas Pertanian, Universitas Sumatra Utara, 2015. (In Indonesian).