The Effect of Varieties on Growth and Yield of Chili
(*Capsicum annum* L.) in Andisol Soil Aceh Besar

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Abstract. This research aims to determine the effect of varieties on the growth and yield of chili plants on the Andisol soil. This research was carried out at Lon Baroh, Lembah Seulawah District Aceh Besar, greenhouse and laboratory of plant physiology, Faculty of Agriculture of Syiah Kuala University, Darussalam, Banda Aceh from November to March 2019. The analysis of data used in this study was Randomized Block Design – non Factorial with 3 replications. There are 2 series of this research, Serie A and Series B. Serie A is used to collect data on growth and yield of chili plants and Serie B is used to collect data on mycorrhizal infection. The factors observed in this research were varieties. Varieties used are Lado F1 and Perintis. The result of this research showed varieties of chili plants highly significant take effect on plant height 15, 30 and 45 DAP, stem diameter 30 and 40 DAP, productive branch numbers, plant fresh weight, plant dry weight, fruit weight, fruit length, fruit number and yield potential and significantly affect on stem diameter 45 DAP, root fresh weight, and root dry weight. The best growth and yield of chili plants is found in Lado F1 varieties.

1. Introduction
Chili (*Capsicum annum* L.) is a vegetable originating from America that has many utility. Generally chili is used as raw material in the culinary and medicine industries and in the comics. Furthermore, chili is needed by the community in large quantities as industrial raw materials such as sauces, ingredients mixed with balm, candy, etc. Especially in Aceh many people cultivate chili in the highlands with Andisol soil types [1]. According to Harwimuka [2], chili is an important plant because it has a high nutrient content, in 100 g of fresh red chili there are 31 g calories, 1 g protein, 0.3 g fat, 7.3 g carbohydrates, 29 mg calcium, 24 mg phosphorus, 0.4 g iron, 260 SI vitamin A, 0.005 mg of vitamin B1, 18 mg of vitamin C, and 90.9 g of water. Therefore the availability of chili must be maintained by increasing the production of chili plants.

The Lado F1 variety has the characteristics of a young fruit color that is medium green while the ripe fruit is bright red. The productivity of this variety is 0.9-1.4 kg plant⁻¹. The variety is a hybrid chili developed by PT. East West Indonesia. Curly Lado F1 chili variety is often called curly all season, because the Lado F1 variety can be cultivated in all seasons with different heights and different climate variations. Besides being able to be planted in the highlands, this variety can grow on hot coasts. Other characteristics of the plant height of the Lado F1 variety are around 100 cm. Age of Lado
F1 varieties chili harvest around 90 DAP. The Lado F1 variety is resistant to bacterial wilt, anthracnose, thrips and even still able to change even though it is attacked by the Gemini virus [3]. Furthermore, there is not much information about how the growth and yield of Lado F1 varieties are cultivated in Andisol soil.

Furthermore, there is one more variety that needs to be studied for growth and varieties in Andisol soil. The variety is Perintis, a local variety that has been developed by many people in Aceh Besar and Pidie Jaya Regencies. Technological test results, the variety is optimal life with maximum results, has a slightly shorter character compared to other types of chili varieties. Another advantage of this variety is that it is resistant to aphids and the Gemini virus which causes chili plants to become curly. These pioneer chili varieties have early maturity of 75-150 day after planting (DAP) and production of 20-25 tons ha\(^{-1}\). Suitable for cultivation in the lowlands and in the highlands [4] [5].

Chili production in Aceh as much as 50% is carried out in Andisol land. Among the characteristics of Andisol soil, it developed from volcanic ash with a colloidal fraction dominated by allophanes with high P retention [6] [7] [8]. The main obstacle in the use of Andisol is that the P element is available but cannot be utilized by plants. Overcoming this problem was also given multiplication of mycorrhizae on Andisol soil in this study. Therefore it is necessary to find the suitable chili varieties developed in Andisol soil.

2. Material And Method

2.1 Time and Place
This research was conducted in Lon Baroh Village, Lembah Seulawah Aceh Besar District and Laboratory of Plant Physiology, Faculty of Agriculture, Syiah Kuala University, Darussalam, Banda Aceh. The study took place from November 2018 to March 2019.

2.2 Tool and Material

2.2.1 Tool
The tools that used in this study are hoes, sieves, rakes, plastic ropes, stakes, scissors, knives, meters, spoons, fat, polybag, calipers, digital scales, autoclaves, sugar plastics, cameras, Nikon microscopes with 100 magnification -400 times, glass preparations and stationery.

2.2.2 Material
The materials used in this study were chili seeds of Lado F1 and Pioneers varieties, mycorrhizal biologies of \textit{Glomus mosseae}, \textit{Gigaspora} sp and Mixes, nitrogen, phosphorus and potassium fertilizers, manure, KOH solution, distilled water, and blue solution Ypan (Quick Parker).

2.3 Data analysis
This research was carried out using a non factorial randomized block design (RBD) with 3 replications. The factors observed were varieties consisting of 3 levels, namely Lado F1 varieties and Pioneer varieties. There are 2 series in this experiment, namely Series A and Series B, series A is used to collect data on growth and yield of chili plants, while series B is used to collect data on mycorrhizal infection.

2.4 Implementation of Research

2.4.1 Land Preparation
The land used for planting chili, is first carried out cleaning by removing weeds that are in the field that can host pests and diseases, then processing the soil by plowing or hoeing with a depth of 30-40 cm. The land that has been hoed is then left for 4 weeks to allow air to exchange and kill the harmful pathogens inside the soil. After that, making a bed that aims to prevent plant roots from being flooded during the rainy season. The beds are made with a width of 1 m, length 18 m, height 40 cm, and the distance between beds with drainage 50 cm.
2.4.2 Seed Preparation The criteria for chili seeds used are seeds that avoid pests and diseases and seeds that have germination above 90%. Supported by the presence of immersion treatment using an aerator as long as the criteria for chili seeds are used which are seeds that avoid pests and diseases and seeds that have germination above 90%. Supported by the presence of immersion treatment using an aerator for 1-24 hours which aims to increase the power of seed germination and seed resistance to pests and diseases.

2.4.3 Nursery Preparation The seeds used in this study were chili seeds of Lado F1 varieties and Pioneers. The seeds are sown in polybags measuring 5 x 10 cm with Andisol soil media. The seeds are planted with one seed per polybag, then given 5g of mycorrhizal treatment per polybag according to the type of mycorrhizal treatment which aims to have the chili plants get mycorrhizal stimulation during nursery.

2.4.4 Manure Application Manure application in this study was 18 kg\(^{-1}\) bed. The provision of manure aims to increase the value of Cation Exchange Capacity in the soil so that nutrients are not easily lost and washed, improve soil structure, and to increase the power to hold water so that more absorbed water.

2.4.5 Black Silver Plastic Mulch Installation of black and silver plastic mulch for planting chili is done after the beds are fertilized. The installation of black silver plastic mulch aims to suppress weed growth, maintain good soil structure, and maintain soil moisture in beds.

2.4.6 Planting and Mycorrhiza Application The spacing used was 60 cm × 60 cm. Planting of manufacture holes using a plastic shovel with a depth of 5 cm. Planting is done by giving mycorrhiza first in the planting hole that has been provided. Chili planting is done in the afternoon. Seeds planted are 24 DAP. Selected seeds that have good growth and have 4-5 leaves. Mycorrhizal strains of Gigaspora sp applied at a dose of 10 g plant\(^{-1}\) was carried out when the seedlings were transplanted.

2.4.7 Potassium, Phosphorus, Nitrogen Fertilizer Application Potassium phosphorus nitrogen fertilizer which was used in this study as much as 50% of the recommended dosage, namely 225 g bed\(^{-1}\). Fertilizers are given during transplanting, 3 weeks after transplanting, and 6 weeks after transplanting by dissolving these fertilizer with the water and splashing on the roots of plants.

2.4.8 Maintenance Maintenance of chili plants is done every day after planting so that the growth of chili plants is better. Maintenance of chili plants is done, namely:
1. Embedding is done when the chili plant is before the age of 14 DAP.
2. Watering is carried out 2 x 1 day in the morning and evening.
3. Weeding is done by cleaning the grass around the beds.
4. Disposal of water shoots is carried out mechanically using scissors at the age of 7-20 DAP and carried out twice a week with the aim of stimulating the growth of chili plants to grow better.
5. Installation of stakes is carried out after chili 14 DAP plants using material from wood with a height of 100 cm which aims to support the chili plants so as not to fall easily.
6. Pest and disease control is carried out by spraying using pesticides if it has attacked more than 20% of the population.

2.4.9 Harvest Chili harvesting is carried out at the age of 90, 95, 100, 105, 110, 115, and 120 DAP with the criteria of a solid and red chili. Harvesting is done by picking the fruit with the stem, so that the fruit stays fresh and lasts longer when stored.
2.5 Parameter of Observation

2.5.1 Plant Height (cm) Measurement of plant height was carried out when plants were 15, 30, and 45 DAP. Measurements were made starting from the base of the stem to the highest growing point of the plant using a meter.

2.5.2 Stem Diameter (mm) Stem diameter measurements were carried out when the plants were 30, 40 and 45 DAP. Measurements were made using calipers at the base of the stem that had marked earlier.

2.5.3 Number of Productive Branches (Branches) Calculation of the number of productive branches was done when the plant is 60 DAP. Observation of the number of productive branches is done by counting the number of branches that produce flowers and fruit.

2.5.4 Plant Wet Weight (g) The weighing of the plant's wet weight was carried out after the plants were 120 DAP, the plants were dismantled and washed with water at the root, then cut the roots of the plants, then weighed the weight of the plants using analytical scales.

2.5.5 Plant Dry Weight (g) Weighing the dry weight of plants was done after the plants have been heated for 2 x 24 hours with a temperature of 60°C or reaching a constant weight. Weighing is done using analytical scales.

2.5.6 Root Wet Weight (g) The weighing of the root wet weight was carried out after the plants were 120 DAP and the plants were dismantled and washed with water at the root, then cut the roots of the plants and separated from the plants then weighed the roots using analytical scales.

2.5.7 Root Dry Weight (g) Weighing the dry weight of root was done after the plants have been heated for 2 x 24 hours with a temperature of 60°C or reaching a constant weight. Weighing is done using analytical scales.

2.5.8 Fruit Weight per Plant (g) The weighing of fruit weight per plant was carried out after the chili fruit was harvested up to 5 harvests at the ages of 90, 95, 100, 105, 110, 115 and 120 DAP. Fruit weighing per plant was carried out by weighing chili fruit using analytical scales.

2.5.9 Fruit Length (cm) The measurement of fruit length is done when finished harvesting, that is by taking 5 samples at each harvest and then taking the average value. The measurement starts from the base of the fruit to the end of the fruit.

2.5.10 Amount of Fruit per Plant (fruit) The number of fruits calculated is fruit harvested at the ages of 90, 95, 100, 105, 110, 115, and 120 DAP. Calculation of the number of fruit plants is done by adding the first fruit to the last harvest.

2.5.11 Percentage of Roots Infected with Mycorrhiza (%) According to Nimalasari [9] and Langer et al., [10], to watch the percentage level of association between fungi and root samples of host plants can be done by staining the roots of plants with the following steps:
1. The plants observed were sample plants that were 45 DAP. The plant is removed and the roots are cut into 2 cm lengths.
2. The cut roots are then washed using distilled water until clean and soaked in 10% KOH solution for 24 hours to whiten the roots.
3. Then the roots are soaked using a blue solution Trypan (Quick Parker) for 24 hours
4. Doing soaking again using clean water (distilled water) so that the roots are clean of ink color.
5. Taken 5 roots of chili plants at random then placed on the glass preparation, then observed using a Nikon microscope with 100-400 times magnification, then calculate the percentage using the formula:

$$\text{Root infected (\%)} = \frac{\text{number of roots infected with mycorrhiza}}{\text{Number of roots observed}} \times 100$$

2.5.12 Yield Potential (ton ha\(^{-1}\)) The yield potential can be calculated by converting from the yield of fruit weight per plant using the following formula:

$$\text{Yield (ton ha}^{-1}\text{)} = \frac{1}{\text{Plant Space}} \cdot \frac{\text{ha}^{-1}}{10} \cdot \text{Fruit Weight Per Plant}$$

3 Result and Discussion

3.1 Characteristics of Andisol Soil Aceh Besar

The results of soil analysis showed that the Andisol soil of Lon Baroh Subdistrict had a pH and other nutrient criteria that were good for chili growth and yield. P absorption to be available for plants has been dealt with by mycorrhizal application strains of *Gigaspora* sp to chili plants. The results of the analysis of Andisol soil are shown in Table 1.

| No. | Soil Parameters                          | Value | Unit       | Criteria    |
|-----|-----------------------------------------|-------|------------|-------------|
| 1.  | Soil Texture                            | 33    | %          |             |
| 2.  | Sand, filtering                         | 22    | %          |             |
| 3.  | Silt, Pipette                           | 45    | %          |             |
| 4.  | Texture Class                           | A     |            |             |
| 5.  | Soil reaction                           |       |            |             |
| 6.  | pH (H\(_2\)O) (1:25)-Electrometric      | 7.37  | -          | Neutral     |
| 7.  | pH (KCl) (1:25)-Electrometric           | 6.01  | -          | Neutral     |
| 8.  | C-Organic (organic C, (Wakley & Black)  | 1.29  | %          | Low         |
| 9.  | Total N, Kjeldahl                       | 0.11  | %          | Low         |
| 10. | P Bray II (Bray II extracted P)         | 0.45  | mg kg\(^{-1}\) | Very Low   |
| 11. | P Oslen (Oslen extractabel P) (each cations, 1N NH\(_4\)COOCH\(_3\), pH 7) | - | mg kg\(^{-1}\) |             |
| 12. | Ca-exchangeable (exch, Ca)              | 6.66  | Cmol.Kg\(^{-1}\) | Very High |
| 13. | Mg-exchangeable (exch, Mg)              | 2.41  | Cmol.Kg\(^{-1}\) | High       |
| 14. | K-exchangeable (exch, K)                | 0.3   | Cmol.Kg\(^{-1}\) | Medium     |
| 15. | Na-exchangeable (exch, Na)              | 0.16  | Cmol.Kg\(^{-1}\) | Low        |
| 16. | Cation exchange capacity (CEC)          | 21.6  | Cmol.Kg\(^{-1}\) | Medium     |
| 17. | Saturation Base                         | 44.12 | %          | Medium      |
| 18. | Al-exchangeable (exch, Al)              | tu    | Cmol.Kg\(^{-1}\) |             |
| 19. | H-exchangeable (exch, H)                | 0.2   | Cmol.Kg\(^{-1}\) |             |
| 20. | Electrical conductivity (EC)             | 0.15  | mS cm\(^{-1}\) | Very Low   |
| 21. |                                          |       |            |             |

Sources: Laboratory analysis (2019)

3.2 Effect of Varieties on Chili Plant Growth

The results of the variance analysis (F test) showed that varieties had a very significant effect on parameters of plant height 15, 30 and 45 DAP, stem diameter 30 and 40 DAP, number of productive
branches, plant dry and wet weight, fruit weight, fruit length, number of fruit and potential results and significant effect on stem diameter 45 DAP, root weight and dry weight.

Plants aged 15, 30 and 45 DAP due to the treatment of the highest varieties found in Lado F1 varieties is 37.34 cm, 59.01 cm and 78.14 cm which are significantly different from the treatment of Perintis varieties. On the diameter of chili stems aged 30, 40 and 45 DAP due to the treatment of the highest varieties found in the Lado F1 variety that is 7.29 cm, 8.49 cm and 9.29 which are significantly different from the Perintis varieties. In the number of productive branches due to the treatment of the most varieties found in the Lado F1 variety, 29 branches were significantly different from the Perintis varieties. The wet and dry weight of chilli plants due to the treatment of the heaviest varieties were found in the Lado F1 varieties of 250.20 g and 77.90 g which were significantly different from the Perintis varieties. The wet and dry weight of chili root due to the treatment of the heaviest varieties was found in the Lado F1 varieties, which were 15.71 g and 6.31 g which were significantly different from the Perintis varieties.

Table 2. Average Chili Plant Growth due to varieties

| Parameters                        | Lado F1 (V₁) | Perintis (V₂) | HSD 0.05 |
|-----------------------------------|--------------|---------------|----------|
| Plant Height 15 DAP (cm)          | 37.34        | 31.57         | 1.67     |
| Plant Height 30 DAP (cm)          | 59.01        | 52.57         | 1.83     |
| Plant Height 45 DAP (cm)          | 78.14        | 69.37         | 3.47     |
| Stem Diameter 30 DAP (mm)         | 7.29         | 6.51          | 0.31     |
| Stem Diameter 40 DAP (mm)         | 8.49         | 7.80          | 0.44     |
| Stem Diameter 45 DAP (mm)         | 9.29         | 8.62          | 0.60     |
| Number of productive branches     | 29           | 24            | 1.07     |
| (branches)                        |              |               |          |
| Wet Plant Weight (g)              | 250.20       | 211.42        | 21.61    |
| Dry Plant Weight (g)              | 77.90        | 65.77         | 7.75     |
| Root Wet Weight (g)               | 15.71        | 13.31         | 1.89     |
| Root Dry Weight (g)               | 6.31         | 5.68          | 0.54     |
| Fruit Weight (g)                  | 627.94       | 552.19        | 8.19     |
| Fruit Length (cm)                 | 9.54         | 11.23         | 0.75     |
| Amount of Fruit (fruit)           | 198          | 177           | 2.61     |
| Percentage of roots infected with | 72.11        | 70.87         |          |
| mycorrhiza (%)                    |              |               |          |
| Yield Potential (ton ha⁻¹)         | 15.64        | 13.81         | 0.19     |

Note: The number followed by the same letter on the same line is different is not real based on the honestly significant difference test (HSD) at the level of α = 0.05.

Table 2 showed the height of chili The weight of plant fruit due to the treatment of the heaviest varieties was found in the Lado F1 variety which was 627.94 g which was significantly different from the treatment of Perintis varieties.
In the length of fruit plants due to the treatment of the longest varieties found Perintis varieties, namely 11.23 cm which were significantly different from the treatment of Lado F1 varieties. In the number of fruit plants due to the treatment of the varieties found the most in the Lado F1 variety which is 198 fruits which are significantly different from the treatment of Perintis varieties. The percentage of mycorrhizal infections due to variety treatment did not have a statistically significant effect, but the percentage values that tended to be higher were found in the Lado F1 variety which was equal to 72.11%. The potential value of crop yields due to the treatment of the highest varieties found in Lado F1 varieties is 15.64 tons ha -1 which is significantly different from the treatment of Perintis varieties.

The results of this study indicate that the best varieties of growth and yield of chilli plants are found in Lado F1 varieties, this can be seen from the parameters of plant height 15, 30, 45 DAP, stem diameter 30, 40 and 45 DAP, number of productive branches, wet and dry weight plants, wet and dry weight of roots, fruit weight, number of fruits and potential yields of chili plants, but in the long parameters of fruit is better found in Perintis varieties. It is suspected that the Lado F1 variety has superior properties, is able to adapt to its living environment so that it is expected to provide high growth and yield.

This is in line with the statement Safrianto et al. [5] that superior varieties have properties that are superior to local varieties. These advantages can be seen from the high fruit yield per plant, response to fertilization, and resistance to plant pests and diseases. Based on the results of the study Zubir [11] that the treatment of varieties on Andisol soil had a very significant effect on plant height, stem diameter, number of productive lengths, plant fresh weight, plant dry weight, root dry weight, number of fruit crops, weight of planting fruit and fruit length.

Lado F1 variety is the best variety in the parameters of fruit weight, number of fruits and potential yield. This is thought to be due to the genetic influence of the plant itself. According to Syafruddin [12], each variety has genetic differences that can affect growth and yield and the adaptability of a variety varies. Safrianto et al., [5] stated that hybrid varieties have many advantages that local varieties do not have, therefore the use of superior hybrid varieties can increase the production of both quantity and quality and the level of resistance to attack by plant pest organisms and response to fertilization.

According to Adisarwanto [13], varieties that are able to survive with environmental conditions and can grow well with the superior properties possessed by varieties, if planted in optimal conditions will achieve the potential results. Trial of pot experiments conducted by Zubir et al, [11] prove that the Lado F1 variety has the best yield if cultivated on Andisol Burni Telong Bener Meriah soil.

4. Conclusion
Varieties have a very significant effect on plant height 15, 30 and 45 DAP, stem diameter 30 DAP and 40 DAP, number of productive branches, plant wet weight, plant dry weight, fruit weight, fruit length, number of fruit and yield potential and have a significant effect on diameter stem 45 DAP, heavy wet and dry roots. The best growth and yield of chili plants is found in Lado F1 varieties.

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References
[1] Syafruddin S, Syakur S and Arabia T 2016 Int. J.Agric. Res 11 69 – 76
[2] Harwimuka 2010 Red Chili Cultivation. Insan Cendikia. Surabaya.
[3] Syukur M and Maharijaya A 2014 Produce Premium Quality Curly Chili. Penebar Swadaya. Jakarta.
[4] Munawar, K. 2017. Pioneer Chili. [http://steemit.com/agriculture/@munawarkhalid/cabe-perintis-a861f5bb1e3ab/] (8 May 2018).
[5] Safrianto R, Syafruddin, Sriwati R 2015 The Growth and Yield of Chili Peppers on Andisol Using Various Organic Manure Fertiliser and Endomycorrhizae. Tesis. Agroecotechnology Master Program, Post graduate School, Syiah Kuala University. Banda Aceh.

[6] Syafruddin and Efendi 2014 J.Agric. Res 9 17-28

[7] Hardjowigeno H S 2017. Soil Classification and Pedogenesis. Akademika. Jakarta. [13] Adisarwanto 2000 Increase peanut production in paddy fields and dry land. Penebar Swadaya. Jakarta.

[8] Subagyo H, Suharta and Siswanto 2013 Agricultural lands in Indonesia, in land resources in Indonesia and their management. Center for Soil and Agro-Climate Research.

[9] Nirmalasari 2015 The presence of arbuscular mycorrhizal fungi (FMA) in durian stands (Durio zibethinus Murr) Skripsi. Faculty of Forestry UNTAN. Pontianak.

[10] Langer I, Syafruddin S, Steinkellner S, Puschenreiter M, Wenzel WW 2010 Plant Soil 332:339–355

[11] Zubir M 2017 Effect of Mixed Mycorrhizal Doses (Glomus mosseae dan Gigaspora sp.) To Growth and Yield of Some Chili Varieties (Capsicum annum L.) n Andisol Burni Telong Land, Bener Meriah Regency. Skripsi. Agrotechnology Department, Syiah Kuala University. Banda Aceh.

[12] Syafruddin S 2017 Int. J.Agric. Res 11 36–40.