The development and the growth of salak pondoh fruit (Salacca edulis L.) planted using different planting methods

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Abstract. The cultivation plays an important role in determining the quality of salak pondoh (Salacca L.), for instance, the planting methods. There are various methods of planting salak pondoh (Salacca L.), monoculture (only salak pondoh) and polyculture (salak pondoh is cultivated with other plants). The goal of this research is to analyze the development and the growth of stamens on salak pondoh (Salacca L.) using different patterns of cultivating. The plot for this research is a garden only for salak pondoh plants (monoculture) and for salak pondoh plants cultivated with other plants (polyculture). The parameters to observe are the morphology of plants, size of stamens, and environmental factors such as temperature, pH, and moist of soil. The result shows that different patterns of cultivating affect the development and the growth of stamens on salak pondoh with polyculture system. The soil temperature in monoculture system is higher than polyculture and the morphology observation towards salak pondoh plant also shows the difference between polyculture and monoculture system.

1. Introduction
Snake fruit or “Buah salak” is a plant belonging to the taxonomic monocots (monocotyledons) as well as the Family of Arecales. Snake fruits can be found in Indo-Malaysian areas where they can thrive well on dry soil containing high organic matters. In Indonesia, the production of snake fruits has increased from 423.5 tons in 2000 to 862.5 tons in 2009. Fresh snake fruits from Indonesia are exported to other countries such as Singapore, Middle-East countries, Malaysia, Hongkong and China.

The cultivation of plants using monoculture is rising higher than polyculture in order to pace the productivity and the benefit. Because of the climate changes and the scarcity of natural resources, many people are interested in using the polyculture method for farming. Some researchers showed that farming using a polyculture system is much better than farming with a monoculture system. Some shade trees dan snake fruit trees planted together at the same time bring several benefits, namely to improve productivity, to stabilize the production, to make prolonging harvest, and to continue it as to balance needs for environment, economy, and socio-culture.

Snake fruit plants can be cross-bred manually by fertilizing the pistil and the stamens. The blooming period for plants is affected by the optimal environmental factors, such as photoperiod, temperature, nutrition, physiological age, and threats. Low temperature can influence the duration for forming the flowers of snake fruit, on the other hand, high temperature will slow down the duration for forming the flesh and the seeds of snake fruit. Snake fruit has blooming periods every 3 months or four times a year, they are in January, April, July, and October. The purposes of this research are to find out the development and the growth of snake fruit's flowers towards the influence of different breeding systems.
2. Methods

2.1 Surveying the location
Surveying the location is held in Pucang Anom Village, Slumbung sub-district, Muntilan Regency, Central Java Province. The location chosen for the research is "Salak Pondoh" plantation with various breeding systems, which are monoculture and polyculture. Monoculture plantation is a field that is only planted with "Salak Pondoh" trees. Polyculture plantation, which is chosen, is a field that is planted with "Salak Pondoh" trees and other plants. They can be shady trees.

2.2 Interviewing the owner of the plantation
The next step for doing this research is having some interviews with the owner of the "Salak Pondoh" plantation. The interviewees are the owners of "Salak Pondoh" plantations that apply monoculture and polyculture breeding methods. Some of the questions are how to breed snake fruits, how old the plants are, where the sources of stamens come from, and what fertilizers are used.

2.3 Observing the snake fruits trees
There are 12 stamens snake fruit trees being observed in the monocultural-system plantation and in the polyculture-system plantation. The objects to observe are the environmental parameters, the morphology of the plants, and the size of stamens in "Salak Pondoh". For the environmental parameters in soil, the factors observed are the temperature of the soil, the soil pH, and the moist of the soil. For the morphology of the plants, the factors observed are the height of the trees, the number of leaf midribs, and the number of the flowers. The following observation is the growth of stamens in "Salak Pondoh" trees, including the length, the width, and the wet weight of the flowers.

3. Results and discussion

3.1 The environmental factors
The environmental parameters (Table 1.) The pH and the moist of the soil using different planting methods show no differences, meanwhile, the temperature of the soil show differences. The temperature of the soil using the monocultural planting method is 26.41°C, while the temperature of the soil using the polyculture planting method is 24.92°C. The temperature of the soil using the monocultural planting method is higher than the temperature of the soil using the polyculture planting method. The differences in the temperature of the soil are caused by the existence of the shady trees, which are Gliricidia trees, in the polyculture planting method. Gliricidia is the most effective plants used as shady trees[13]. The existence of the shady trees can decrease the threats of water and heat by creating microclimate under the soil through buffering of temperature [14].

Table 1. The Environmental Parameters in Soil Towards Different Planting Methods

| The Soil Parameters         | Monoculture | Polyculture |
|----------------------------|-------------|-------------|
| Temperature (°C)           | 26.41°C     | 24.92°C     |
| pH                         | 6.05        | 6.05        |
| The moist of The Soil (%)  | 68%         | 62%         |
3.2 The garden maintenance

The results of the interview with the plantation's owner about the plant's maintenances (Table 2.) They are pruning, irrigation, and fertilizing. The pruning and the fertilizing on the two plantations using different planting methods have the same treatments. The pruning is done twice a month. The goal of pruning is to optimize the growth of the plants [15]. Manure and NPK fertilizer are used to fertilize the plants. The mixture between manure and NPK can increase the growth and the productions of the plants[16, 17].

| Maintenance       | Monoculture       | Polyculture       |
|-------------------|-------------------|-------------------|
| Pruning (every month) | Twice            | Twice             |
| Irrigation        | Yes               | No                |
| Fertilizing       | Manure + NPK fertilizer | Manure + NPK fertilizer |

Irrigation only exists in polyculture plantation. The irrigation is run when the dry season comes. The management of the irrigation is very crucial for the soil system, for giving nutrition access and providing water to make the plants grow faster, and improving the production because there is no nutrition competition [18]. Snake fruit plants require abundant water for the whole year for the process of blooming [19, 20].

3.3 The Morphology of the snakefruit plants

The morphology observation towards the snake fruit plants using different planting methods (Table 3.) shows the age, the height of the plants, the number of midrib, and the flowers. The age of the snake fruit plants in the two plantations is different. The snake fruit plants using the monoculture method are younger, around 3-4 years old, on the other hand, the snake fruit plants in the polyculture method age 10 years old. The different range in age will affect the way they grow. The older the plants are, the higher the plants grow. It can be recognized from the increasing growth such as the height, the number of the leaves, and the number of the flowers on snake fruit plants which are older. According to[21], the forming of flowers takes longer than the forming of other vegetative organs. The forming of the snake fruit's flowers happens when it is 3-4 years old.

| The Growth                      | Monoculture       | Polyculture       |
|---------------------------------|-------------------|-------------------|
| Age                             | 3-4 Years         | 10 Years          |
| The height of the plants (m)    | ± 1.5 m           | ± 2-2.5 m         |
| The number of the leaf's midrib | ± 10              | ± 20              |
| The number of the flower (every bunch) | ± 5               | ± 10              |
3.4 The growth of stamens on snakefruit plants
The parameters of the blooming flowers in snake fruit plants are the length, the width, and the wet weight of the flowers (Table 4.) it shows real average results that vary from one to another. The polyculture planting system has a length, width, and wet weight higher than the monoculture planting system. The stamens in the polyculture system have longer and wider size of flowers compared with the stamens in the monoculture system. The length and the width of stamens in the polyculture system are 87.57±14.60 cm and 19.47±3.29 cm. The wet weight of the stamens in the polyculture system is heavier, which is 5.61±3.11 g, while the wet weight of the stamens in monoculture is lighter, which is 17.53±8.57 g.

**Table 4. The growth of Stamens on Snakefruit Plants**

| The growth of Stamens on Snakefruit Plants | Planting systems |
|------------------------------------------|------------------|
|                                          | Monoculture      | Polyculture     |
| Length (cm)                              | 55.25±12.93      | 87.57±14.60     |
| Width (cm)                               | 12.57±3.00       | 19.47±3.29      |
| Wet weight (g)                           | 5.61±3.11        | 17.53±8.57      |

The forming of the flowers is a transitional phase from the vegetative to plant reproduction phase [22]. The flowering on snake fruit plants occurs four times a year [23]. The process of forming flower is affected by temperature and photoperiod [24]. The quality of the flowers is influenced by genetic factors and environmental factors, including temperature and water supply [25]. The production of the snake fruit is determined by the number of flowers in every bunch [26].

What makes the difference in the quality of stamens is they are planted using different systems. The polyculture planting system has lower soil temperatures than the monoculture planting system. The shady tree in the polyculture system is Gliricidia trees. Shady trees can reduce the temperature in the environment due to the effects of sunlight in tropical and sub-tropical areas [27]. Snake fruit plants only require 30-70% sun exposure [28]. The total of sun exposure in a monoculture system increases the evaporation process, which can cause stress [29]. Snake fruit plants are weak to direct sun exposure because high temperature can increase evaporation so that the flowers will dry quickly before fertilization [30]. Fertilization that fails will prevent the formation of snake fruit.

4. Conclusion
The conclusion of this research is the planting of snake fruit using the polyculture system has a higher length, width, and wet weight than the planting using the monoculture system. The difference in stamens growth is influenced by the planting systems and environmental factors such as temperature. The suggestion for snake fruit farmers in Indonesia is to apply a polyculture planting system by combining snake fruit plants with shady trees to increase the growth of snake fruit flowers.

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References
[1] Razifah M R, Mamat A S, Adzemi M A and Shariah S N 2014 *J. of Biol. Agric. and Health.* 4 915-20
[2] Supapvanich S, Megia R and Ding P 2011 *Posthar. Biol. and Tech. of Trop. and Subtrop. Fruits* 334-350
[3] Lestari R, Ebert G and Huyskens-Keil S 2011 *J. of Agric. Sci.* 3 4 261-268
[4] Setiwana, E 2019 *Rekayasa* 12 1 43-48
[5] Andres C, Comoe H, Beerli A, Schneider M, Rist S and Jacobi J 2016 *Sustain. Agric. Rev.* 19 121-153

[6] Liu C L C, Kuchma O and Krustovsky K V 2018 *Glob. Ecol. and Conserv.* 15 p e00419

[7] Tjokrodingnirat S, Ashari S, Syekhafani S and Aini N 2016 *RJOAS* 1058 13-23

[8] Sumantra I K, Ashari S, Wardiyati T and Suryanto A 2012 *Int. J. of Bas. & Appl. Sci. IJBASEN* 10 26 214-222

[9] Widodo P, Herawati W and Sukarsa 2019 *Majalah Ilmiah Biologi Biosfera: A Scientific Journal* 36 1 10-14

[10] Tyagi S, Mazumdar P A, Mayee P, Shivaraj S M, Anand S, Singh A, Madhuranrakam C, Sharma P, Das P, Kumar A and Singh A 2018 *Plant Sci.* 277 251-266.

[11] Sumantra I K, Pura S and Ashari S 2014 *Agric. Forest. and Fishe.* 3 2 102-107

[12] Warnita I, Suliansyah A, Syarif and Adelina R 2019 *IOP Conf. Sci.: Earth and Envir. Sci.* 347 1-7

[13] Evi zal R, Sugiatno, Prasmatiwi F E and Nurmayasari I 2016 *Biodiversitas* 17 1 234-240

[14] Boreux V, Vaast P and Ghazoul J. 2016 *Agro. for Sustain. Dev.* 36 42 1-9.

[15] Hapsari R, Indradewa D dan Ambarwati E 2017 *Vegetalita* 6 3 37-49

[16] Han S H, an J Y, Hwang J, Kim S B and Park B B 2016 *For. Sci. and Tech.* 12 3 137-143

[17] Eliaspour S, Sharifi R S and Shirkhani A 2019 *Food Sci. & Nutr.* 8 2789-2797

[18] Boneta A, Salis M, Ercilla-Montserrat M, Gabarrell X and Rieradevall J 2019 *Front. Plant Sci.* 10 341 Doi:10.3389/fpls.2019.00341.

[19] Rai I N, Wiraatmaja I W, Semarajayaand C G A, Astiari N K A 2014 *J. of Degrade. and Min. Lands Manage.* 2 1 219-222 Doi:10.15243/fdmlm.2014.021.219

[20] Sudaryono T 2017 *J. Hijau Cendekia* 2 2 78-82.

[21] Ashfaryan N P, Sannemann W, Leon J and Ballvora A 2020 *J. of Expert. Bots.* 71 3 893-906

[22] Alfahany N P, Sannemann W, Leon J and Ballvora A 2020 *J. of Expert. Bots.* 71 3 893-906

[23] Hapsari R, Indradewa D dan Ambarwati E 2017 *Vegetalita* 6 3 37-49

[24] Han S H, an J Y, Hwang J, Kim S B and Park B B 2016 *For. Sci. and Tech.* 12 3 137-143

[25] Eliaspour S, Sharifi R S and Shirkhani A 2019 *Food Sci. & Nutr.* 8 2789-2797

[26] Boneta A, Salis M, Ercilla-Montserrat M, Gabarrell X and Rieradevall J 2019 *Front. Plant Sci.* 10 341 Doi:10.3389/fpls.2019.00341.

[27] Lin B and Yann-Jou L 2010 *Hortic. Sci.* 45 1 83-86

[28] Astuti 2007 *Budidaya Salak* (Jakarta: Agromedia)

[29] Neither W, Armengot L, Andres C, Schneider M and Gerold G 2018 *Ann. of For. Sci.* 75 38

[30] Firdausy B, Pujiastuti and Murdiyah S 2018 *Bioedukasi* 26 1 47-60