**Centella asiatica** tendril growth of Samosir – Indonesia accession

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**Abstract.** Medicinal plants often used is pegagan (*Centella asiatica*). Due to the benefits of pegagan, it is important to know the growth of this plant in detail, in this case, the growth of tendrils, which is, of course, related to biomass production. Plant materials are needed that are guaranteed production levels and quality by applying recommended cultivation. This study was proposed to understand the influence of phosphorus on the growth of pegagan tendrils. This research was conducted using a single factor with six levels of P2O5 fertilizer dosage with a non-factorial randomized block design repeated 3 times. The 6 levels of fertilizer dosage are 0, 20, 40, 60, 80, 100 kg P2O5/ha. The treatment of phosphorus (F) at 3-12 WAP did not reveal a prominent influence on the number of the primary tendrils; however, phosphorus’s application affects the growth component of the primary tendril length in acid soil conditions. Pegagan can still grow well even though the land conditions are very acidic.

1. **Introduction**

*Centella asiatica* or Pegagan is a medicinal plant that has been utilized for generations as medicine of inflammation, rheumatism, asthma, hemorrhoids, tuberculosis, leprosy, dysentery, fever; and as a wound healer and an appetite enhancer. In Japan, medicinal and aromatic plants are highly utilized. It imports the plants from India and China, which China is the largest exporter of the plants [1].

Pegagan contains several saponin compounds, which include asiaticosides [2, 3]. The bioactive compounds of asiaticosides help accelerate the wound healing process and are advantageous to treat leprosy and tuberculosis [4, 5]. The development of pegagan on a large scale needs to be supported by cultivation efforts. To produce quality pegagan products, it requires plant materials with guaranteed production levels and qualities [6]. Plant material is an important thing to pay attention to get simplicia with high centelloside content.

The research objective was to obtain the potential plant material with a high centelloside content to be used as seeds to obtain a biomass production with high centelloside content from North Sumatra. Nowadays, what is meant by organic compounds from natural materials is limited to compounds known as secondary metabolites. The utilization of plants as medicines is related to these plants' chemical content, especially bioactive substances. Without a bioactive compound in plants in general, the plant cannot be used as a medicine. Bioactive compounds found in plants are usually secondary metabolic compounds such as alkaloids, flavonoids, steroids, terpenoids, saponins, etc.

*Centella asiatica* or Pegagan in the international market has been employed as a medicinal ingredient for various diseases treatment [5, 8, 9]. Its advantages have caused it to be commercial cultivated in...
several countries, especially in China and India [10, 11]. The increasing demand of Pegagan in national and international is mainly supported by wild populations, which results in the overexploitation of the plant as is the case around the world [12].

The studies of the bioactive compounds in pegagan such as asiaticoside, madecassosside, and asiatic acid have focused on the complexes and benefits of biochemical processes [13], their concentration in various parts of the plant [14, 15, 16], and reviews of their growth under controlled conditions [4]. Limited literature or studies, especially in the Indonesian region, deliver information of the harvest time influences on the concentration of important bioactive compounds from pegagan cultivated in fields. The observation has made for the Pegagan field's production vary in terms of quality and quantity throughout the year [2, 3, 6, 17, 18]. Field location, climatic conditions, and type of accession contributes to this inconsistency and deserves further study [13, 17].

The formation of secondary metabolites is influenced by many factors, including temperature, pH, water activity, and light intensity. The thermal (non-photochemical) reaction rate is sensitive to temperature and some reaction rates will rise with an increase in a temperature of 100°C. A relatively dry land, pH, and soil moisture are relevant parameters for forming secondary metabolism.

In this research, planting is carried out with agronomic action by giving phosphorus to see the consistency of the plant's response in biomass production and phytochemical compounds. In previous studies, it was found that giving phosphorus without methyl jasmonate would result in higher biomass production, and the asiaticoside content in leaves and roots would be affected so that the production of asiaticoside per g of dry matter would be higher [18]. The urgency of this research on pegagan is due to the many benefits of pegagan in various aspects, such as effective for inhibiting or preventing age-related retinal deterioration/ degeneration, useful for developing drugs or functional foods, protecting neuron cells, and useful pegagan herbs [19].

2. Methods

Pegagan Samosir accession was given phosphorus increased from the previously analyzed. The growth and photochemical content of pegagan was analyzed. The material in this research was pegagan accession upland Samosir. The tools used were digital scales, digital cameras, soil processing equipment, meters, and others.

This research was conducted using a single factor with 6 levels of P2O5 fertilizer dosage with a randomized block design repeated 3 times. The 6 levels of fertilizer doses, namely 0, 20, 40, 60, 80, 100 kg P2O5/ha at the Samosir.

2.1. Cultivation Field and Research Preparation

This study used Pegagan seed from the accession of Samosir, North Sumatra, Indonesia. The collected stolons were directly planted after being separated from the mother plant. Each plot contained four seeds planted at a 40 cm distance from each other. The soil fertilization using Urea and KCl was done three times during the cultivation period at 0, 20, and 40 days after planting (DAP). In every fertilization period, Urea's application dose was 30 g/plot, and KCl was 22 g/plot distributed evenly around all of the planting holes.

2.2. Seed Planting and Maintenance

Cultivation maintenance consisted of regular watering, weeding, and replanting crops. Watering was consistently done in the afternoon by considering the weather conditions in the field. Stitching was done two weeks after planting to replace dead plants. Weeding was done manually every day by removing weeds from the soil by hand. Control of pests and diseases was conducted each week to avoid or prevent the distribution of pests and diseases. The plants were harvested at the same time at 12 weeks after planting (WAP) by collecting all parts of the plant.

2.3. Growth characteristics’ measurements

Primary tendrils (tendrils that come out from the main plant) and secondary tendrils (tendrils that come out from the primary tendrils) were measured for their number and length every week at 3-12 WAP.
The length of primary tendril data was at 3-12 WAP observations. The stolons were counted every week at 12 WAP from the formed stolons that came out from the tendrils.

2.4. **Wet and Dry Weight Measurement**
The harvested Pegagan plants were separated into two sample categories: the leave samples containing the leaves and petioles; and the root samples consisting of the roots and tendrils. They were weighed for dry weight.

3. **Results and discussion**

3.1. **Number of primary tendrils (WAP)**
Figure 1 shows the number of primary tendrils (tendrils) at 3-12 WAP observation. It reveals that the treatment factor for the dose of phosphorus (F) at 3-12 WAP had no prominent impact on the number of primary tendrils. The highest average number of the primary tendrils was obtained at 8-12 WAP observations in the phosphorus fertilizer treatment at 40 P₂O₅ kg/ha (F2) aged 6-12 WAP and 100 P₂O₅ kg/ha (F5) aged 12 WAP.

![Figure 1](image)

**Figure 1.** The relationship between the lengths of Primary Tendrils age (WAP) of *Centella asiatica*

3.2. **Length of Primary Tendril (cm)**
Table 2 lists the length of the primary tendrils at 3-12 WAP. Similarly, the variance analysis demonstrates that the treatment factor for the dose of phosphorus (F) application at the ages of 3-7, 9, and 12 MST also has an insignificant effect on the primary tendrils’ length. At the same time, it shows a prominent impact at the ages of 8, 10, and 11 WAP on the length.

The phosphorus treatment at 8 WAP had a notable influence on the length of the primary tendrils. The influence is linear as shown in Figure 2.

The phosphorus fertilization at 10 WAP has significantly affected the length of the primary tendrils. The phosphorus effect on the length of the primary tendrils at 10 WAP is quadratic, as shown in Figure 3.

Figure 4 presents the adding of the phosphorus fertilization at 11 WAP, which is also quadratic in which the higher phosphorus fertilization increases the length of the primary tendril to a certain extent, then a decrease occurs.
Table 1. The average length of Primary Tendrils (cm) in Phosphorus Treatment at 3-12 WAP

| Treatment | Primary Tendril Length (cm) (WAP) |
|-----------|----------------------------------|
|           | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 |
| F0 = 0 kg P₂O₅/ha | 0.00 | 12.67 | 24.33 | 34.00 | 43.00 | 55.67 b | 69.67 | 80.00 bc | 83.33 bc | 89.00  |
| F1 = 20 kg P₂O₅/ha | 0.00 | 12.50 | 22.83 | 37.50 | 47.67 | 58.67 b | 70.67 | 79.33 bc | 82.67 bc | 97.33  |
| F₂ = 40 kg P₂O₅/ha | 0.00 | 11.17 | 34.00 | 47.67 | 56.67 a | 69.33 a | 82.00 | 90.00 a   | 96.00 a   | 99.00   |
| F₃ = 60 kg P₂O₅/ha | 0.00 | 7.17 | 20.00 | 31.00 | 43.00 | 56.67 b | 73.00 | 87.33 ab | 89.67 abc | 91.67   |
| F₄ = 80 kg P₂O₅/ha | 4.00 | 12.67 | 25.33 | 39.00 | 53.67 | 61.00 ab | 80.00 | 86.00 abc | 93.33 ab | 104.33 |
| F₅ = 100 kg P₂O₅/ha | 0.00 | 7.00 | 23.83 | 33.83 | 42.00 | 63.33 ab | 73.00 | 76.67c | 82.00 c | 100.33 |

Note: Numbers followed by the same lowercase letter in the same column, show insignificant differences at the 5% level based on Duncan's Multiple Range Test.

Figure 2. The phosphorus application and the length of the primary tendrils at 8 WAP

Figure 3. The effect of the phosphorus addition on the length of the primary tendrils at 10 WAP
3.3. Number of Secondary Tendrils (tendrils)

Table 2. The average number of secondary tendrils at 6-12 WAP in the phosphorus fertilizer treatment

| Treatment       | Number of secondary tendrils (WAP) |
|-----------------|-------------------------------------|
|                 | 6    | 7    | 8    | 9    | 10   | 11   | 12   |
| $F_0 = 0 \text{ kg } P_2O_5/\text{ha}$ | 1.33 | 2.67 | 7.00 | 12.33| 17.33| 25.67| 42.33|
| $F_1 = 20 \text{ kg } P_2O_5/\text{ha}$ | 1.67 | 3.33 | 6.33 | 9.67 | 14.00| 23.00| 32.33|
| $F_2 = 40 \text{ kg } P_2O_5/\text{ha}$ | 4.00 | 5.67 |10.00 |14.67| 18.33| 25.00| 41.00|
| $F_3 = 60 \text{ kg } P_2O_5/\text{ha}$ | 2.33 | 3.00 | 9.33 | 14.00| 18.33| 20.33| 37.33|
| $F_4 = 80 \text{ kg } P_2O_5/\text{ha}$ | 4.33 | 6.67 |11.33 |14.33| 18.67| 24.67| 40.67|
| $F_5 = 100 \text{ kg } P_2O_5/\text{ha}$| 2.67 | 5.33 |10.33 |15.00| 18.67| 26.00| 44.33|

Table 3 displays the average number of the secondary tendrils at 6-12 WAP observations. It can be seen from the observation of the secondary tendrils aged 6-12 WAP, the number of secondary tendrils is not notably different due to the phosphorus fertilization. The highest number of the secondary tendrils and an increasing rate occur from 8 to 12 WAP observations. The phosphorus fertilization treatment at 5-12 WAP observation on the highest number of secondary tendrils is obtained at 100 P2O5 kg/ha (F5) phosphorus application.

3.4. Data of Production

Figure 5 exhibits the average data of the pegagan plant production. The variance analysis reveals that the phosphorus treatment did not prominently impact the dry weight of leaves and petiole, dry weight of roots and tendrils. However, the F2 (40 kg P2O5/ha) treatment was the highest compared to other treatments.

The statistical analysis exhibits that various phosphorus treatments slightly influenced the length of the primary tendrils of 8, 10, and 11 WAP. Simultaneously, the other parameters of the growth and production did not show a significant impact. The phosphorus application escalates the length of the primary tendrils at the age of 10 and 11 WAP in a quadratic response. The length of the primary tendrils rises to a certain extent, and then it declines thereafter. The application of 93 kg P2O5/ha phosphorus obtains the maximum tendril length. Although the phosphorus application, in general, does not reveal a prominent influence, there is an increasing yield trend as a result of the adding of the phosphorus doses given to pegagan plants up to 40 kg P2O5/ha (F2). Overall, the fertilized plants tend to have better results than those of the unfertilized plants. The growth parameters such as number of leaves, length of petiole, total leaf area of parent plant, number of primary tendrils, number of stolons, wet weight per plot, highest leaf dry weight, and root dry weight, are found in the phosphorus treatment at the level of 40 kg P2O5/ha. However, the highest parameter of the primary tendrils’ length is achieved by adding
the phosphorus at the level of 80 kg P2O5/ha, and the best parameter of the number of secondary tendrils was obtained at the application of phosphorus at the level of 100 kg P2O5/ha. The adequate nutrients in plants are useful to help the plants grow. Mengel and Kirkby (1982) stated that phosphorus is one of the necessary plant macronutrients which roles in several plants' life processes, such as photosynthesis, carbohydrate metabolism, and energy flow processes.

Figure 5. The average of the dry weights of leaves and petiol; androots and tendrils as the phosphorus

This is supported by Vinolina et al (2012) [17] in the earlier study that soil P content had effects on the centelloside content of pegagan. The phosphorus benefit stimulates better root formation to advance the nutrients and water absorption and the amount of leaf chlorophyll (the amount of leaf chlorophyll increases with increasing phosphorus application). The other benefits are that phosphorus can lead to a good photosynthesis process to gain photosynthate. Those benefits are considered to magnify the amount of asiaticoside compounds in plants. Phosphorus cannot be diminished in plants. It remains as phosphates in its free form, but it is esters when bound to organic compounds. Phosphate esters are formed with sugars, alcohols, acids, or other phosphates (polyphosphates). This compound is considered an intermediate for the pentose phosphate pathway of primary metabolites and is derived from precursors to secondary metabolites. Vinolina et al [2, 3, 18] mentioned that the elements of soil phosphorus influence the levels of asiaticoside, madecassoside, and asiatic acid in several accessions observed.

Phosphorus is also a crucial component of various phosphate sugars, which is helpful during reactions in the dark phases of photosynthesis, respiration, and various other metabolic processes. It has a function in energy storage and transfer. Besides, it can elevate the plants’ production or dry matter and enhance the yield’s quality [20].

4. Conclusion
The addition of phosphorus influences the growth component of the length of the primary tendril in acid soil conditions.

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