Growth and yield of *Fragaria sp.* in mixed and volume of plant media

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**Abstract.** Strawberry can be planted in polybags, but the right mix and volume of the media are unknown. The study aims to determine the effect of media mix and volume on the growth and yield of strawberries [*Fragaria sp.*]. The right mixture of media will provide optimum growth and plant yield. Media volume is important to provide adequate root growth space. Minimum media volume is required but can provide maximum growth and yield. The study was conducted in Solok Regency, West Sumatra, using a factorial randomized block design consisting of two factors. The first factor is the media mixture consisting of three levels, namely: A1 [soil + charcoal husk], A2 [soil + cow manure + husk charcoal], A3 [soil + chicken manure + husk charcoal]. The second factor is the volume of media consisting of three levels, namely: B1 [3 liters], B2 [5 liters] and B3 [7 liters]. The observations showed that the interaction between soil mixture, chicken manure, rice husk charcoal or soil mixture, cow manure, rice husk charcoal with a media volume of 7 liters showed the best results at root length. The highest number and weight of fruit were produced at a single factor A3 [soil + chicken manure + husk charcoal], and media volume of 7 liters, but not significantly different from other treatments.

Keywords: cow manure, chicken manure, husks charcoal, strawberries

1. Introduction

Strawberry [*Fragaria sp.*] are the preferred fruit plants because they taste sweet and sour. Strawberries contain that can be used for treatment including pro-vitamin C, anthocyanin, ellagic acid, catechins, quaterferin, and kaemferol. Ellagic acid is a phenol compound that acts as an anti-toxin, anti-free radical, anti-carcinogenic, and anti-mutagen that has the potential to inhibit cancer [1], [2], [3]. Compared to other berries, strawberries contain a higher percentage of vitamin C, phenolic and flavonoids [4].

To overcome the limited area of land and the availability of fertile land, an attempt to strawberries in a polybag. This effort will be more efficient when using the right mix and volume of media. The right mixture of media will produce fertile media and provide enough nutrients for strawberry growth. The volume of media will determine the area of space available for growth and the strength of roots to support plants. Required media with minimal volume but can support plant growth. The volume of 7-liter planting media produces more and longer stolons than the 3-liter planting media [5]. Planting media are media used to grow plants, where roots or roots will grow and develop, planting media are also used by plants as a place to hold the roots so that the plant canopy stands firmly on the media and as a means to support plants [6]. Increasing the volume of the planting medium significantly affected...
the growth of passion fruit [7], increasing the number of leaves and the dry weight of tomato plants [8].

Cow manure is an organic material that has the role of increasing the availability of phosphorus and microelements, reducing the bad influence of aluminum, and contains many nutrients needed by plants such as N, P, K, Ca, Mg, S and B [9]. A mixture of planting media consisting of soil + chicken manure + charcoal husk provides better growth for mustard caisin [10]. It is known that the best mix of planting media for growth and yield of strawberry plants and vertical gardens is organic planting media in the form of husk charcoal with a soil mixture of 2:1 composition and with a total media weight of 265 g [11].

2. Materials and Methods

2.1. Time and place
The study was conducted from April to July 2018, in Nagari Batu Bajanjang, Lembang Jaya District, Solok Regency, which is located at an altitude of ± 1400 meters above sea level. The materials used include California varieties of strawberry seeds, andosol soil, cow manure, chicken manure, husk charcoal, NPK 16:16:16 fertilizer, and polybag sizes [30x50, 40x50, 50x50].

2.2. The design of the experiment
This research used Factorial in Randomized Block Design. Consists of two factors, namely the mixed media planting factor [A] and the media volume factor [B]. 1. Plant media mixed factor [A] consists of 3 levels, namely: A1 = Mixed [soil + charcoal] 2:1 ratio, A2 = Mixed [soil + cow manure + husk charcoal] 1:1:1 ratio, A3 = Mixed [soil + chicken manure + husk charcoal] 1:1:1 ratio. 2. The volume of planting media [B] consists of 3 levels, namely: B1 = 3 liters, B2 = 5 liters, B3 = 7 liters. From the two factors above, we get the combination of treatments as listed in Table 1. All data obtained were analyzed with analysis of variance [ANOVA] followed by Duncan New Multiple Range Test, with a 5% level of significance.

| Media Mix | Media Volume |
|-----------|--------------|
|           | B1 | B2 | B3 |
| A1        | A1B1 | A1B2 | A1B3 |
| A2        | A2B1 | A2B2 | A2B3 |
| A3        | A3B1 | A3B2 | A3B3 |

2.3. Research Implementation
The media used were previously sieved using a sieve, except the husk charcoal. Then mixed evenly according to treatment. Seedlings in the form of chicks that are one month old are planted in prepared polybags. Maintenance includes watering, weeding, fertilizing and trimming. The fertilizer given is NPK 16:16:16 with a dose of 12 g per plant, given a week age, 30 and 60 days. Observations were made on plant height [cm], number of leaves [stems], flowering age [days], number of flowers [florets], first harvest age [days], weight of fruits per plant [g], number of fruits per plant [fruit] and root length [cm].

3. Results and discussion

3.1. Plant Height
All treatments did not affect the height of the strawberry [Table 2].
Table 2. The average height of strawberry plants [cm] in various mixtures and volumes of planting media, age 4 weeks after planting

| Media Mix                              | Media Volume | Influence of mixed media [cm] |
|----------------------------------------|--------------|-------------------------------|
|                                        | B3 [7 liters]| B1 [3 liters]                | B2 [5 liters] |
| A3 [soil + chicken manure + charcoal husk 1: 1: 1] | 21.71 a      | 21.54 a                      | 21.50 a       | 21.58 a       |
| A2 [soil + cow manure + charcoal husk 1: 1: 1] | 21.46 a      | 21.36 a                      | 21.24 a       | 21.35 a       |
| A1 [soil + charcoal husk 2:1]          | 21.35 a      | 21.34 a                      | 21.28 a       | 21.32 a       |
| Influence Media Volume [cm]            | 21.50 a      | 21.41 a                      | 21.34 a       |

CV = 0.04 %

Values are the mean of four replicates. The average followed by the same lowercase letters is not significantly different according to the F test at a 5% significance level.

Plant height increase occurs because of the process of increasing the number and elongation of cells. Besides the high rainfall during the study allegedly affected the increase in plant height. The mixture of media consisting of materials that have high porosity such as husk charcoal and manure will experience washing elements. Water flowing out of the media container will carry the elements contained in the media [12].

3.2. Number of Leaves
All treatments did not affect the number of leaves [Table 3].

Table 3. The average number of leaves of strawberry plants [fruit] in various mixtures and volumes of planting media, age 4 weeks after planting

| Media Mix                              | Media Volume | Influence of mixed media [piece] |
|----------------------------------------|--------------|---------------------------------|
|                                        | B3 [7 liters]| B2 [5 liters] | B1 [3 liters] |
| A3 [soil + chicken manure + charcoal husk 1: 1: 1] | 12.66 a      | 12.53 a        | 12.46 a      | 12.55 a      |
| A2 [soil + cow manure + charcoal husk 1: 1: 1] | 12.61 a      | 12.60 a        | 12.26 a      | 12.50 a      |
| A1 [soil + charcoal husk 2:1]          | 12.66 a      | 12.40 a        | 12.40 a      | 12.49 a      |
| Influence Media Volume [piece]        | 12.64 a      | 12.51 a        | 12.37 a      |

CC = 0.09 %

Values are the mean of four replicates. The average followed by the same lowercase letters is not significantly different according to the F test at a 5% significance level.

The number of leaves will be consistent with plant height, the higher the plant the more leaves. The number of leaves is related to the growth of the stems or height of the plant where the stem is composed of segments that span between the stem books where the leaves are attached. The number of leaves will be determined by the number of nutrients and water that can be absorbed by plants. If there are enough nutrients and water, the photosynthesis process will run optimally to produce assimilation [13].
3.3. Flowering Age
Flowering age is influenced by the composition contained in the media, where the soil mixture + chicken manure + charcoal husk shows the fastest flowering age, which is 62.10 days, not significantly different from the mixed soil + cow manure + husk charcoal [Table 4]

Table 4. The average age of the flowering of strawberry plants [days] in various mixtures and volumes of planting media

| Media mix                               | Media Volume | Influence of mixed media [days] |
|-----------------------------------------|--------------|-------------------------------|
|                                         | B3 [7 liter] | B2 [5 liter] | B1 [3 liter] |                               |
| A3 [soil + chicken manure + charcoal husk 1: 1: 1] | 62.73 a      | 61.73 a      | 61.93 a      | 62.10 a                       |
| A2 [soil + cow manure + charcoal husk 1: 1: 1] | 62.07 a      | 63.27 a      | 62.13 a      | 62.47 ab                      |
| A1 [soil + charcoal husk 2:1]           | 64.67 a      | 63.33 a      | 62.80 a      | 63.77 b                       |
| Influence Media Volume [days]           | 63.13 a      | 62.93 a      | 62.27 a      |                               |

CC = 0.06 %

Values are the mean of four replicates. The average followed by the same lowercase letters are not significantly different according to the F test at 5% significance level.

The P content in both treatments can stimulate faster reproductive growth. Although chicken manure has a P element content of 3.32%, while in cow manure it is only 0.61% [14].

3.4. Number of Flowers
All treatments did not affect the number of flowers of strawberry plants [Table 5].

Table 5. The average number of flowers of strawberry plants [florets] in various mixtures and volumes of planting media

| Media mix                               | Media Volume | Influence of mixed media [floret] |
|-----------------------------------------|--------------|----------------------------------|
|                                         | B3 [7 liters] | B2 [5 liters] | B1 [3 liters] |                               |
| A3 [soil + chicken manure + charcoal husk 1: 1: 1] | 11.20 a | 11.93 a | 10.60 a | 11.24 a                       |
| A2 [soil + cow manure + charcoal husk 1: 1: 1] | 11.20 a | 10.73 a | 10.53 a | 10.82 a                       |
| A1 [soil + charcoal husk 2:1]           | 10.93 a | 10.26 a | 10.73 a | 10.64 a                       |
| Influence Media Volume [floret]         | 11.11 a | 10.97 a | 10.62 a |                               |

CC = 0.41 %

Values are the mean of four replicates. The average followed by the same lowercase letters are not significantly different according to the F test at 5% significance level.

It is suspected that the number of strawberry flowers is more influenced by genetic factors of the plant itself. Different media mixes and media volumes will produce the same amount of relative interest. Strawberry flowers are arranged in panicles and are flowers hermaphroditic. In one individual interest, there are five or more sepals green, five or more petals that are white, several stamens and several pistils attached to one enlarged receptacle [15]. The ability of plants to be able to grow and
develop uniformly even in an environment that does not support is caused by genetic factors of the plant itself [16].

3.5. First Harvest Age

The mixture of soil media + chicken manure + husk charcoal and soil mixture + cow manure + husk charcoal provides the fastest harvest age [Table 6].

Table 6. The average age of the first harvest of strawberries [days] in various mixtures and volumes of planting media

| Media mix                                      | Media Volume | Influence of mixed media [days] |
|------------------------------------------------|--------------|---------------------------------|
| A3 [soil + chicken manure + charcoal husk 1:1:1] | B3 [7 liters] | 95.00 a                         |
|                                                | B1 [3 liters] | 94.60 a                         |
|                                                | B2 [5 liters] | 94.10 a                         |
| A2 [soil + cow manure + charcoal husk 1:1:1]   | B3 [7 liters] | 92.80 a                         |
|                                                | B1 [3 liters] | 92.60 a                         |
|                                                | B2 [5 liters] | 93.40 a                         |
| A1 [soil + charcoal husk 2:1]                  | B3 [7 liters] | 93.20 a                         |
|                                                | B1 [3 liters] | 92.40 a                         |
|                                                | B2 [5 liters] | 92.00 a                         |
| Influence Media Volume [days]                  | B3 [7 liters] | 93.67 a                         |
|                                                | B1 [3 liters] | 93.20 a                         |
|                                                | B2 [5 liters] | 93.17 a                         |

CC = 0.03 %

Values are the mean of four replicates. The average followed by the same lowercase letters are not significantly different according to the F test at 5% significance level

In this case, the number of nutrients contained in chicken manure can meet the needs of plants to accelerate the process of cooking fruit compared to cow manure. But different media volumes have no significant effect on harvest time. Strawberry fruit begins to ripen 15-30 days after flowering, if the strawberries start flowering at the age of 60 days after planting, then the strawberries will begin to ripen at the age of 75-90 days after planting. One of the planting media mixtures that serve to increase porosity is husk charcoal [2]. Husk charcoal has very mild characteristics [BJ = 0.2 kg / l], rough so that the air circulation is high because it contains many pores, high water holding capacity, neutral pH, and relatively clean from pests, bacteria and weeds [17].

3.6. Fruit Weight per Plant

All treatments did not affect fruit weight [Table 7]. Environmental conditions experienced during planting with high rainfall resulting in less sunlight, resulting in relatively low fruit production. Though it should be able to produce fruit with an average weight of 150 grams/plant [18]. Adding the husk charcoal can cause the media mixture to be too porous so that it cannot hold water well. It can be seen from the growth of the smaller stem diameter in the treatment of the most husk charcoal mixture which is 20% in tomato plants [19].
Table 7. The average weight of fruit per plant [g] in various mixtures and volumes of planting media

| Media mix                              | Media Volume | Influence of mixed media [gram] |
|----------------------------------------|--------------|--------------------------------|
|                                        | B3 [7 liters]| B1 [3 liters]                 | B2 [5 liters] |
| A3 [soil + chicken manure + charcoal husk 1:1:1] | 47.80 a      | 39.13 a                       | 43.40 a        | 43.44 a        |
| A2 [soil + cow manure + charcoal husk 1:1:1] | 43.66 a      | 47.86 a                       | 37.80 a        | 43.11 a        |
| A1 [soil + charcoal husk 2:1]          | 38.60 a      | 35.40 a                       | 36.00 a        | 36.67 a        |
| Influence Media Volume [gram]          | 43.35 a      | 40.80 a                       | 39.07 a        |

CC = 0.82 %

Values are the mean of four replicates. The average followed by the same lowercase letters are not significantly different according to the F test at 5% significance level.

3.7. Number of fruits per plant
All treatments did not affect the number of fruits per plant [Table 8].

Table 8. The average number of fruits per plant [fruit] in various mixtures and volumes of planting media

| Media mix                              | Media Volume | Influence of mixed media [fruits] |
|----------------------------------------|--------------|----------------------------------|
|                                        | B3 [7 liters]| B1 [3 liters]                   | B2 [5 liters] |
| A3 [soil + chicken manure + charcoal husk 1:1:1] | 6.40 a       | 5.00 a                          | 5.67 a        | 5.67 a        |
| A2 [soil + cow manure + charcoal husk 1:1:1] | 5.67 a       | 5.66 a                          | 4.86 a        | 5.37 a        |
| A1 [soil + charcoal husk 2:1]          | 5.66 a       | 5.00 a                          | 4.86 a        | 5.17 a        |
| Influence Media Volume [fruits]        | 5.89 a       | 5.22 a                          | 5.11 a        |

CC = 0.75 %

Values are the mean of four replicates. The average followed by the same lowercase letters are not significantly different according to the F test at 5% significance level.

The amount of fruit will be greatly affected by the variety of plants, the number of flowers and the environment during planting. It is suspected that this is due to the relatively high rainfall experienced during the strawberry growth period so that nutrients will be washed and carried out of the polybags. Husk charcoal is porous, lightweight, not dirty, but can absorb low water and good porosity [20].

3.8. Root Length
Treatment is given a significantly different effect on root length [Table 9]. From Table 9 it can be seen that the interaction between soil mixture + chicken manure + husk charcoal or soil mixture + cow manure + husk charcoal with a media volume of 7 liters produces the longest average root length. Means with this treatment makes soil conditions looser so the roots can grow better. Besides, a considerable volume of media can sustain root growth and make roots grow better. More media volume guarantees relatively more water and nutrient availability. Conversely, a small volume of
media will provide little nutrients for plants. Small pots will indirectly reduce the total nutrient content in pots [21]. More efficient use of soil can be done by reducing the volume of media loaded into the poly bag. A good volume of media for plant cultivation is the volume of media that can support the growth and development of roots and meet the needs of plants for water and nutrients. Media volume manipulation is appropriate by making media compositions that can maintain soil moisture in a relatively long time and can provide nutrients for plants [22].

Table 9. The average root length of strawberry plants [cm] in various mixtures and volumes of planting media

| Media mix                                      | B3 [7 liter] | B1 [3 liter] | B2 [5 liter] | Influence of mixed media [cm] |
|------------------------------------------------|--------------|--------------|--------------|------------------------------|
| A3 [soil + chicken manure + charcoal husk 1:1:1]| 49.57 f      | 45.38 d      | 43.83 b      | 46.26 b                      |
| A2 [soil + cow manure + charcoal husk 1:1:1]  | 48.84 f      | 47.44 e      | 42.36 a      | 46.21 b                      |
| A1 [soil + charcoal husk 2:1]                  | 45.32 d      | 44.16 bc     | 43.56 b      | 44.34 a                      |
| Influence Media Volume [cm]                    | 47.91 c      | 45.66 b      | 43.25 a      |                              |

CV = 0,05 %

Values are the mean of four replicates. The average followed by the same lowercase letters are not significantly different according to the F test at 5% significance level.

4. Conclusion
From the research, it was found that there was an interaction between soil mixture, chicken manure, husk charcoal or soil mixture, cow manure, husk charcoal with a media volume of 7 liters on root length observations, whereas in other observations there were no interactions. The highest number and weight of fruit were produced at a single factor A3 [soil mix + chicken manure + husk charcoal], and media volume of 7 liters, but not significantly different from other treatments.

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