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Comparison of Pebbles Growing Media from Agricultural Waste Materials on Productivity Growth of Melon (cv. Orange Man and cv. Galia 248) Cultivated in Greenhouse Conditions

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Abstract

The objective of this research project was to compare the results from the use of pebbles growing media made from agricultural waste suitable for the growth and productivity of two cultivars, Orange Man melon and Galia 248 melon in a greenhouse. Pebbles growing media could reduce cost from the traditional material used for growing melon and have higher productivity for farmers. The experiment was divided into 5 experimental sets, namely, set that uses 100% of pebbles from agricultural waste (T1), set that uses normal planting material(coconut husk and chopped coconut coir in the ratio of 2 to 1), 25% mixed with pebbles from agricultural waste at 75% (T2), 50% mixed with pebbles from agricultural waste at 50% (T3), 75% mixed with pebbles from agricultural waste at 25% (T4), and normal planting material 100% (T5).The research methodology is CRD, with one-way and two-way analysis of variance (ANOVA). In addition, the pair test with Scheffe's method to compare the difference that affects fruit weight of the melon at 42 days after pollination was used. The comparison of the means and standard deviation were performed by Scheffe's method at $P \leq 0.05$ significance level. From the growth and productivity records of two cultivars melon, it was found that the experimental set that is most suitable is T2 which gave high yield of fruit width, fruit length, fruit weight and Brix value. Orange Man cultivars grown with T2 exhibited the average fruit width, fruit length, fruit weight and Brix value at 23.6±1.8 cm, 23.7±1.9 cm, 1.9±0.1 kg and 16±0.0° Brix, respectively. Galia 248 cultivars grown with T2 exhibited the average fruit width, fruit length, fruit weight and Brix value at 23.2±0.8 cm, 24.4±1.2 cm, 1.9±0.1 kg and 15±0.6° Brix, respectively. These results indicated that the factors of cultivar and treatment at the time of pollination are not different from each other with the statistical significance and confidence level of 95% compared with melons grown with T5 (normal planting material). These findings can lead to benefit farmers by reducing the cost of growing material for as much as 75% per time. The new material are easily manageable as well as having a long service life.

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Introduction

Melon (*Cucumis melo* L.) is an edible plant ripe fruit offering a sweet aroma, sweet taste and high nutritional value. Rich in vitamin A, vitamin C and beta-carotene, 236 g of melon pulp provides 78 kilocalories of energy, 28 mg of sodium, 593 mg of potassium, 25 g of carbohydrates, 2 g of fiber, 21 g of sugar, 90 mg of vitamin C, 4 mg of calcium and 10 mg of iron. It also contains adenosine that helps prevent blood clotting and a high level of carotenoids that can prevent cancer and reduce the risk of lung cancer (Lester, 1997). Currently, it is popular to grow melons in greenhouses so that the environment can be controlled, reducing the spread of pest and producing quality products, including efficiency in providing water and fertilizer with a drip irrigation system, using planting materials that are easily available locally, such as sand, burnt rice husks, rice husks and coconut husks. However, each type of melon can grow well in each specific type of planting material and different environments. These things effect the quality of the product differently, including innovation to find the appropriate local agricultural waste materials to help reduce management costs. In particular, reusable materials can help reduce production costs and increase profits for farmers as well as being a worthwhile and sustainable use of natural resources.

Clay pebbles or pebbles growing media is a material used for growing plants in pots and for sprinkling on top of pots for ornamental plants and flowers. Apart from beautifying the pot, it also helps preserve moisture in the plant pot for a longer time without frequent watering. This is due to the properties of the pebbles growing media's ability to hold water well and not allow ion exchange. Therefore, it does not react with nutrients (Janbuala & Wasanapiarnpong, 2015). Since pebbles have a high porosity, it can hold water well while allowing good water and air drainage. It has a durable and strong structure, which can be easily disinfected and a long service life. Pebbles have been used as a material for growing hydroponic vegetables and offered a good germination rate. In addition, nutrients or organic matter can be added to the soil pebbles at any time and decomposes naturally without destroying the environment as well as not being a source of disease and insect accumulation (Chaitayakul, 2008). Pebbles growing media can be used as planting material for multiplying stone flowers by cutting leaves instead of volcanic stones, which are expensive (Jaruwattanaphan et al., 2015) and can also be used as a substitute for mixed soil for growing potted plants indoors to reduce the problem of collapse and compaction of mixed soil (Assadayudh et al., 2020).

This study examines melon growth including stem height (cm), stem circumference (cm), number of leaves (leaves), leaf width and leaf length (cm) at ages 7, 14, 21, 28, 35, 42 and 49 days after transplanting and yields including fruit width and length (cm) and fruit weight (kg/fruit) on days 28, 35 and 42 and melon fruit sweetness (°Brix) on 42 days after transplanting seedlings of Orange Man and Galia 248 melons in a greenhouse by using pebbles growing media from agricultural waste along with coconut dust and coconut coir in different ratios in 5 experimental sets. The study will help farmers source local waste materials for growing melons along with reducing costs and increase agricultural production.

Materials and methods

1. Materials

Certified seeds of two melon cultivars were selected for the study, namely the Orange Man and Galia 248 melons, each have characteristics consistent with the purebred breeds.

2. Seed preparation for planting

The plant seedlings were soaked in warm water for 3-4 hours and then mixed the seeds with Trichoderma germs. Next, the seeds were wrapped in a damp cloth (the cloth must never be wet) and incubated in a closed container for 24-30 hours. The roots will grow 3-5 mm before being planted in peat moss in a seed tray with the size of 72 holes and filled with peat moss in the hole tray. Each hole was approximately half a centimeter deep. The seeds were placed in the holes, one in each hole, with the roots facing down. The seeds needed to be water well and placed in the sunlight all day. It is important not to place the seeds indoors because the seedlings will stretch weak and easily broken. In this seedling stage, if there are insects, directed spray with a thin layer of various protective substances or provide nourishing hormones were used to make the seedlings plump and fuller, but do not use it with high concentration because the leaves of the seedlings can burn. Planting seeds can be done in a nursery or placed in a greenhouse right from sowing.

3. Preparation of planting materials for melon seedlings

When the seedlings were 10-14 days old, they were transplanted with complete roots into the prepared planting material. The experiment used a Completely Randomized Design (CRD) with a total of 5 experimental sets, 4 replicates, as follows: planting material containing a mixture of pebbles growing media from agricultural waste at 100% (T1), normal planting material containing a mixture of coconut dust with chopped coconut coir in a ratio of 2 to 1 mixed with pebbles growing media from agricultural waste at 75% (T2), normal planting material is a mixture of coconut husks and chopped coconut husks in a ratio of 2 to 1 mixed with pebbles growing media from agricultural waste at 50% (T3), normal planting material consisting of a mixture of coconut dust with chopped coconut coir in a ratio of 2 to 1 mixed with pebbles growing media from agricultural waste material at 25% (T4). Compared to the control set with normal planting material. Normal planting material containing a mixture of coconut husks and chopped coconut husks in a ratio of 2 to 1 (T5).

4. Growing melon seedlings in the greenhouse

The Galia 248 and Orange Man melons that were transplanted into the planting material were placed in the greenhouse of Suan Dusit University, Suphanburi Campus, Suphanburi Province.When the melon started to crawl, the use of string was used to hold them up. Branches were cut off leaving only branches 9-12 for pollination. When the fruit reached the size of a chicken egg, selected only one perfect fruit per plant. Then, plucked the 30^{th} leaf bud and plucked 5 lower leaves that were close to the material. Harvesting begins approximately 40 days after pollination and approximately 50% of the cracks in the fruit pole could be observed.

5. Data collection

The growth data included stem height (cm), stem circumference (cm), number of leaves (leaves), leaf width and leaf length (cm) at 7, 14, 21, 28, 35, 42 and 49 days after transplanting seedlings were collected. The height measurement was measured from the surface level of the planting material to the tip of the bud. Then, calculated the average value for each period and information on melon fruit growth, including fruit width and length (cm) and fruit weight (kg/fruit) on days 28, 35 and 42 days after pollination and sweetness of melon fruit (°Brix) on 42 days after pollination.

6. Statistical analysis

Statistical analysis was performed on cut fresh melon fruits of both cultivars that were 42 days old. The fruits were weighted. Then, the results were analyzed by one-way and two-way analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS) Software version 22.0, tested in pairs using the Scheffe's method and comparing the means and standard deviation were performed by Scheffe's method at $P \leq 0.05$ significance level.

Results and discussion

1. Growth characteristics of melon plants at 7, 14, 21, 28, 35, 42 and 49 days after transplanting seedlings

This study on the growth of two melon cultivars: Orange Man and Galia 248, by mixing pebbles growing media from agricultural waste with normal planting material (coconut dust mixed with chopped coconut coir, in the ratio of 2 to 1) in different proportions, which was divided into 5 experimental sets as follows:

T1 Experimental set 1: 100% pebbles growing media

T2 Experimental set 2: 75% pebbles growing media (25% original material)

T3 Experimental set 3: 50% pebbles growing media (50% original material)

T4 Experimental set 4: 25% pebbles growing media (75% original material)

T5 Control set: Coconut dust mixed with chopped coconut coir, in the ratio of 2 to 1.

From the experiment comparing 5 sets of planting materials on the growth of two melon cultivars: Orange Man and Galia 248, to study on the appropriate proportions for using pebbles growing media from agricultural waste mixed with coconut dust and chopped coconut coir as a material for growing melons in greenhouses. The findings from the study showed the growth of melon, including the height of the plant, stem circumference, number of leaves, leaf width and leaf length at the ages of 7, 14, 21, 28, 35, 42 and 49 days after transplanting seedlings (Table 1-5) and the results of the study showing the growth of fruits. After 49 days, average plant height was in the range of 164.3-175.0 cm. Galia 248 cultivars seedlings that were grown with T1, T2, T3, T4 and T5 had the highest average height at 175.0±0.0 cm. Moreover, Orange Man cultivars seedlings that were grown with T3 and T4 also had the highest average height at 175.0±0.0 cm (Table 1). Analysis of stem circumference and number of melon leaf at 49 days

showed that there was no statistically significant difference between cultivar and treatment at the time of pollination (Table 2 and 3). Nevertheless, when comparing the average leaf width and leaf length of the two cultivars and treatment, there was a statistically significant difference. Orange Man cultivars grown with T3 had the highest leaf width and leaf length at 23.9±0.9 and 24.2±0.5, respectively (Table 4 and 5). The data on fruit width and fruit length at 28, 35 and 42 days after pollination, and fruit weight and sweetness at 42 days after pollination was collected from plants grown with T1, T2, T3, T4 and T5. No statistically significant differences were observed in fruit width and fruit length at 42 days after pollination. The fruit width ranged from 22.0-23.6 cm and the fruit length ranged from 22.2-24.4 cm.

Table 1 The average height of stems of Orange Man and Galia 248 melon of 7, 14, 21, 28, 35, 42 and 49 days after transplanting seedlings using five experimental sets (T1-T5)

Material ratio of growing treatment (PGM:NPM)	Average stem height after planting (cm)						
	7 days^{ns}	14 days^{ns}	21 days	28 days	35 days	42 days	49 days
T1(100:0) Orange Man	12.1±0.6	12.5±0.5^{a}	29.5±4.1^{bc}	85.3±8.2^{ab}	121.3±12.7^{a}	147.0±12.7^{ab}	168.3±11.1^{ab}
Galia 248	12.2±0.4	12.6±0.5^{a}	36.1±4.3^{ab}	113.5±9.1^{de}	169.7±26.0^{c}	175.0±0.0^{e}	175.0±0.0^{c}
T2 (75:25) Orange Man	12.1±0.7	12.8±0.7^{a}	31.1±6.0^{bc}	93.7±15.6^{abc}	134.8±17.9^{ab}	156.3±16.9^{abcd}	173.1±5.7^{bc}
Galia 248	12.1±0.7	12.7±0.5^{a}	40.4±5.6^{a}	123.3±14.2^{e}	170.8±25.5^{c}	175.0±0.0^{e}	175.0±0.0^{c}
T3 (50:50 Orange Man	12.2±0.5	13.3±1.0^{a}	34.2±6.1^{ab}	102.1±10.6^{cd}	139.0±18.2^{ab}	153.6±14.5^{abc}	175.0±0.0^{c}
Galia 248	12.4±0.5	13.0±0.6^{a}	40.0±7.8^{a}	121.3±16.2^{e}	173.5±19.9^{c}	161.8±16.1b^{cde}	175.0±0.0^{c}
T4 (25:75) Orange Man	12.1±0.5	12.6±0.8^{a}	31.0±4.4^{bc}	96.3±5.9^{bc}	134.0±11.5^{ab}	152.1±11.1^{abc}	175.0±0.0^{c}
Galia 248	12.6±0.5	13.1±0.6^{a}	39.7±6.1^{a}	117.8±10.0^{de}	173.4±17.2^{c}	172.3±5.9^{de}	175.0±0.0^{c}
T5 (control) Orange Man	12.7±0.5	12.9±0.7^{a}	26.2±1.6^{c}	79.2±5.8^{a}	117.1±10.4^{a}	141.5±4.5^{a}	164.3±5.8^{a}
Galia 248	12.4±0.5	13.0±0.8^{a}	28.6±1.2^{bc}	96.6±3.5^{bc}	149.1±17.2^{bc}	165.6±12.3^{cde}	175.0±0.0^{c}

Remark: Uppercase letters in colum ns refer to differences in the mean values for the studied factors. ns indicate no statistically significant differences ($p<0.05$)

Table 2 The average circumference of melon stems of 7, 14, 21, 28, 35, 42 and 49 days after transplanting seedlings using five experimental sets (T1-T5)

Material ratio of growing treatment (PGM:NPM)	Average circumference of melon stems after planting (cm)						
	7 days^{ns}	14 days	21 days	28 days	35 days	42 days	49 days^{ns}
T1 (100:0) Orange Man	0.2±0.0^{a}	0.6±0.1^{d}	0.7±0.1^{b}	0.9±0.1^{bc}	1.0±0.1^{c}	1.1±0.1^{bc}	1.1±0.1^{a}
Galia 248	0.2±0.0^{a}	0.5±0.1^{cd}	0.7±0.1^{b}	0.8±0.1^{ab}	0.9±0.1^{bc}	1.0±0.1^{abc}	1.1±0.1^{a}
T2 (75:25) Orange Man	0.2±0.0^{a}	0.5±0.1^{cd}	0.7±0.1^{b}	0.9±0.1^{bc}	0.9±0.1^{bc}	1.1±0.1^{bc}	1.1±0.1^{a}
Galia 248	0.2±0.0^{a}	0.5±0.1^{cd}	0.7±0.1^{b}	0.8±0.1^{ab}	0.9±0.1^{bc}	1.0±0.1^{abc}	1.1±0.1^{a}
T3 (50:50 Orange Man	0.2±0.0^{a}	0.5±0.1^{cd}	0.7±0.1^{b}	0.9±0.1^{bc}	0.9±0.1^{bc}	1.0±0.1^{abc}	1.1±0.1^{a}
Galia 248	0.2±0.0^{a}	0.5±0.1^{cd}	0.7±0.1^{b}	0.8±0.1^{ab}	0.9±0.1^{bc}	0.9±0.1^{b}	1.1±0.1^{a}
T4 (25:75) Orange Man	0.2±0.0^{a}	0.5±0.0^{bc}	0.7±0.1^{b}	0.9±0.1^{bc}	0.9±0.1^{bc}	0.9±0.2^{ab}	1.1±0.1^{a}
Galia 248	0.2±0.0^{a}	0.5±0.1^{cd}	0.7±0.1^{b}	0.8±0.1^{ab}	0.9±0.0^{a}	0.9±0.0^{a}	1.1±0.1^{a}
T5 (control) Orange Man	0.2±0.0^{a}	0.4±0.0^{a}	0.6±0.0^{a}	0.8±0.0^{a}	0.9±0.1^{bc}	1.1±0.1^{bc}	1.1±0.1^{a}
Galia 248	0.2±0.0^{a}	0.4±0.0^{a}	0.6±0.0^{a}	0.8±0.1^{ab}	0.9±0.1^{bc}	1.1±0.1^{bc}	1.1±0.1^{a}

Remark: Uppercase letters in colums refer to differences in the mean values for the studied factors. ns indicate no statistically significant differences ($p<0.05$)

Table 3 The average number of melon leaf of 7, 14, 28, 35, 42 and 49 days after transplanting seedlings using five experimental sets (T1-T5)

Material ratio of growing treatment (PGM:NPM)	Average number of melon leaves after planting (leaves)						
	7 days^{ns}	14 days	21 days	28 days	35 days	42 days	49 days^{ns}
T1 (100:0) Orange Man	2±0.0^{a}	4±0.5^{abc}	6±0.7^{bcd}	13±1.0^{abc}	16±1.9^{abc}	27±2.2^{ab}	29±2.1^{a}
Galia 248	2±0.0^{a}	5±0.3^{c}	7±0.8^{d}	15±1.7^{cd}	21±2.8^{bc}	26±1.8^{ab}	30±2.9^{a}
T2 (75:25) Orange Man	2±0.0^{a}	4±0.5^{abc}	6±1.2^{ab}	13±1.0^{abc}	20±2.9^{bc}	29±2.5^{b}	30±1.5^{a}
Galia 248	2±0.0^{a}	4±0.6^{bc}	7±0.9^{cd}	14±1.8^{bcd}	22±2.4^{c}	27±2.3^{ab}	31±2.6^{a}
T3 (50:50) Orange Man	2±0.0^{a}	4±0.3^{ab}	6±0.7^{abc}	14±1.7^{abcd}	19±2.2^{abc}	29±2.0^{b}	30±1.8^{a}
Galia 248	2±0.0^{a}	4±0.3^{ab}	7±0.9^{d}	15±2.2^{d}	22±3.0^{c}	26±1.6^{ab}	29±1.8^{a}
T4 (25:75) Orange Man	2±0.0^{a}	4±0.5^{abc}	6±0.5^{abc}	13±1.8^{abcd}	19±1.9^{abc}	27±2.4^{ab}	31±2.1^{a}
Galia 248	2±0.0^{a}	4±0.3^{ab}	7±1.0^{d}	15±1.6^{cd}	22±1.8^{c}	25±2.2^{a}	30±1.3^{a}
T5 (control) Orange Man	2±0.0^{a}	4±0.3^{ab}	5±0.5^{a}	13±1.0^{a}	16±0.9^{a}	25±1.7^{a}	30±1.9^{a}
Galia 248	2±0.0^{a}	3±0.3^{a}	5±0.5^{ab}	12±1.6^{ab}	18±1.0^{ab}	27±2.3^{ab}	31±1.7^{a}

Remark: Uppercase letters in columns refer to differences in the mean values for the studied factors. ns indicate no statistically significant differences ($p<0.05$)

Table 4 The average width of melon leaf of 7, 14, 21, 28, 35, 42 and 49 days after transplanting seedlings using five experimental sets (T1-T5)

Material ratio of growing treatment (PGM:NPM)	Average width of melon leaf after planting (cm)						
	7 days^{ns}	14 days^{ns}	21 days	28 days	35 days	42 days	49 days
T1 (100:0) Orange Man	4.8±0.4^{a}	11.4±0.8^{a}	15.2±1.2^{ab}	18.1±1.5^{abc}	20.4±1.8^{ab}	23.2±1.4^{cd}	23.4±1.3^{cd}
Galia 248	4.5±0.5^{a}	11.4±0.9^{a}	14.7±1.2^{ab}	17.2±1.3^{ab}	19.3±1.2^{a}	20.1±1.0^{a}	21.9±1.2^{abc}
T2 (75:25) Orange Man	4.6±0.5^{a}	11.0±0.9^{a}	14.9±2.0^{ab}	18.6±2.4^{bc}	19.9±2.7^{ab}	22.0±1.8^{bcd}	23.0±1.5^{bcd}
Galia 248	4.8±0.4^{a}	11.3±0.9^{a}	15.0±0.9^{ab}	18.0±1.8^{abc}	19.5±1.4^{a}	20.9±1.3^{ab}	21.5±1.0^{ab}
T3 (50:50) Orange Man	4.4±0.5^{a}	11.4±0.9^{a}	15.6±1.6^{b}	19.5±1.1^{c}	22.0±1.9^{b}	23.3±1.3^{cd}	23.9±0.9^{d}
Galia 248	4.7±0.5^{a}	10.8±0.8^{a}	14.8±1.0^{ab}	18.7±1.5^{bc}	20.4±1.2^{ab}	21.7±1.2^{abcd}	22.2±1.2^{abcd}
T4 (25:75) Orange Man	4.8±0.5^{a}	10.4±0.5^{a}	14.7±1.1^{ab}	18.0±1.4^{abc}	21.2±1.3^{ab}	23.2±1.4^{cd}	23.8±1.0^{d}
Galia 248	4.7±0.5^{a}	11.1±1.2^{a}	14.8±1.0^{ab}	17.8±0.7^{abc}	19.9±0.9^{ab}	20.4±1.0^{ab}	20.9±0.9^{a}
T5 (control) Orange Man	4.4±0.5^{a}	10.2±2.4^{a}	13.9±0.5^{ab}	16.1±1.4^{a}	20.1±1.3^{ab}	21.3±0.8^{abc}	21.6±0.8^{ab}
Galia 248	4.8±0.4^{a}	10.0±2.2^{a}	13.6±0.8^{a}	16.4±1.0^{a}	20.1±0.8^{ab}	20.7±0.8^{ab}	21.0±0.7^{a}

Remark: Uppercase letters in columns refer to differences in the mean values for the studied factors. ns indicate no statistically significant differences ($p<0.05$)

Table 5 The average length of melon leaf of 7, 14, 21, 28, 35, 42 and 49 days after transplanting seedlings using five experimental sets (T1-T5)

Material ratio of growing treatment (PGM:NPM)	Average length of melon leaf after planting (cm)						
	7 days^{ns}	14 days	21 days	28 days	35 days	42 days	49 days
T1 (100:0) Orange Man	5.0±0.0^{a}	11.4±1.0^{b}	15.1±1.0^{ab}	17.4±1.6^{ab}	20.0±2.3^{ab}	21.9±1.0b^{cd}	22.5±0.9^{bc}
Galia 248	5.0±0.0^{a}	11.4±0.8^{b}	14.1±1.1^{a}	16.6±1.1^{ab}	18.6±1.0^{a}	19.8±0.8^{a}	21.1±0.7^{a}
T2 (75:25) Orange Man	5.0±0.0^{a}	11.0±0.9^{ab}	15.1±1.5^{ab}	17.9±2.2^{ab}	21.7±1.7^{b}	22.1±1.1^{cd}	22.2±0.7^{cd}
Galia 248	5.0±0.0^{a}	11.0±0.9^{ab}	14.4±1.0^{ab}	17.4±1.5^{ab}	18.5±1.4^{a}	20.1±1.0^{ab}	20.4±0.7^{a}
T3 (50:50) Orange Man	5.0±0.0 ^{a}	11.6±0.9^{b}	15.8±1.3^{b}	19.0±0.9^{b}	21.7±1.9^{b}	22.7±2.6^{cd}	24.2±0.5^{d}
Galia 248	5.0±0.0^{a}	10.8±0.9^{ab}	14.3±1.2^{ab}	17.4±1.5^{ab}	19.8±1.9^{ab}	20.9±1.6^{abc}	21.4±1.1^{ab}
T4 (25:75) Orange Man	5.0±0.0^{a}	10.6±0.6^{ab}	14.9±0.9^{ab}	17.8±1.1^{ab}	21.7±1.3^{b}	23.1±0.5^{d}	23.7±0.8^{d}
Galia 248	5.0±0.0^{a}	10.7±0.6^{ab}	14.2±0.9^{a}	17.1±1.1^{ab}	18.8±1.1^{a}	19.9±1.0^{a}	20.3±1.2^{a}
T5 (control) Orange Man	5.0±0.0^{a}	10.0±1.3^{a}	13.7±0.5^{a}	16.1±0.7^{a}	19.5±0.7^{ab}	20.1±0.9^{ab}	20.6±0.7^{a}
Galia 248	5.0±0.0^{a}	10.1±1.3^{a}	13.7±0.5^{a}	16.6±0.6^{a}	19.8±0.4^{ab}	20.0±0.5^{ab}	20.7±0.7^{a}

Remark: Uppercase letters in columns refer to differences in the mean values for the studied factors. ns indicate no statistically significant differences ($p<0.05$)

2. Melon fruits characteristics at 28, 35 and 42 days after pollination

At the end of the experiment, the mean weights of melon yields were compared between the Orange Man cultivars and the Galia 248 cultivars. It was found that the two melon cultivars grown with T2, T3, T4 and T5 planting materials gave yields with the same mean weight, while the two melon cultivars grown with T1 planting materials gave the lowest yields. Two cultivars of melon fruits, Orange Man and Galia 248, 42 days after pollination were investigated concerning fruit weight and Brix value (Fig. 1a. and 1b.).The fruits of Orange Man cultivars grown with T2 had the highest Brix value at 16±0.0° similar as T5 (control) (Table 6). Therefore, the most suitable treatment set is T2 which gave high yield of fruit width, fruit length, fruit weight and Brix value, overall.

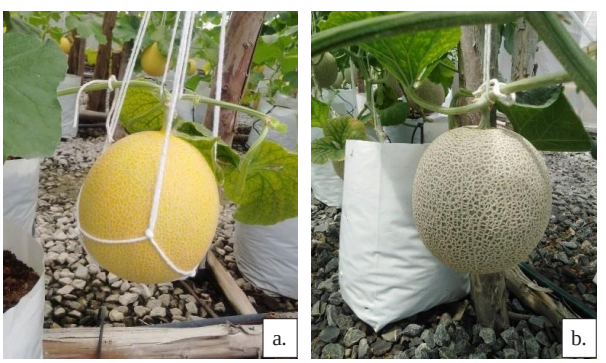

Fig. 1 Melon fruits, 42 days after pollination a. Galia 248 melon cultivar b. Orange Man melon cultivar

3. Results of ANOVA and Scheffe's method

Comparing the average weight of melons grown in planting materials T1, T2, T3, T4 and T5 by taking the average weight of melons grown in planting materials in all 5 sets to analyze the variance of the data (Analysis of variance; ANOVA) or F-test showed the basic statistics of the mean weight of the Orange Man and Galia 248 melons in each experimental set. The data includes the amount of melon production, average weight of results, standard deviation, the 95% confidence interval of the mean and maximum and minimum values that reflect the results of the analysis of variance. As for testing the hypothesis that there are differences between the experimental sets or within the experimental set, the test results showed that the significance value of the average weight of the melon fruit of both cultivars is equal to .000, which is less than the significance level of 0.05, indicating that both cultivars had differences between the experimental sets. Therefore, pairwise tests using Scheffe's method was performed to test which pairs of experiments had differences that affected the mean weight of melon fruit. Test results showed that the mean weight of Orange Man melons from all 5 experimental sets (T1-T5) had differences in 4 pairs: T1 is different from T2, T1 is different from T3, T1 is different from T4 and T1 is different from T5. The test results of the five experimental sets for the Galia 248 melon showed the same results as the Orange Man melon. The results showed that planting the two melon cultivars in T2, T3, T4 and T5 planting material yielded melons with the

Table 6 The average width and length of melon fruit of 28 35 and 45 days after pollination and the average weight and Brix value of melon fruit of 42 days after pollination using five experimental sets (T1-T5)

Material ratio of growing treatment (PGM:NPM)	Average width after pollination (cm)			Average length after pollination (cm)			Average weight after pollination (kg)	Brix value after pollination (°brix)
	28 days^{ns}	35 days^{ns}	42 days^{ns}	28 days	35 days	42 days^{ns}	42 days	42 days
T1 (100:0) Orange Man	20.5±1.7^{a}	21.3±1.0^{a}	22.2±1.3^{a}	19.5±1.4^{ab}	20.9±1.6^{a}	22.2±1.8^{a}	1.6±0.1^{a}	14±0.0^{a}
Galia 248	21.7±1.0^{a}	21.8±0.9^{a}	22.5±0.7^{a}	21.0±1.4^{abc}	22.6±1.2^{abc}	23.5±1.0^{a}	1.6±0.1^{ab}	14±0.6^{ab}
T2 (75:25) Orange Man	21.3±1.9^{a}	22.2±0.9^{a}	23.6±1.8^{a}	20.3±1.5^{abc}	21.0±1.8^{ab}	23.7±1.9^{a}	1.9±0.1^{c}	16±0.0^{b}
Galia 248	22.0±0.9^{a}	22.8±0.7^{a}	23.2±0.8^{a}	21.8±1.3^{bc}	23.5±1.4^{bc}	24.4±1.2^{a}	1.9±0.1^{c}	15±0.6^{ab}
T3 (50:50) Orange Man	21.4±1.1^{a}	21.2±0.9^{a}	22.8±0.9^{a}	20.3±1.4^{abc}	20.9±1.0^{a}	23.4±1.1^{a}	1.8±0.1^{c}	15±0.0^{ab}
Galia 248	21.2±1.6^{a}	21.8±1.5^{a}	22.3±1.1^{a}	21.5±1.7^{abc}	22.8±2.1^{abc}	23.7±1.2^{a}	1.8±0.1^{bc}	15±0.6^{ab}
T4 (25:75) Orange Man	21.5±1.2^{a}	21.8±1.0^{a}	22.7±1.1^{a}	19.5±1.1^{a}	21.3±1.5^{abc}	23.0±1.9^{a}	1.9±0.1^{c}	16±0.6^{ab}
Galia 248	21.7±0.5^{a}	22.0±0.6^{a}	22.0±0.6^{a}	22.0±0.6^{c}	23.8±1.0^{c}	24.3±0.6^{a}	1.9±0.1^{c}	15±0.6^{ab}
T5 (control) Orange Man	21.0±1.2^{a}	21.8±1.4^{a}	22.4±1.4^{a}	20.3±1.3^{abc}	21.9±1.3^{abc}	22.5±0.8^{a}	1.9±0.1^{c}	16±0.0^{b}
Galia 248	21.4±1.1^{a}	21.9±1.1^{a}	22.2±1.3^{a}	21.8±1.7^{abc}	23.0±1.8^{abc}	23.1±1.7^{a}	1.9±0.1^{c}	15±0.6^{ab}

Remark: Uppercase letters in columns refer to differences in the mean values for the studied factors. ns indicate no statistically significant differences ($p<0.05$)

same standard weight. Meanwhile, melons grown in T1 planting material, which is 100% pebbles growing media, yielded melons with the lowest average weight and was significantly different from the planting materials in all 4 experimental sets, at confidence level of 95% (Table 7-8).

Table 7 Results of multiple comparisons (Scheffe's method) showing a difference fruit weight of Orange Man between experimental sets (T1-T5)

Treatment	T1	T2	T3	T4	T5
T1	-	-.29861*	-.25635*	-.32778*	-.32778*
T2		-	.04226	-.02917	-.02917
T3			-	-.07143	-.07143
T4				-	.00000
T5					-

Remark: * The mean difference is significant at the .05 level

Table 8 Results of multiple comparisons (Scheffe's method) showing a difference fruit weight of Galia 248 between experimental sets (T1-T5)

Treatment	T1	T2	T3	T4	T5
T1	-	-.280000*	-.20000*	-.28182*	-.31250*
T2		-	.08000	-.00182	-.03250
T3			-	-.08182	-.11250
T4				-	-.03068
T5					-

Remark: * The mean difference is significant at the .05 level

Conclusion

The study on pebbles growing media from agricultural waste for growing melons in greenhouses was conducted by studying the process of making pebbles growing media produced from agricultural waste materials and the use of such material for growing two melon cultivars, namely, Orange Man and Galia 248. This was done by mixing with normal planting material (coconut dust mixed with chopped coconut coir in the ratio of 2 to 1) in different proportions, divided into 5 experimental sets, namely, T1 experimental set: 100% pebbles growing media, T2 experimental set: 75% pebbles growing media, T3 experimental set: 50% pebbles growing media, T4 experimental set: 25% pebbles growing media compared and T5 experimental set: normal planting material. From the experimental results it was found that the appropriate experiment set for using pebbles growing media from agricultural waste as melon planting material was the T2 experiment set that uses 75% pebbles growing media mixed with 25% normal planting material. T2 uses the highest proportion of pebbles growing media to mix with normal planting material. This makes this planting material have a lot of space in the soil, allowing for good ventilation which is suitable for melon growth. As a result, the melon yield with the average weight per fruit is not significantly different at the 95% confidence level compared to the melon yield grown with normal planting material (T5), consistent with other studies. Chaitayakul. (2008) studied the production of pebbles growing media to be used as a material for growing hydroponic vegetables. This is due to pebbles growing media being highly porosity. Therefore, it can hold water well while allowing good water and air drainage. Therefore, it causes vegetables to have a good germination rate. It also has a durable and strong structure and has a long service life. It is also consistent with a study of Jaruwattanaphan et al. (2015) who found that pebbles growing media are the best planting material that can be used to propagate rock flowers by leaf cuttings and a study by Supakamnerd & Ketsamut (2015) that experimented with using pebbles growing media as a planting material for the Prachin Yellow Slipper Orchid instead of using volcanic rocks, which are expensive in the country. Therefore, the T2 experimental set is a suitable planting material in reducing production costs from the original use of coconut dust mixed with chopped coconut coir at a ratio of 2 to 1 as melon planting material which has few limitations on reuse and must be changed frequently, increasing the cost of melon production.

This study found that the usage of pebbles growing media from agricultural waste to replace traditional planting materials is beneficial since traditional planting materials are high in cost and have a short life. Pebbles growing media will reduce the service cost of planting materials by up to 75% per time, which can lead to expanding results for farmers in the case of commercial melon cultivation because pebbles growing media have a long service life and can be reused many times. Furthermore, it does not affect the growth of melons compared with the traditional planting material.

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References

Assadayudh, A., Pichakum, N., & Boonkorkaew, P. (2020). Study of diatomite pellet medium to substitute mixed soil for indoor pot plant. In *Proceedings of 58th Kasetsart University Annual Conference: Plants, Animals, Veterinary Medicine, Fisheries, Agricultural Extension and Home Economics* (pp. 252-259). Bangkok: Kasetsart University.

Chaitayakul, M. (2008). Development expanded clay for substrate culture in vegetable hydroponics. *Agricultural Science Journal, 39*(3), 400-403.

Janbuala, S., & Wasanapiarnpong, T. (2015). Effect of rice husk and rice husk ash on properties of lightweight clay bricks. *Key Engineering Materials, 659,* 74-79.

Jaruwattanaphan, T., Longchuphon, S., & Chulaka, P. (2015). Effect of growing media on growth of *Selaginella pulvinata* (Hook. et Grev.) Maxim. leafy shoot cutting. Agricultural Science Journal 46(3), 209-212.

Lester, G. (1997). Melon (*Cucumis melo* L.) fruit nutritional quality and health functionality. Hortechnology, 7(3). 222-227.

Supakamnerd, N., & Ketsamut, L. (2015). Research and development on lady's slipper orchid for commercial (Research report). Bangkok: Department of Agriculture.