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Research Article
Morphological Characterization and Adaptation of Four Dragon Fruit Genotypes in Pangandaran Regency of Indonesia

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Abstract

Background and Objective: Dragon fruit is a popular cultivated fruit in Indonesia because of its nutritional value. Recently, farmers have begun to cultivate coloured varieties of dragon fruit such as yellow (*Hylocereus megalanthus*), red (*H. polyrhizus*), orange and black (*H.* Hybrid). However, the morphological characters of these varieties are yet to be elucidated. The objective of this study was to evaluate the morphological characters of four coloured dragon fruit varieties. **Materials and Methods:** Four dragon fruit genotypes (*Hylocereus megalanthus*, *H. polyrhizus* and two *H.* Hybrid) were cultivated in Pangandaran regency of Indonesia with an altitude of 10 m above sea level with the minimum and maximum temperature of 24 and 37°C, respectively. The experiment was conducted from November, 2017 to September, 2018. About 75 individual plants for each genotype were cultivated. Parameters related to plant growth such as growth rate, stem height, number of shoot and also plant phenotype were recorded during plant growth and development. **Results:** The result showed that the four dragon fruit genotypes each have different characterizations. The red variety has the best growth condition, while the yellow variety exhibited the lowest growth rate. **Conclusion:** This study concluded that the red variety is more suitable and adaptable to be cultivated in Pangandaran.

Key word: Adaptation, fruit genotypes, best growth condition, fruit varieties, morphological characters, dragon fruit, Pangandaran

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Pangandaran Regency is a city in Indonesia that has an area of 1,685.09 ha. The altitude of this regency ranges from 0-700 m above sea level (asl) and the slope[1] rate is 0-40%. Rainfall is estimated to reach 1,647 mm/year with an air humidity of 85-89% with temperatures ranging from 20-30°C. The main commodity in this regency is paddy with an area of paddy fields amounting[2] to 51,903 ha in 2012. Pangandaran has a considerable amount of unused, non-productive land. Plants that can grow in non-productive lands, such as dragon fruit, can be grown to utilize these lands. Dragon fruit belong to the Cactaceae family which originated from the southern and central regions of Mexico and America[3]. It contains a large amount of nutrients and minerals such as vitamin B1, vitamin B2, vitamin B3, vitamin C, protein, fat, carbohydrates, fiber, flavonoids, thiamin, niacin, pyridoxine, cobalamin, glucose, phenolic, b-cyanine, polyphenols, carotene, phosphorus, iron and phytoalbumin[4]. It has many health benefits such as supporting the digestive process, preventing colon cancer, preventing diabetes, neutralizing toxins such as heavy metals, reducing cholesterol levels and high blood pressure and if consumed regularly can treat asthma and cough[5].

Dragon fruit grow well in tropical and subtropical regions with the optimal condition being dry areas. The maximum temperature for dragon fruit is 38°C with an optimal range[6] of 18-25°C. Doan *et al.*[7] stated that dragon fruit will stop growing in extreme heat or cold.

Each dragon fruit genotype has different characteristics and growing conditions. The *Hylocereus* species is semi-epiphytic and optimally grown in half-shaded areas, while *H. undatus*, *H. costaricensis* and *H. purpusii* can grow in full light conditions even if hot conditions and lack of water causes stems to burn and loss of buds[8]. Rahmawati and Mahajoeno[9] showed that there are variations of dragon fruit morphology such as stem color, flower petals, flesh color, taste, isomin variation and different vitamin C contents for super red, red and white variants in four different locations. In order to obtain suitable dragon fruit plants for Pangandaran Regency, a morphological and growth identification and characterization of each cultivated variety in the Pangandaran regency is needed. So this study was aimed to examine the morphological characters of four coloured dragon fruit varieties.

MATERIALS AND METHODS

Plant materials preparation: The experiment was conducted in Pangandaran city, West Java, Indonesia at 5 m above sea level from November, 2017 until August, 2018. Four dragon fruit genotypes, namely *H. polyrhizus* (red color), *H. megalanthus* (yellow color) and two *H.* Hybrid (orange and black colours) are utilized. About 75 cuttings of each genotypes were cultivated in the paddy field with modified cultivation technology and growing medium. During the cultivation periods, the plants were fertilized with compost and NPK (15:15:15). To control and prevent pest and disease, the plants were sprayed with fungicide and insecticide.

Plant growth analysis: To analyze growth characteristics, 10 moths of plant cuttings were identified for its vegetative growth. Assessments on several parameters such as plant growth rate, plant height, number of shoot, diameter of stem and morphological characterization were conducted during cultivation periods.

Statistical data analysis: The experiment was conducted under five replicates of a completely randomized design. Data normality was tested using Kolmogorov Smirnov method and statistical data analysis used one factor analysis of variance (ANOVA) method followed with Duncan's Multiple Range Test (DMRT) at $p<0.05$ to compare differences among varieties.

RESULTS

Four dragon fruit genotypes exhibited different plant morphology: Under cultivation area in low altitudes, the four genotypes showed different plant morphology such as stem and spine structure. The different morphologies were caused by its own characteristics and the cultivation area did not have any effects. Visually, there were a number of differences among the dragon fruits, namely the shape of the stem and areolus. The black dragon fruit has a rectangular-shaped stem with the thickest parenchyma tissue and has a light grey areoles that resemble small mounds with 3 different size of spines (Fig. 1a, e). The orange dragon fruit has a triangular stem shape with the thickest parenchyma tissue and has a dull yellow areoles on small mounds which have 3 wide-bared cone shaped dark brown spines with same size (Fig. 1b, f). The *H. megalanthus* and *H. polyrhizus* have a triangular stem shape with the color of yellowish green and dark green, respectively and they have the thinnest parenchyma compared to two hybrid dragon fruit (Fig. 1c, d). Beside of that, *H. megalanthus* has dull yellow areoles containing 3 wide-bared cone shaped spines in light brown colour and the same size (Fig. 1g), while *H. polyrhizus* appears to have grey areoles in which one spine is larger than the others (Fig. 1h).

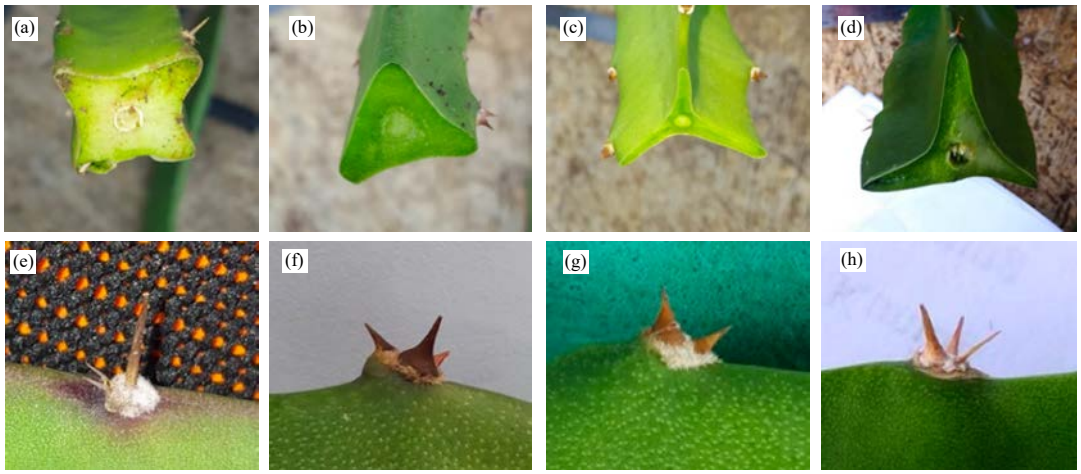

Fig. 1(a-h): Appearance of stem and spines of four dragon fruit genotypes, (a, e) Black colour dragon fruit, (b, f) Orange colour dragon fruit, (c, g) Yellow color dragon fruit (*H. megalanthus*) and (d, h) Red colour dragon fruit (*H. polyrhizus*)

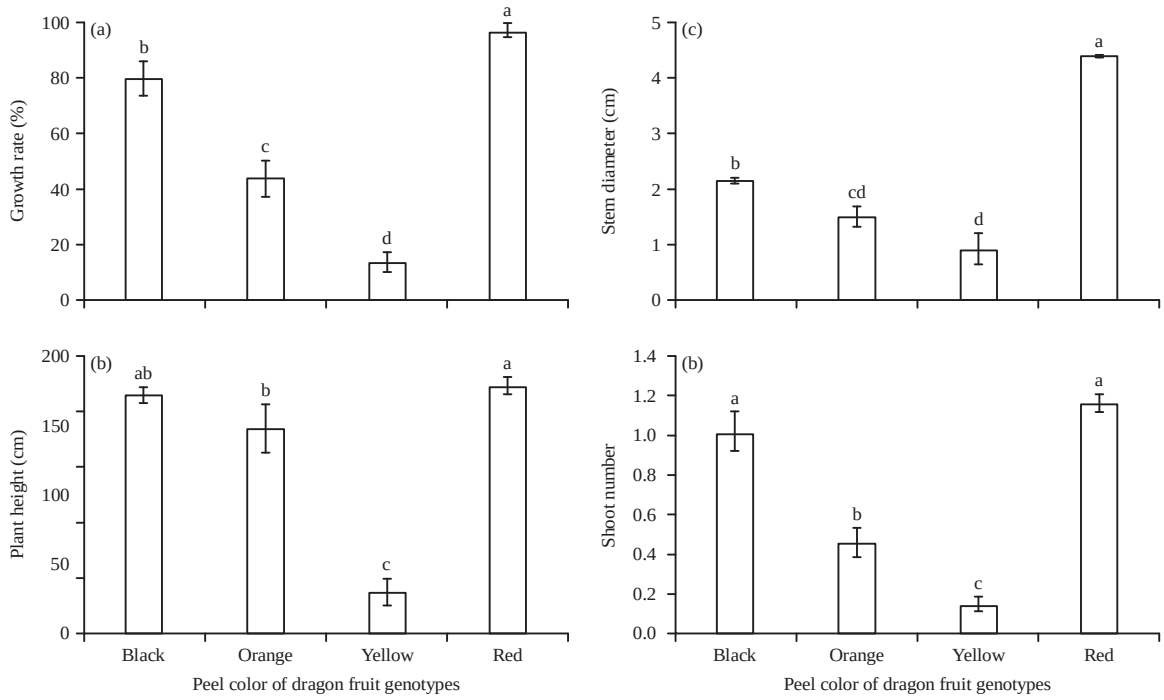

Fig. 2(a-d): Plant growth characters of four dragon fruit varieties. Growth rate was taken at 3 months after planting, whereas plant height, shoot diameter and shoot number were taken at 9 months after planting

Red dragon fruit (*H. polyrhizus*) resulted the best plant growth characters: Several parameters have been examined to identify and characterize the plant growth, development and morphology of the four different dragon fruit genotypes. Based on the statistical data analysis, it can be seen that there is a difference of plant growth and development from the examined dragon fruit varieties. Yellow dragon fruit showed the lowest growth rate that resulted the shortest plant height, stem diameter and lowest shoot number (Fig. 2a-d), whereas the highest growth rate was obtained from red dragon fruit with the value almost reaching 100% (97.34%) (Fig. 2a). The other two dragon fruit varieties, black and orange have moderate growth rate, plant height and stem diameter, which have significantly lower values compared to the red dragon fruit (Fig. 2a-d).

DISCUSSION

Recently, dragon fruit has become one of the important fruit crops in the beginning of this century[10]. Indonesia have developed dragon fruit production and it production has developed vastly with cultivation of several dragon fruit varieties but the characteristics and its adaptation in different altitudes have not been clearly elucidated yet. This study analysed the characteristic on four dragon fruit genotypes in low altitudes of Pangandaran regency to find out which one is the most optimal to cultivate. The most important characteristics of *Hylocereus* is its stem morphology[11,12]. Morillo *et al*.[13] stated there were several morphological characteristics that can be described to distinguish different types of dragon fruit species.

Four genotypes of dragon fruit showed different plant characteristics. De Dios[14] stated that the main differences of *Hylocereus* species were the size and color of the fruit and also the shape and number of the spine. This statement corresponded with current analysis on the four investigated *Hylocereus* genotypes, in which the differences of the stem shape and number of spines were observed among them (Fig. 1). A similar research conducted by Sandoval *et al*.[15] and Mejia *et al*.[12], they stated that the number of spines were reliable characteristics to describe *Hylocereus*. The four dragon fruit grown in Pangandaran have similarities in the number of spines per areola but differ in the shape and color of the spines.

The four *Hylocereus* genotypes showed differences in plant growth and development, in which the yellow colored dragon fruit having the lowest growth rate. From the data, it could be seen that the growth of yellow dragon fruit was inhibited due to several factors. Therefore, it could be concluded that there was a correlation between growth rate and plant height. The altitude of cultivation was a big factor in dragon fruit growth. In this study there was a possibility that the yellow colored dragon fruit could not grow properly because of unsuitable cultivation locations. Yellow colored dragon fruit grown in its place of origin with an altitude of 1,180-1,932 m above sea level (asl) with the temperatures ranging between 18-24°C and annual precipitation ranging[13,16] between 1,300-2,200 mm. Another study by Weiss *et al*.[17] indicated that *H. megalanthus* was less adaptable than red dragon fruit (*H. undatus*) in semi-arid conditions. This was caused by the shape of the stomata that are different from *H. undatus* which showed that it was more succulent than *H. megalanthus*[18,19], which could make *H. undatus* stronger than *H. megalanthus*[20]. The differences in anatomical structure and morphology of plants could cause differences in its optimal growth location.

Morphological and agronomic characteristics can be used to measure genetic diversity in a particular individual population. The plant phenotypic can be considered as a form of plant adaptation to the environmental conditions in which they are located. This certainly can make changes to certain species planted in different environments[21]. Beside of that, growing media affects the plant growth[22]. In this case, red colour dragon fruit has good adaptability compared to other dragon fruit genotype when planted in Pangandaran which was a low land. In general, dragon fruit was able to survive in a high-temperature environment (38-40°C)[23]. Raveh *et al*.[19] stated that dragon fruit planting in dry and hot climates requires the installation of 30-60% artificial shade net to avoid the effects of high solar radiation. The plant growth characteristics of the four dragon fruit varieties observed in this study were the response of plants to their environment factors that influence the differences that occur.

If seen through production purposes, the ability of plants to adapt and grow well will affect the production potential of dragon fruit both in quality and quantity. The results showed that the growth rate and number of yellow colour dragon fruit shoots was lower than other types of dragon fruit, which will affect the potential of dragon fruit in producing flowers. The possibility could occur because the number of shoots will affect the number of areola that have buds. These shoots will have the potential to produce new shoots or flowers[24]. In some types, flowers were produced at the end of the bud[13].

CONCLUSION

This study concluded that the four dragon fruit species, namely *H. polyrhizus*, *H. megalanthus* and two *H.* Hybrid resulted a different plant growth and development. *H. polyrhizus*, resulted the best plant growth, whereas *H. megalanthus* resulted the lowest plant growth, therefore the red variety is more suitable and adaptable to be cultivated in Pangandaran.

SIGNIFICANCE STATEMENT

This study discover the potential dragon fruit genotypes in Pangandaran city that has a good plant growth and development that can be beneficial for develop dragon fruit cultivation in this area. This study will help the researcher to uncover the critical areas of dragon fruit cultivation technique in coastal area that many researchers were not able to explore. Thus a new theory on plant growth analysis of different dragon fruit genotypes in coastal area may be arrived at.

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