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# Application of Gibberellic Acid ($Ga_3$) in Stem Cutting of Dragon Fruit (Hylocereus Polyrhizus): Effects on Fruit Quality and Yield at Harvest.

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**Abstract**
Dragon fruits (*Hylocereus polyrhizus*) is a desert plant and highly adaptable to a new environment. They originated from North, Central and South America and are cactus in nature. This study was done in the field of undeveloped agricultural land (BRIS soil) in Rhu Tapai, Terengganu. This study was carried out to determine the effect of gibberellic acid ($GA_3$) application on the physical quality of *H. polyrhizus* fruit. After one week transplanting, *H. polyrhizus* stems were sprayed with 0, 1, 10, 50 ppm $GA_3$. $GA_3$ was sprayed once again during fruit set with the same concentrations. Results showed that the physical properties of *H. polyrhizus* fruits were affected by the application of $GA_3$. Fruit from $GA_3$ treated tree gave significant differences on weight, length, width and volume as compared to control. Greater quality of fruit was obtained when treated with 50 ppm $GA_3$. It was concluded that $GA_3$ spray have promotive effects on fruit quality.
**Keywords:** BRIS soil, plant growth regulator, fruit setting, postharvest

## 1.Introduction

*Hylocereus polyrhizus* (dragon fruits) belongs to the cactus family, *Cactaceae* and it originated from North, Central and South America (Mizrahi *et al.,* 1997). The ripened H. polyrhizus fruit had an attractive purple-red peel and the flesh is soft and succulent with small black seeds. Since, this fruit are being promoted as a healthy food, many countries like Nicaragua, Colombia, Vietnam, Australia, United States, Thailand, Taiwan (Merten, 2003 and Jamilah et al., 2011) as well as Malaysia has started to commercialize *H. polyrhizus*. Pitaya peel constitutes 22% of the whole pitaya and it contained considerable amount of pectin, betacyanin pigment and total dietary fibre (Jamilah et al., 2011). Eating red-fleshed *H. polyrhizus* fruit was reported to increase bone density and prevent colon cancer and constipation (Anon, 2007a). These factor, as well as the prospect of a good economic return, attracted big investors.

There are about 280 ha of *H. polyrhizus* being planted commercially around Malaysia (Rasnani, 2003 and Zainuddin, 2006). These plants grow well on the poor white-sandy leached soil or kerangas soil in Sarikei (Anon, 2007a). In this study, *H. polyrhizus* was grown on BRIS soil. The BRIS soils are sandy, excessively drained soils with a very low inherent fertility status. The utilization system of these soils requires a careful selection of crops to suit the soil, a high level of investment, experienced management and high input investment. The major crop currently planted on BRIS soil are coconut, tobacco, watermelon, roselle and some annual and perennial crops (Nik Mazlan, 2003). The State Agriculture and Regional Development Committee was trying to find crops which can provide a good return to farmers with small plots of land and *H. polyrhizus* is a good choice.

There are three species of *H. polyrhizus* namely, *H. polyrhizus* (red), *H. undatus* (white) and *Selenicereus megalenthus* (yellow) flesh. *H. polyrhizus* has red skin and white flesh dotted with edible black seeds while *S. megalanthus,* the pitaya amrillo or yellow pitaya, has yellow skin and clear-to-white flesh containing edible black seeds. However, only the red and white flesh varieties are popular in Malaysia (Zainuddin, 2005).

Since the fruit physical properties are one of the important aspects for postharvest quality, therefore this study was focused to increase the fruit qualities that are suitable for marketing. There are various ways to determine of fruit is physically of harvest maturity such as surface color, shape, size, shoulder growth and specific gravity.

The government's policy towards agriculture focuses on increasing production, in order to achieve food self-sufficiency and to develop exports in an efficient and competitive manner. To increase the fruit production, plant growth regulators are one of the production tools that can enhance product quality and marketability. They must be used with proper attention to other cultural practices, especially proper fertility and irrigation management (Latimer, 2001).

Plant growth regulators (PGRs) are chemicals that are designed to affect plant growth and development through its role as a messenger and are needed in small quantities at low concentrations. Generally biosynthesis of PGRs is different to their site of action. Most of the plant growth regulators exhibit a broad spectrum; therefore, a single PGR can affect several different processes at the same time (Kassem et al., 2010). Moreover, many previous studies have shown that the application of PGRs can enhance the rapid changes in physiological and biochemical characters thus increasing crop productivity.

Exogenous hormonal treatment, $GA_3$ is valuable production tools that can enhance product quality and marketability. For many plant species, flowering is stimulated by the application of GAs, thus reducing the amount of time needed for crop production (Barrett, 2001). Gibberellic acid has been reported to influence vegetative growth, flowering, fruiting and various disorders in many fruit crops (Paroussi et al., 2002). Sprayed $GA_3$ had been shown a positive effect on fruit development, reduced fruit drop, fruit crack and improved fruit quality of wax apple under field conditions (Nguyen and Yen, 2013). Therefore, this study was conducted to determine whether the quality of fruit is affected by $GA_3$ treatment or not.

## 2.Materials and methods

### *2.1Location of the study*

The field study was conducted on BRIS soil at the Department of Agriculture Rhu Tapai, Terengganu, Malaysia. The chemical properties of the BRIS soil at Rhu Tapai are shown in Table 1.

**Table 1:** Basic soil properties of BRIS soil (Rhudua Series) at Rhu Tapai, Terengganu.

| Chemical Properties | Amount |
|---|---|
| pH ($H_2O$) | 5.68 |
| pH (KCL) | 5.20 |
| Nitrogen (%) | 0.62 |
| Phosphorus (ppm) | 43.46 |
| Kalium (ppm) | 7.72 |
| Magnesium (ppm) | 1.97 |
| Calcium (ppm) | 21.30 |
| Iron (ppm) | 0.09 |
| Manganase (ppm) | 0.60 |
| Zinc (ppm) | 1.74 |
| Copper (ppm) | 0.03 |

### *2.2Plant materials*

Stem cutting techniques of *H. polyrhizus* were chosen for the study. The cuttings were obtained from a private farm in Kuala Pilah, Negeri Sembilan.

### *2.3Plant growth regulator application (Gibberellic acid)*

Cuttings of *H. polyrhizus* were spraying with gibberelic acid ($GA_3$) solutions at 0 ppm, 1 ppm, 10 ppm and 50 ppm one week after transplanting into the field on BRIS soil at the Department of Agriculture Rhu Tapai, Terengganu. $GA_3$ spray solutions were prepared in distilled water in the laboratory a day before application. The design used was Randomized Complete Block Design (RCBD). Each treatment was replicated three times and six cuttings were used for each replicate.

### 2.*4 Planting and maintenance*

*H. polyrhizus* cuttings were planted with one, two and three cuttings per pole. Pieces of erect 4” x 4: x 5” reinforced concrete poles (trellis) were used to support and for the climbing of the growing plant. Weekly irrigation on a regular basis was practiced after transplanting. Solid organic fertilizer is included in the planting hole. The organic fertilizer, Complexhumus® was applied about 200 g per plant after the first month. Foliar sprays estimated at 5 L/ha were applied twice a month one month after transplanting into the field. Bio-plus foliar sprays with micro elements added were used to encourage vegetative growth. Fertilizer applications were increased for the growth performance of *H. polyrhizus*. Fertilizer supplement and nutrient availability from the BRIS soil is an important source for *H. polyrhizus*. Fertilizer supplement and availability from the BRIS soil is an important source for *H. polyrhizus* growth and yield.

### *2.5Physical properties*

*H. polyrhizus* were picked manually and were classified into four grade standard. Fruits for each treatment were individually analyzed for physical characteristics. Fruit yield parameters such as fresh weight, length, diameter and volume of fruit, were measured. Fruits were weighed to ±0.1 g. the length and diameter of the fruits were measured with a varnier caliper to an accuracy of 0.01 mm. The length was measured at the polar axis of fruit, (between the apex and the stem). The maximum width of the fruit, measured in the direction perpendicular to the polar axis, defines the diameter of the fruits' volume (V) as function of moisture content, were determined by using the liquid displacement method. Then, fruits were washed and stored at -20°C before analysis. The fruits were peeled prior to determining the nutritional properties.

### *2.6.Data collected*

***Three replicates of 10 fruits for each concentrations of $GA_3$ were individually analyzed for physical characteristics. The physical properties of fruits were recorded by different concentrations of $GA_3$.***

### *2.7 Statistical analysis*

Data obtained for each parameter were subjected to statistical analysis using SPSS Version 13.0. Analysis of variance (ANOVA) and Duncan Test were performed to determine the effect on each variables measurement of these factors and the interaction between them. Pair-wise comparisons were made between the least square means using the least significance difference (LSD) multiple comparison test. All the data were analyzed according to Duncan Multiple Range Test (DMRT) and Independent T-Test. Statistical analysis for bivariate correlation was computed using Pearson's correlations with significant level of $P \leq 0.01$ and $P \leq 0.05$.

## 3.Results and discussion

This study was investigated the effect of $GA_3$ on the physical properties of the *H. polyrhizus*. Accorrding to Duncan's Multiple Range Test (DMRT), Table 1clearly showed that $GA_3$ gave highly significant differences ($p<0.01$) on fruit weight, length, width and volume of *H. polyrhizus* as compared to control. $GA_3$ application at 1, 10 and 50 ppm increased fruit weight by 510.4 g, 550.8 g and 561.4 g, respectively.

*H. polyrhizus* cuttings treated with 50 ppm of $GA_3$ gave the best quality of fruits as measured by fruit weight, length, width and volume (Table 1). This statement is in agreement with Clayton *et al.,* (2006) who reported $GA_3$ application gave significant improvements on fruit size and firmness of 'Bing' sweet cherry.

**Table 1:** The effect of $GA_3$ on fruit weight, length, width and volume of *H. polyrhizus* fruits.

| Concentration (ppm) | Weight (g) | Length (cm) | Width (cm) | Volume ($g^3$) |
|---|---|---|---|---|
| **0** | 402.6a | 9.6a | 8.4a | 392.80a |
| **1** | 510.4b | 10.5b | 9.0ab | 494.56b |
| **10** | 550.8b | 10.7b | 9.1b | 540.40b |
| **50** | 561.4b | 11.0b | 9.3b | 547.40b |

Mean within the same column followed by the same letter are significantly different to each other according to LSD at $p \leq 0.01$.

Chang and Lin (2006) reported on the effects of $GA_3$ on fruit growth in 'Yu Her Pau' litchi over 2 years in Taiwan. Their hypothesised that sprays of $GA_3$ during stage I of fruit growth would increase fruit and aril weight. According to Nguyen and Yen (2013), highest concentration of $GA_3$ indicated the better results in the physiological and biochemical parameters of wax apple fruit with improved fruit size, fruit weight, stimulated fruit growth, and increased total soluble solids.

However, the proportion increase in fruit weight ranged from 21.9 to 27.4% in 'Yu Her Pau', while it ranged from 7.7 to 26.6% in Indian cultivars (Chang and Lin, 2006). Chang and Lin (2006) also reported that $GA_3$ sprays also enhanced the growth of pericarp and aril, in the absence of a normal seed in 'Yu Her Pau'. They concluded that sprays of GA3 at stage I of fruit growth can enhance fruit size without affecting other fruit quality (percentage of aril weight of total fruit weight of TAA) in 'Yu Her Pau' litchi.

Fresh weight of *H. polyrhizus* was estimated between 300 to 800 grams, but the average weight in 400 grams (Anon, 2007a). Merten (2003) deferred the fruit can weight up to 900 grams, but the average weight is between 350 and 450 grams. Table 2 showed *H. polyrhizus* fruit were classified to four grades following the grade standard of Federal Agricultural Marketing Authority (FAMA). 2007

 

**Table 2:** Grading standard for dragon fruit

| No. | Grade | Fresh weight (g) |
|---|---|---|
| **1.** | XL | Above 451 |
| **2.** | L | 351-450 |
| **3.** | M | 251-350 |
| **4.** | S | 200-250 |

*Reported by FAMA, 2007

Figure 1 showed that $GA_3$ plays a very important role in enlarging fruit size, where fruit sizes increased by the rate of $GA_3$. $GA_3$ had been proven to enhance the production of litchi (Chang and Lin, 2006) and increased fruit size of sweet cherry (Canli and Orhan, 2009), nevertheless in this study, it had improved both the production and overall quality appearance of *H. polyrhizus* fruit.

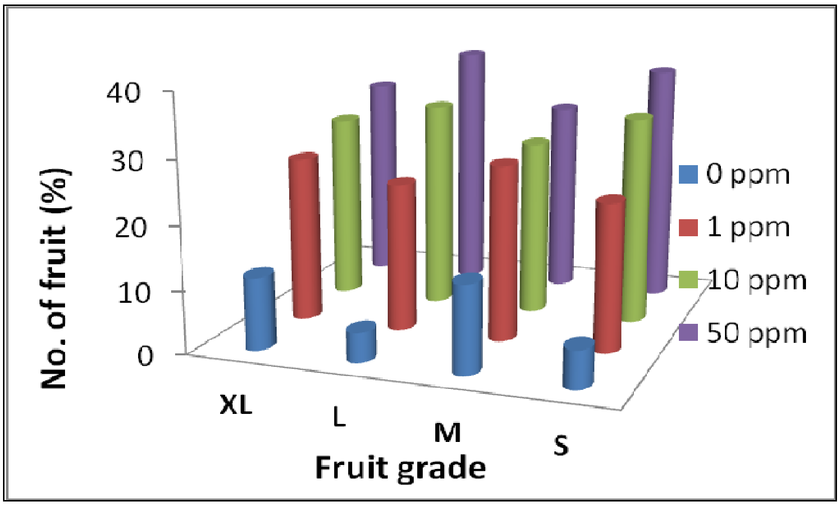


**Figure 1**. Effect of different concentration of $GA_3$ on fruit yield of *H. polyrhizus*. Grading standard by FAMA, 2007.

The result of the study shows that average fresh weight of grade XL, L, M and S were 571.68 g, 368.62 g, 256.54 g and 224.64 g, respectively (Table 3). Grade L gave the highest number of fruis (36.16 %) as compared to other grades. Percentage of the number of fruit in grade XL, M and S were 34.46 %, 20.34 % and 6.4 %, respectively. Table 3 also showed that gibberellic acid ($GA_3$) plays a very important role in enlarging fruit size of *H. polyrhizus*. These findings strengthen the role of gibberellic acid ($GA_3$) in the agricultural sector where previously it had been well known to be used to increase fruit set and fruit size of many plants and fruits: grapes (*Vitis vinifera*), lemon (*Citrus* spp .), banana (*Musa* spp.), currant (*Ribes aureum*), pineapple (*Ananas comosus*) and sweet cherry (*Prunus avium*) (Garner et al., 2011).

**Table 3:** Fresh weight and fruit yield of *H. polyrhizus* by grading standard as influence by different concentrations of gibberellic acid.

| | **Grade of Fruit** | | | |
|---|---|---|---|---|
| | **XL** | **L** | **M** | **S** |
| Mean of fresh weight (g) | 571.68 | 368.62 | 256.54 | 224.64 |
| Number of fruit (%) | 34.46 | 36.16 | 20.34 | 9.40 |
| Number of fruit by treatment (%) | | | | |
| 0 ppm | 11.46 a | 4.67a | 13.86 a | 5.96 a |
| 1 ppm | 26.23b | 23.42b | 27.63b | 23.29 b |
| 10 ppm | 29.51c | 32.76c | 27.78b | 32.88 c |
| 50 ppm | 32.80d | 39.15d | 30.73c | 37.87d |

Mean within the same column followed by the same letter are significantly different to each other according to LSD at $p \leq 0.01$.

**Conclusions**

Gibberellic acid once again proving the effectiveness of its influence in improving the quality of the fruit, where it has been impacted by the production of better quality of *H. polyrhizus* fruits. The highest concentration of $GA_3$

 

gave the highest number of fruit setting and yield. Besides, highest concentration of $GA_3$ also gave the best weight, length, width and volume of *H. polyrhizus* fruit that are compared to other concentration. It may be more economical to use for induced early flowering. It shows that application of $GA_3$ treatment at appropriate concentration may help plant to give suitable size of fruit for commercialization.

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