國立屏東科技大學農園生產系

博士學位論文

紅龍果性狀多樣性、開花、授粉與果實套袋之研究

Studies on plant characteristic diversity, flowering, pollination and fruit bagging in pitaya (*Hylocereus* spp.)

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摘要

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論文摘要內容：

本研究之目的在調查火龍果之：(1)形態變異及果實品質、(2) 30 種基因型之開花物候性及其開花對夜間光照處理之反應、(3)授粉需求、以及(4)常見品種及優良選系之適合套袋材質等。本研究自 2013 年 4 月至 2015 年 4 月連續在國立屏東科技大學進行 2 年。依 IUPOV 標準檢定標準，總計調查了 35 種火龍果植株之莖、花及果實等形態性狀。結果顯示供試之 30 種不同基因型之火龍果植株，其莖及果實性狀可歸類於 4 種不同之群別。第一群為具有白或淡粉紅色果肉，莖直線狀且具有波浪狀突起的莖脊(如 *H. undatus* 或其相關種)。第二群為紅色果肉，莖直線狀，且莖脊平滑(如 *H. polyrhizus* 或其相關種)。第三群為深紅色果肉，莖彎曲且莖脊凹陷(如 *Hylocereus* sp.)。第四種為深紅色肉，莖直線狀且莖脊有波浪狀突起(如 *Hylocereus* sp.)。此外，研究發現有 9 種基因型在一些重要的果實特性，如果實大小、果重、果皮厚度、果肉率、與糖度等育種目標上具有市場發展的潛力。

在屏東正常火龍果約自 5-6 月至 10 月間開花，在高溫下開花期則會早些。不同基因型之植株開花波數及每株每季之開花數也不同，分別約在 3-6 波及 9-40 朵花之間。在供試的 30 種不同基因型植株中，有 3 種白色及 3 種深紅色果肉之基因型具有完全自交親和性 (F-SC)，有 2 種深

紅色果肉基因型為部分自交親和性(P-SC)，其餘 22 種紅肉或深紅色果肉則為完全自交不親和性。在冬季利用 100 瓦白熾燈於晚間 10 時至翌日上午 2 時連續照光 4 小時之人工夜間光照處理來測定植株之開花敏感度。相較於白肉種，紅及深色紅果肉種需要較低溫度進行花芽誘導。越早進行暗期中斷(10 月 10 日開始) 成功率越高。所有的基因型或品種，與夏天光照處理者比較，冬季處理之植株其開花波數及開花數較少，但冬果甜度較高，且部分基因型還有果實較大的現象。

研究授粉方法、花粉源對 4 種的火龍果(越南白、潮洲 5 號、Orejona 及‘F_{11}’)著果及果實特性之研究。結果顯示不同之授粉方法對 4 種不同之營養系植株之著果率 (FSPs) 及果實鮮重 (FFWs) 有不同之影響。’越南白’在人工或天然授粉下皆有較高之著果率及鮮重。以蜜蜂到訪情形言在無天然授粉源的情況下，P-SC 型之’潮洲 5 號’或 C-SI 型之‘Orejona’及‘F_{11}’僅在人工授粉下有較高之著果率及鮮果重。著果率及鮮果重也受花粉來源之影響。‘潮洲 5 號’、‘Orejona’及‘F_{11}’需要用與其親和之花粉來授粉始能有適當之著果率及鮮果重，而’越南白’則在自花授粉有最佳效果。不論是否有天然授粉昆蟲的存在，在花中之花藥與柱頭的相對位置可作為是否需要人工授粉的指標。

套袋對 3 種火龍果營養系 (‘越南白’, ‘竹崎劉’及潮州 5 號)果實特性及保護之影響的研究。花後 7 天即進行白紙袋 (P-WB)、黑網袋(NS-BB)、黑塑膠袋(PP-BB)、白塑膠袋(PP-WB)套袋及無套袋等 5 種處理，直到果實採收為止。結果顯示套袋會影響果實外觀、果皮厚度、果實硬度及果實受傷害程度。其中白紙袋、黑塑膠袋為最佳的處理，它能改善果實顏色及有效降低裂果等生理損傷、鳥害及污斑等。本研究之結果可應用於各品種及改進的栽培方法上，以提高火龍果之產量及品質。

關鍵詞：火龍果、植株形態、開花物候性、光照催花、自交親和性、授粉、果實套袋

ABSTRACT

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The content of abstract in this dissertation:

The aims of these studies are to investigate (1) morphological diversity and fruit quality; (2) flowering phenology, flowering response to night-breaking treatment and breeding system of a collection of 30 pitaya genotypes; (3) pollination requirements; and (4) fruit bagging materials suitable for some typical and promising pitaya genotypes. The experiments were conducted in two consecutive years (April, 2013 – April, 2015) at National Pingtung University of Science and Technology (NPUST). In total, 35 morphological traits of stem, flower, and fruit of pitaya materials were examinedbased on the Standard Test Guidelines of IUPOV (TG/271/1, 2011). Results showed a wide morphological trait variation among 30 different genotypes. Based on the stem and fruit characteristics, the pitaya germplasmscould be grouped into 4 groups: Group 1 that has white or light pink flesh, and straight rid-segment with convex rid-margin (such as the *H. undatus* or its relatives); Group 2 that has red flesh and straight rid-segment with flat rid-margin (such as the *H. polyrhizus* or its relatives); Group 3 that has magenta flesh, sinuous rid-

segment and concave rid-margin (such as *Hylocereus*sp.); and Group 4 that has magenta flesh, straight rid-segment with convex rid-margin (such as the *Hylocereus* sp.). Furthermore, some important fruit traits such as fruit size/weight, peel thickness, proportion of fruit flesh, and sweetness in breeding targets were found in 9 genotypes that may become the most promising materials of desirable fruits for markets.

The natural flowering season of pitaya in Pingtung, Taiwan usually started from May-June to October and earlier flowering may occur under higher temperature conditions.The number of flowering flushes and total flowers/season/plant highly varied among genotypes with 3 to 6 waves and 9 to 40 flowers, respectively. Among 30 genotypes tested, 3 white and 3 magenta flesh genotypes showed full self-compatibility (F-SC) and two magenta flesh genotypes exhibited partial self-compatibility (P-SC) whereas 22 genotypes with red or magenta flesh were completely self-incompatible (C-SI). The artificial night lighting treatment using 100 watt incandescent light bulbs to light the plants for fourcontinuous hours from 10.00 pm to 2.00 am the next day was used to test flowering sensitivity in the winter season. Red or magenta flesh pitaya species required lower temperatures for flowering initiation than white flesh types. Earlier night-breaking application (starting from October 10) was more successful than one month later. In comparison with the summer crop season, numbers of flowering flushes and flowers induced by lighting treatment were fewer, but winter fruits were sweeter in all fruiting genotypes and bigger in several genotypes.

Effects of pollination method and pollen source on fruit set/fruit characteristics and some flowering characteristics among 4 typical pitaya genotypes including ‘Vietnam White’ (‘VN-White’), ‘Chaozhou 5’, ‘Orejona’, and ‘F_{11}’were elucidated. The pollination methods differently affected fruit set percentages (FSPs) and fruit fresh weights (FFWs) among four genotypes. F-SC genotype, ‘VN-White’ obtained high FSP and FFW after hand self-, or open-pollination. Due to lack of a natural pollination efficiency as honey bee

visitations, P-SC type, ‘Chaozhou 5’ or C-SI type, ‘Orejona’ and ‘F_{11}’ had high FSPs and FFWs by only hand-cross pollination. Pollen sources also affected FSPs and FFWs. ‘Chaozhou 5’, ‘Orejona’, and ‘F_{11}’ required crossing with their compatible pollen source to ensure optimal FSPs and FFWs, while ‘VN-White’ obtained the best results by selfing (its own pollen). The relative location between the anthers and the stigma in the flower may be used as an indicator of whether hand pollination is required for a pitaya cultivar grown under the conditions with or without an availability of naturally correlative pollinator(s).

The effect of bagging on fruit characteristics and physical fruit protection in three pitaya genotypes (‘VN-White’, ‘Chuchi Liu’ and ‘Chaozhou 5’) was also studied in the summer season of 2013. Four types of bags, including paper-white bag (P-WB), net screen-black bag (NS-BB), polyethylene plastic-black bag (PP-BB), polyethylene plastic-white bag (PP-WB) bag and non-bagged (control) were applied to fruits at 7 days after anthesis and continued until harvest. Fruit bagging can affect fruit appearance, peel thickness, fruit firmness and physiological fruit damage. Bagging fruits with P-WB or PP-WB, as the best treatments, could improve the fruit color and effectively reduce the loss of damaged fruits caused by physiological factors such as cracking, birds, and blemishes in the three genotypes. The results obtained from this research can be applied for the improvement of varietal and cultural practices to increase the yield and quality of pitaya.

Keywords: Pitaya, plant morphology, flowering phonology, lighting-flowering induction, self-compatible, pollination, fruit bagging.

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Tran Dinh Ha

TABLE OF CONTENTS