施用不同形式鈣肥對'金煌'芒果果實品質之影響

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關鍵字：金煌、芒果、施鈣、生理劣變

摘要：本試驗探討施用不同形式鈣肥對改善'金煌'芒果生理劣變之影響。果實品質及劣變率之比較，以施用海草肥及 Cell-Bine 處理之早(7/2)採收的果實劣變率僅10%，未施肥處理者較高為 20%。另外，晚(7/21)採收的果實，在未施肥處理者劣變率達 60%，而海草肥及 Cell-Bine 處理者分別為 40%與 45%，故施用鈣肥可降低果實劣變率。果實無機元素濃度方面，施用海草肥及 Cell-Bine 處理之早(7/2)採收的果實可增加果皮、外層果肉及內層果肉鈣濃度。晚(7/21)採收的果實，Cell-Bine 處理者可增加果皮及內層果肉鈣濃度。N/Ca、K/Ca、Mg/Ca 比值的變化顯示，在外層果肉方面，早(7/2)採收的果實，在海草肥及 Cell-Bine 處理其比值均較對照組低，而晚(7/21)採收的果實，不同處理間各比值均無顯著差異，但以 Cell-Bine 處理比值較低。在內層果肉方面，早(7/2)採收的果實，Cell-Bine 處理在 N/Ca、K/Ca、Mg/Ca 比值均較低，對照組處理最高。整體而言，施用海草肥或 Cell-Bine 均可增加果實鈣濃度，降低果實劣變發生率，且降低外層果肉及內層果肉的 N/Ca、K/Ca、Mg/Ca 比值。

前 言

芒果(*Mangifera indica* L.)又名檬果、檨仔，為漆樹科(*Anacardiaceae*)芒果屬(*Mangifera*)常綠果樹，原產於印度。因果實具有豐富營養成分，果形外觀美麗、果肉香甜、風味獨特，故為熱帶地區重要果樹。'金煌'芒果為高雄縣六龜鄉黃金煌先生於民國 65 年，以懷特為母本凱特為父本雜交時所選育出的品種，其果形碩大、種子扁且薄、肉質厚、纖維少、糖度高無酸味及耐炭疽病，但果實於發育後期或樹上後熟時，常會有生理劣變的情形發生(李,

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1996)，且在外觀卻不易察覺，故造成產業上的損失。為減少'金煌'芒果果實劣變率，陳氏(1997)以氯化鈣噴施'金煌'芒果葉片，結果亦發現可降低果實劣變率。因此，本試驗調查施用不同形式鈣肥對'金煌'芒果果實鈣濃度之影響，以期降低'金煌'芒果果實劣變發生率。

材 料 及 方 法

一、材料來源

試驗材料為台中市軍功林氏果園之'金煌'芒果品種，每個施鈣處理分別選擇 5 植株於花芽萌發前，進行土壤施肥及葉面施肥。於 92 年 3 月 4 日進行處理，每個處理共 5 株，土壤施肥處理，以每株 5 公斤的海草肥(SeaGold, 含 18.8% calcium)於根部周圍進行環施；葉面施肥處理則以 Cell-Bine(含 calcium chloride、calcium sulfate and calcium citrate, 有效成分: Ca 含 25% (325 g/袋)以上, CaO 含 35%以上)稀釋 1000 倍，噴施於整株且每週施用，共進行 7 次；對照組則不作任何施肥處理。並於 5 月 23 日以不透光之牛皮紙袋進行套袋處理。於 2003 年 7 月 2 日及 7 月 21 日進行兩次採果，每個處理每次採 20 果供調查。另外，將果實置於 30℃下以 400 ppm 益收(ethrel)進行催熟 3 日後，調查催熟後品質。

二、調查項目與分析方法

(一)施用不同形式鈣肥對'金煌'芒果果實品質之影響

於 2003 年 7 月 2 日及 7 月 21 日進行兩次採果，每個處理每次採 20 果供調查，果實採收後置於 30℃下以 400 ppm 益收(ethrel)進行催熟 3 日，以調查催熟後之品質，包括果實重量、體積及比重、糖度、硬度、果肉顏色及果實劣變發生率，其中發生果肉劣變之數目，是指從輕微的黑點症狀到果肉組織嚴重壞死的現象均包括。

(二)施用不同形式鈣肥對'金煌'芒果果實營養元素之影響

果實經上述品質測定完畢後，每個處理取 10 個果實供分析，取樣部位分成果皮、靠近果皮之外層果肉及靠近種子之內層果肉三部分，以液態氮急速冷凍後，裝入封口袋內進行冷凍乾燥，約 72 小時後完全乾燥，以磨粉機磨成粉末，再放入封口袋內密封，置於-20℃冷凍庫下備用。無機元素之分析，分別秤取 1.0 g 外層及內層果肉與 0.5 g 果皮冷凍乾燥粉末置於坩堝中，放入灰化爐內(muffle furnace)，先以 200℃加熱 2 小時，繼以 400℃加熱 1 小時，最後以 550℃加熱 2 小時使樣品完全灰化，取出後待樣品冷卻，加入 5 ml 2 N HCl(Merck Company)將灰分完全溶解，並以無灰分(ashless)濾紙(Whatman#42)過濾，濾液定量至 25 ml，混合均勻後裝入 PE 塑膠瓶中保存待測。

上述濾液可直接測定鐵、錳、鋅、銅四種元素；測鉀及鎂各取 0.1 ml 濾液加 3.9 ml 去離子水稀釋；測鈣則取 1 ml 濾液加 3 ml 去離子水及 1 ml 5% 氧化鑭(lanthanum oxide)，以原子吸收儀(Varian 20A Techtron atomic absorption spectrophotometer)測定之。

磷之測定採用鉬黃法(vanadate-molybdate yellow method)，取 1 ml 濾液加 3 ml 去離子水及 1 ml 鉬黃試劑(vanadate-molybdate reagent)，混合均勻後靜置 10 分鐘，以分光光度計(spectrophotometer, Hitachi U-2000)測定 470 nm 之吸光度。氮之分析採用 Micro-Kjeldahl 法，精秤 0.2 g 果肉粉末，包於濾紙(Whatman#1)中，投入分解管並加入 1 g 催化劑(Merck 8030)及 4.5 ml 濃硫酸，置於 410℃分解爐上加熱 2.5-3 小時，待樣品分解至澄清或淡綠色，取出冷卻後加入 15 ml 蒸餾水，再倒入 Micro-Kjeldahl 裝置之容器中，加入 20 ml 12 N NaOH，並以裝有含 2% boric acid 20ml 指示劑(19 μM bromocresol green 及 25 μM methyl red)之塑膠燒杯接收蒸餾出之氨水，至燒杯溶液體積達 50 ml 時取出，以 1/14 N H_2SO_4 標準酸滴定，計算氮含量百分比。

結　果

一、施用不同形式鈣肥對'金煌'芒果果實品質之影響

果實品質及劣變率之比較，早(7/2)採收與晚(7/21)採收的果實，所調查的項目在果實比重可溶性固形物、硬度及果肉顏色方面均無明顯差異(表 1、2)。

表 1. 施用不同形式鈣肥對'金煌'芒果果實催熟後品質之影響

Table 1. Effect of calcium applications on the quality of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Specific gravity	TTS[x] (°Brix)	Firmness (N)
2, July, 2003	SeaGold	1.00a[z]	12.9a	205.4ab
	Cell-Bine	1.00a	13.4a	183.9b
	Control	1.00a	12.5a	219.4a
21, July, 2003	SeaGold	1.02a	17.1a	33.3b
	Cell-Bine	1.02a	17.6a	37.0a
	Control	1.03a	17.1a	39.3a

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

[x] TTS=total soluble solid.

果實劣變率，早(7/2)採收的果實在施用海草肥及 Cell-Bine 處理間，劣變率僅 10%，未施肥之對照組較高為 20%。晚(7/21)採收的果實，劣變率在對照組達 60%，而海草肥及 Cell-Bine 處理分別為 40%與 45%。整體而言，在兩次採收時期之調查，以晚(7/21)採收的果實其果實比重、可性固形物及劣變率均較早(7/2)採收的高，且施用鈣肥可降低果實劣變率(表 2)。

表 2. 施用不同形式鈣肥對'金煌'芒果果實催熟後品質之影響

Table 2. Effect of calcium applications on the quality of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Pulp color[w]			Breakdown
		Lightness	Chroma	Hue angle	(%)
2, July, 2003	SeaGold	56.0a[z]	30.2a	87.7a	10
	Cell-Bine	54.6a	31.3a	85.7a	10
	Control	57.4a	31.9a	88.2a	20
21, July, 2003	SeaGold	52.8a	30.2a	82.8a	40
	Cell-Bine	53.5a	30.9a	82.4a	45
	Control	53.7a	30.4a	83.4a	60

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

[w] Chroma=$(a+b)^{1/2}$，Hue angle=$\tan^{-1}(b/a)$.

二、施用不同形式鈣肥對'金煌'芒果果實營養元素之影響

果實無機元素濃度，在果皮之變化顯示，早(7/2)採收的果實在海草肥及 Cell-Bine 處理均可增加果皮鈣濃度，而不同處理間在鉀、鐵、錳濃度均無顯著差異。晚(7/21)採收的果實，在海草肥及 Cell-Bine 處理間均可增加果皮鈣濃度；其中海草肥處理同時可增加果皮氮、磷、鉀、鐵、錳、鋅、銅濃度，而 Cell-Bine 處理亦可增加錳濃度(表 3、4)。

外層果肉的變化顯示，早(7/2)採收的果實，在海草肥及 Cell-Bine 處理均可增加外層果肉鈣濃度；其它元素濃度，各處理間並無明顯之差異。至於晚(7/21)採收的果實，不同處理間在外層果肉無機元素濃度均無顯著差異(表 5、6)。

表 3. 施用不同形式鈣肥對'金煌'芒果果實催熟後果皮大量元素濃度之影響

Table 3. Effect of calcium applications on the macro concentration of peel of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Macro element (%)				
		N	P	K	Ca	Mg
2, July, 2003	SeaGold	0.55a[z]	0.095ab	1.15a	0.18b	0.100a
	Cell-Bine	0.48b	0.088b	1.11a	0.21a	0.079b
	Control	0.59a	0.104a	1.07a	0.15c	0.104a
21, July, 2003	SeaGold	0.57a	0.113a	1.51a	0.19a	0.088a
	Cell-Bine	0.47b	0.089b	1.31b	0.17ab	0.072b
	Control	0.49b	0.090b	1.24b	0.15b	0.078ab

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

表 4. 施用不同形式鈣肥對'金煌'芒果果實催熟後果皮微量元素濃度之影響

Table 4. Effect of calcium applications on the micro concentration of peel of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Micro element (ppm)			
		Fe	Mn	Zn	Cu
2, July, 2003	SeaGold	15.90a[z]	10.27a	6.82b	5.38a
	Cell-Bine	16.56a	13.27a	5.94b	4.29b
	Control	15.81a	9.93a	8.38a	5.54a
21, July, 2003	SeaGold	17.11a	11.02a	8.23a	4.49a
	Cell-Bine	14.67b	8.73ab	6.53b	3.74a
	Control	15.36b	6.53b	7.38ab	3.89a

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

表 5. 施用不同形式鈣肥對'金煌'芒果果實催熟後外層果肉大量元素濃度之影響

Table 5. Effect of calcium applications on the macro concentration of outer pulp of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Macro element (%)				
		N	P	K	Ca	Mg
2, July, 2003	SeaGold	0.50b[z]	0.057ab	0.80ab	0.031ab	0.036a
	Cell-Bine	0.47b	0.050b	0.68b	0.036a	0.034a
	Control	0.56a	0.065a	0.83a	0.028b	0.038a
21, July, 2003	SeaGold	0.38a	0.054a	0.61a	0.027a	0.034a
	Cell-Bine	0.37a	0.054a	0.60a	0.029a	0.031a
	Control	0.37a	0.056a	0.58a	0.030a	0.031a

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

表 6. 施用不同形式鈣肥對'金煌'芒果果實催熟後外層果肉微量元素濃度之影響

Table 6. Effect of calcium applications on the micro concentration of outer pulp of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Micro element (ppm)			
		Fe	Mn	Zn	Cu
2, July, 2003	SeaGold	14.41a[z]	2.67a	3.90b	4.40a
	Cell-Bine	13.04a	2.92a	3.15c	3.55b
	Control	13.12a	2.55a	4.65a	4.65a
21, July, 2003	SeaGold	9.91a	1.22a	3.72a	3.87a
	Cell-Bine	10.09a	1.30a	3.40a	3.37a
	Control	10.08a	1.10a	3.82a	3.77a

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

內層果肉的變化顯示，不論在不同採收時期或處理間，均可增加內層果肉的鈣濃度。早(7/2)採收的果實，不同處理間在鎂、鐵、錳、銅濃度均無顯著差異，Cell-Bine 處理內層果肉磷、鉀濃度較對照組低。至於晚(7/21)採收的果實，不同處理間內層果肉無機元素磷、鉀、鎂、鐵、鋅、銅濃度均無顯著差異，海草肥及 Cell-Bine 處理內層果肉氮濃度較低(表 7、8)。N/Ca、K/Ca、Mg/Ca 比值的變化顯示，外層果肉方面，早(7/2)採收的果實，在海草肥及 Cell-Bine 處理其比值均較對照組低。而晚(7/21)採收的果實，不同處理間各比值均無顯著差異，但以 Cell-Bine 處理比值較低。在內層果肉方面，早(7/2)採收的果實，Cell-Bine 處理在 N/Ca、K/Ca、Mg/Ca 比值均較低，對照組處理最高(表 9、10)。

整體而言，'金煌'芒果果實鈣濃度，由果皮至內層果肉有遞減之趨勢，施用海草肥或 Cell-Bine 均可增加果實鈣濃度，降低果實劣變發生率。而外層果肉及內層果肉的 N/Ca、K/Ca、Mg/Ca 比值，以對照組處理最高。

討　論

鈣與果實的生理劣變具有相關性(Shear, 1975)，而芒果果肉發生劣變之部位大多為靠近果頂處的果肉(Katrodia *et al.*, 1988; Katrodia, 1988)。學者指出'Kent'及'愛文'芒果，其果肉鈣濃度之分部均由果梗端往果頂端及外層果肉往內層果肉遞減(Burdon *et al.*, 1991; 謝, 1990)，而'金煌'芒果變的部位偏果頂及種核附近的果肉較為嚴重，故果肉劣變與鈣濃度之分布似乎有關連(李, 1996)。本試驗結果，鈣濃度在果實之分布，由外層果肉往內層果肉遞減，而果皮的鈣濃度明顯高於外層及內層果肉，表示鈣離子在果實不易運移(表 3、4、5、6、7、8)。

植物吸收鈣之多寡不一定和土壤中的鈣含量成正比，且植物新根生緩慢，老根又具有卡氏帶(Casparian band)，導致根對於鈣的吸收有限，因此，若想提高組織鈣濃度可藉葉面施用鈣肥，迅速補充植物所需之養分(Haub, 1986; Maroto *et al.*, 1986)。在'Anjou'梨方面，採收前噴施 $CaCl_2$ 可有效降低栓皮病(cork spot)、表皮燙斑(superficial scald)的發生(Raese and Drake, 2000b)，並延長櫥架壽命。'Golden Delicious'蘋果，在採收前噴施 $CaCl_2$ 或 $Ca(NO_3)_2$，可有效增加果實內之鈣含量，降低苦痘病的發生(Raese and Drake, 2000a)。不同形式之鈣肥亦會影響果實的吸收量，對'Anjou'梨而言，$CaCl_2$(含 34% Ca)處理比 $Ca(NO_3)_2$(含 24% Ca)處理，對增加果實鈣含量的效果較佳(Raese *et al*, 1995)。本試驗結果，施用海草肥之土壤性肥料及 Cell-Bine 之葉面施肥處理，均可增加果皮、外層果肉及內層果肉鈣濃度，並可降低果實劣變發生率。游氏(2003)以'七星'絲瓜為試驗材料，進行不同形式鈣肥之葉面施肥，亦發現 Cell-Bine 噴施處理，絲瓜植株的鮮重與乾重明顯較高。

整體而言，'金煌'芒果鈣濃度由果皮往內層果肉遞減，而施用不同形式鈣肥後，均可增加果皮、外層果肉及內層果肉的鈣濃度(表 3、4、5、6、7、8)，降低果實劣變發生率。

且對照組其外層果肉及內層果肉的 N/Ca、K/Ca、Mg/Ca 比值明顯較高(表 9、10)，顯示離子間發生不平衡的現象，而具較高之果實劣變率。

表 7. 施用不同形式鈣肥對'金煌'芒果果實催熟後內層果肉大量元素濃度之影響

Table 7. Effect of calcium applications on the macro concentration of inner pulp of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Macro element (%)				
		N	P	K	Ca	Mg
2, July, 2003	SeaGold	0.50b[z]	0.081a	0.96a	0.015ab	0.032a
	Cell-Bine	0.47b	0.068b	0.81b	0.017a	0.029a
	Control	0.56a	0.087a	0.94a	0.012b	0.031a
21, July, 2003	SeaGold	0.48ab	0.061a	0.78a	0.012ab	0.029a
	Cell-Bine	0.45b	0.060a	0.74a	0.013a	0.029a
	Control	0.52a	0.065a	0.72a	0.010b	0.027a

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

表 8. 施用不同形式鈣肥對'金煌'芒果果實催熟後內層果肉微量元素濃度之影響

Table 8. Effect of calcium applications on the micro concentration of inner pulp of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Micro element (ppm)			
		Fe	Mn	Zn	Cu
2, July, 2003	SeaGold	12.58a[z]	2.17a	4.89ab	3.62a
	Cell-Bine	11.79a	2.17a	4.40b	3.15a
	Control	12.56a	2.22a	5.02a	2.67a
21, July, 2003	SeaGold	11.25a	1.77a	4.61a	2.74a
	Cell-Bine	11.31a	1.92a	4.42a	3.02a
	Control	10.58a	1.32b	4.29a	2.40a

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

表 9. 施用不同形式鈣肥對'金煌'芒果果實催熟後外層果肉 N/Ca、Mg/Ca、K/Ca 比值之影響

Table 9. Effect of calcium applications on the N/Ca、K/Ca、Mg/Ca ratio of outer pulp of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Outer pulp		
		N/Ca	K/Ca	Mg/Ca
2, July, 2003	SeaGold	16.37b[z]	26.70a	1.19ab
	Cell-Bine	13.27b	19.45b	0.98b
	Control	21.17a	31.00a	1.41a
21, July, 2003	SeaGold	13.77a	21.99a	1.13a
	Cell-Bine	14.60a	22.70a	1.26a
	Control	13.74a	21.00a	1.13a

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

表 10. 施用不同形式鈣肥對'金煌'芒果果實催熟後內層果肉 N/Ca、Mg/Ca、K/Ca 比值之影響

Table 10. Effect of calcium applications on the N/Ca、K/Ca、Mg/Ca ratio of inner pulp of 'Chiin Hwang' mango fruits after ripening.

Harvest date and treatments[y]		Inner pulp		
		N/Ca	K/Ca	Mg/Ca
2, July, 2003	SeaGold	35.20b[z]	67.17b	2.19b
	Cell-Bine	28.28b	49.44c	1.78c
	Control	48.65a	79.89a	2.64a
21, July, 2003	SeaGold	36.25b	59.38b	2.28a
	Cell-Bine	42.16b	67.63ab	2.54a
	Control	54.62a	74.15a	2.81a

[z] Means followed by the same letter within harvest date and column are not significantly different by Duncan's multiple range test at 5% level.

[y] SeaGold (contains 18.8% calcium were applied) 5kg per tree into soil; Cell-Bine (contains calcium chloride、calcium sulfate and calcium citrate) were foliar applied.

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Effect of Calcium Applications on the Quality of 'Chiin Hwang' Mango Fruits

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Key words：'Chiin Hwang', Mango, Physiological disorder, Calcium applications

Summary

The objectives of this study were to investigate the effect of different forms of calcium fertilizers to 'Chiin Hwang' mango trees. Results indicated that the calcium treated mango fruits tended to have a reduced frequency of the occurrence of physiological disorders. Fruits were calcium treated which harvested at 2nd July the incidence of physiological disorders were 10%, and untreated fruits were 20%. Fruits were harvested at 22th July, the SeaGold and Cell-Bine treated, the incidence of physiological disorders were respectively 40% and 45%, and untreated fruits were 60%. The calcium treated mango fruits which harvest at 2nd July have higher calcium concentration in the peel, outer and inner pulps and lower N/Ca、K/Ca、Mg/Ca ratio. The Cell-Bine treated mango fruits which harvest at 22th July have higher calcium concentration in the peel and inner pulp and lower N/Ca、K/Ca、Mg/Ca ratio. In general, mango fruits treated with SeaGold or Cell-Bine tended to increase calcium concentration, decrease N/Ca、K/Ca、Mg/Ca ratio in the inner and outer pulps and reduced frequency of the occurrence of physiological disorders of 'Chiin Hwang' mango fruits.

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