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灌溉及不同氮肥施用量對愛文芒果產量、果實品質及葉片礦物元素濃度之影響

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摘　要

本研究嘉義農業試驗分所擇一四年生愛文芒果園，（0.2 ha，栽培密度4×2 m），於民國八十一年八月開始進行灌溉與氮肥施用量複因子試驗至八十二年八月止；灌溉試驗分成灌溉與不灌溉兩種處理，灌溉處理爲每週三、六各灌溉一次，每次每株灌溉量約爲40 l；氮肥施用量分成每株施用尿素0.62 kg、0.26 kg及不施用尿素三種處理。試驗結果顯示單株產量以灌溉處理組較高，但果實品質如果實大小、糖度、酸度則與不灌溉之間無差異。葉片營養元素濃度方面，盛花期氮、鉀、銅濃度以灌溉組較高，鈣、鎂、鐵、硼濃度則反之，以不灌溉組較高，其餘各元素濃度則無差異，至於果實成熟期則各元素濃度於兩處理組間均無差異。各氮肥處理之間的比較，單株產量及果實品質在各處理間無差異，葉片元素濃度於盛花期各處理間無差異，於果實成熟期，氮濃度以不施尿素處理組最低，"0.62 kg尿素"與"0.26 kg尿素"處理間無差異，其餘各元素濃度於三種處理間均無差異。在灌溉與不同氮肥施用量複合處理比較方面，單株產量以"灌溉＋不施尿素"略高，"不灌溉＋0.26 kg"略低，果實大小與酸度，各處理組間無差異，糖度以"不灌溉＋0.62 kg"略低，葉片營養元素濃度方面，盛花期氮濃度以"不灌溉＋不施尿素"略低，鉀濃度以"不灌溉＋不施尿素"、"不灌溉＋0.26 kg"略低，鎂濃度以"灌溉＋0.62 kg"及"灌溉＋0.26 kg"略低，磷、鈣、鐵各處，理組之間均無差異各微量元素濃度各處理組之間無規則可循；於果實成熟期，氮濃度以"灌溉＋不施尿素"略低，鈣濃度以"不灌溉＋0.26 kg"及"不灌溉＋ 0.62 kg"較低，鐵濃度以"不灌溉＋0.62 kg"較高，"灌溉＋不施尿素"較低，錳濃度以"不灌溉＋不施尿素"、"不灌溉＋0.26 kg"較低，至於磷、鉀、銅、鋅、硼濃度，各處理組之間無差異，與盛花期相較果實成熟期於各處理組有較低的氮、磷、鉀、鈣濃度。

關鍵字：芒果、氮肥、灌溉、產量、品質、礦物元素濃度。

前　言

過去本省芒果栽培常有著果不良之問題，然自從花期飼養授粉昆蟲及病蟲害防治的技術增進後，此情形已大爲改善，栽培管理良好的果園，近三年來每公頃產量可高達20公噸以上，較過去每公頃8公噸的產量可提高2至3倍，但是產量遽增，相對的因高產所導致的樹體養份損失如何補充之問題亦困擾著這些果園，由於本省芒果栽培尚未建立一套完整的肥培管理制度，果農施肥時常苦無可循的依據，此益發突顯出建立肥培管理制度的重要性，而在所有的肥料元素中，以氮肥的施用量最大，其使用量直接關係到產量與品質，但卻是不容易控制的，由於土壤水分與氮肥施用效果有密切的關係，因此本試驗擬就灌溉與不同氮肥施用量對

產量、果實品質、樹體營養的影響加以探討，以提供生產者與有關研究人員的參考。

材料與方法

本研究嘉義農業試驗分所擇一四年生愛文芒(*Mangifera indica* L.)果園，該園佔地0.2 ha，栽培密度4×2 m，民國八十一年八月開始進行灌溉與氮肥施用量複因子試驗至八十二年八月止；灌溉試驗分成灌溉與不灌溉兩種處理，灌溉處理爲每週三、六各灌溉一次，每次灌溉量約爲40 l；根據曾氏所著芒果栽培手冊一書中，四年生芒果氮素施用量及三倍施用量將氮肥用量分成每株0.26 kg、0.62 kg及不施用尿素三種處理，施用時間爲供試植株盛花期。試驗期間栽培管理方法則依一般方法行之，並於盛花期及果實成熟期採取葉片進行分析，於採收期後稱單株產量並分析果實品質，有關分析項目說明如下：

一、果實品質分析：果實於軟熟時採收，每試驗組選5株，每株取5個果實，調查果重、果長、果寬、果肉重、種子重、可溶性固形物含量及酸度。

二、葉片分析：每試驗組選5株，於東南西北四方位，採花穗下第一節枝條中部之葉片，進行分析。取樣日期爲民國82年2月16日，7月29日，約爲植株之盛花期及果實成熟期，分析方法如下：

㈠葉片採集後之處理：先用自來水將表面灰塵洗淨，而後用蒸餾水快洗三次，沖洗時間前後不超過一分鐘，洗畢後裝入紙袋，置於通風之乾燥箱於70℃烘乾48 hr以上。之後將烘乾之樣品用磨碎機磨碎並過篩(40 mesh)，將粉末裝入硫酸紙袋，以供乾灰化。

㈡元素分析：乾灰化乃取烘乾樣品，精稱0.5 g均勻放入坩堝中，置入灰化爐(muffle furnace)內，先以200℃加熱2 hr後，將溫度調整至400℃加熱1 hr，最後再調高至550℃，加熱2 hr後，立刻用夾子夾出，待冷卻後加入2 N HCl 5 ml，充分溶解灰分後，再用Whatman No. 42濾紙過濾，利用去離子水洗淨坩堝三次，再將濾液定量至25 ml，然後利用石腊膜封住定量瓶瓶口，充分搖勻，將濾液倒入100 ml之塑膠瓶備用。

測定鐵、銅、鋅、錳時，直接取上述濾液；測定鉀、鎂取0.1 ml濾液稀釋至4 ml；測定鈣時取0.1 ml濾液，加入1 ml 5%氧化鑭(Lanthanum oxide)再稀釋至5 ml，然後用Varian Spectra AA 10/20 systems原子光譜吸收儀測定。

磷測定則採用Vanadate-Molybdate-Yellow法[4]，取1 ml濾液加入1 ml HNO_3 Vanadate-Molbdate reagent（1升試劑中含22.5 g $(NH_4)_5Mo_7O_2 \cdot 4H_2O$，1.25 g NH_4VO_3及250 ml conc. HNO_3），以去離子稀釋至5 ml，混合均勻後，靜置30分鐘，以Hitachi U-2000 Spectrophotometer光電比色計測定波長在470 nm之吸光度。標準曲線以磷含量50 ppm配製。

㈢全氮測定是採用Micro-Kjeldahl方法。精稱0.2 g磨碎之乾燥植物組織粉末，包於Whatman No. 1（110 mm切割成四等分）濾紙內，置入分解瓶中，並加入1 g催化劑(K_2SO_4：$CuSO_4$：Se=100：10：1)，然後加入4.5 ml濃硫酸立刻放於410℃分解爐上加熱，使分解至澄清綠色後，繼續加熱30分鐘，取出冷卻並加入15 ml蒸餾水，之後會呈淡藍色透明液，將此液倒入Micro-Kjeldhl裝置中，加入20 ml 12 N NaOH。另外用裝有2% 20 ml指示劑（含19μm Brmocresol Green及25μm Methyl Red）之燒杯，收集經蒸餾之氨水至接收杯內溶液體積爲50 ml止。然後以1/14 N H_2SO_4滴定，計算含氮之比例。

結　果

灌溉對愛文芒果單株產量、果實品質及葉片營養要素濃度的影響

單株產量以灌溉處理組較高，但果實品質如單果重、果長、果寬、糖度及酸度則與不灌溉處理之間無差異（表一）；葉片營養元素濃度方面，盛花期氮、鉀、銅濃度以灌溉處理組較高，鈣、鎂、鐵、硼濃度則以不灌溉處理組較高，其餘各元素濃度則無差異（表二）；至於果實成熟期則各元素濃度於兩處理組之間均無差異（表三）。

表一、灌溉對四年生愛文芒果單株產量及果實品質的影響[1]

Table 1. Effect of irrigation on yield and quality of four-year-old "Irwin" mango

Treatments	Average yield of single tree	Average fruit weight	Fruit length	Fruit diameter	Aril weight	Seed weight	Total soluble Solids	Acidity
	(Kg)	(g)	(cm)	(cm)	(gm)	(gm)	(Brix°)	(%)
Irrigated[2]	22.24*[4]	296.45ns	99.47ns	76.72ns	226.18ns	22.97ns	15.13ns	0.31ns
Nonirrigated[3]	17.86	299.61	99.66	77.01	227.94	24.66	14.38	0.28

[1] In this experiment urea was used as nitrogen fertilizer source.
[2] Including "Irrigated + no urea", "Irrigated + 0.26kg urea", "Irrigated + 0.62kg urea".
[3] Including "Nonirrigated + no urea", "Nonirrigated + 0.26kg urea", "Nonirrigated + 0.62kg urea".
[4] * indicated significant difference by 5% level.

表二、灌溉對盛花期之四年生愛文芒果葉片營養要素濃度的影響[1]

Table 2. Effect of irrigation on leaf mineral elements concentrations of four-year-old "Irwin" mango at full bloom stage

Treatments	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B
	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Irrigated[2]	2.17*[4]	0.18ns	1.35*	2.12**	0.17**	79.70*	677.5ns	7.83*	67.57ns	26.50*
Nonirrigated[3]	2.04	0.19	1.27	2.43	0.20	89.93	580.0	6.80	65.47	31.65

[1,2,3] See Table 1.
[4] * and ** indicated significant difference at 5% and 1% level, respectively.

表三、灌溉對果實成熟期之四年生愛文芒果葉片營養要素濃度的影響[1]

Table 3. Effect of irrigation on leaf mineral elements concentrations of four-year-old "Irwin" mango at maturing stage

Treatments	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B
	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Irrigated[2]	1.53ns[4]	0.16ns	1.09ns	1.61ns	0.17ns	61.43ns	764.71ns	5.0ns	78.57ns	24.64ns
Nonirrigated[3]	1.57	0.16	1.09	1.86	0.19	64.54	614.11	5.0	75.36	23.35

[1,2,3] See Table 1.
[4] ns indicated no significant difference.

不同氮肥施用量對愛文芒果單株產量、果實品質及葉片營養元素濃度的影響

單株產量及果實品質於三種不同氮肥用量處理間均無差異（表四），葉片營養元素濃度方面，於盛花期各元素濃度於三種處理間均無差異（表五），於果實成熟期，氮濃度以"不施尿素"處理組較低，"0.62 kg尿素"與"0.26 kg尿素"處理組無差異，其餘各元素濃度於三種處理間均無差異（表六）。

表四、不同氮肥施用量對四年生愛文芒果單株產量及果實品質的影響[1]

Table 4. Effect of different nitrogen levels on yield and quality of four-year-old "Irwin" mango

Treatments	Average yield of single tree	Average fruit weight	Fruit length	Fruit diameter	Aril weight	Seed weight	Total soluble solids	Acidity
	(Kg)	(g)	(cm)	(cm)	(gm)	(gm)	(Brix°)	(%)
0.62Kg urea	21.38 a[2]	300.7 a	99.6 a	77.2 a	230.8 a	23.6 a	14.5 a	0.29 a
0.26Kg urea	17.21 a	299.1 a	100.0 a	77.2 a	226.8 a	24.2 a	15.1 a	0.29 a
No urea	21.55 a	294.2 a	99.0 a	76.3 a	223.6 a	23.6 a	14.7 a	0.32 a

[1] Every treatment include "Irrigated" and "Nonirrigated".
[2] Means separation within columns by Duncan's multiple range test at 5% level.

表五、不同氮肥施用量對盛花期之四年生愛文芒果葉片營養要素濃度的影響[1]

Table 5. Effect of different nitrogen levels on leaf mineral elements concentrations of four-year-old "Irwin" mango at full bloom stage

Treatments	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B
	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
0.62Kg urea	2.16 a[2]	0.19 a	1.35 a	2.23 a	0.18 a	81.3 a	676.8 a	7.65 a	64.55 a	28.15 a
0.26Kg urea	2.06 a	0.19 a	1.29 a	2.26 a	0.18 a	89.7 a	567.5 a	7.05 a	71.05 a	29.91 a
No urea	2.10 a	0.18 a	1.30 a	2.34 a	0.19 a	83.5 a	642.0 a	7.25 a	63.95 a	29.19 a

[1,2] See Table 4.

表六、不同氮肥施用量對果實成熟期之四年生愛文芒果葉片營養要素濃度的影響[1]

Table 6. Effect of different nitrogen levels on leaf mineral elements concentrations of four-year-old "Irwin" mango at fruit maturing stage

Treatments	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B
	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
0.62Kg urea	1.65 a[2]	0.15 a	1.08 a	1.84 a	0.18 a	65.20 a	742.8 a	5.00 a	73.00 a	24.52 a
0.26Kg urea	1.66 a	0.17 a	1.14 a	1.71 a	0.19 a	64.56 a	650.3 a	5.00 a	81.88 a	24.04 a
No urea	1.36 b	0.16 a	1.07 a	1.65 a	0.19 a	59.50 a	668.8 a	5.00 a	77.00 a	23.44 a

[1,2] See Table 4.

灌溉與不同氮肥施用量對愛文芒果單株產量、果實品質及葉片營養元素濃度的影響

本試驗灌溉處理與不同氮肥施用量處理彼此間交感作用不顯著。在灌溉與不同氮肥施用量複合處理比較方面，單株產量以"灌溉+不施尿素"略高，"不灌溉+0.26 kg"略低，果實大小與酸度，各處理組間無差異，糖度以"不灌溉+0.62 kg"略低，葉片營養元素濃度方面，盛花期氮濃度以"不灌溉+不施尿素"略低，鉀濃度以"不灌溉+不施尿素"、"不灌溉+0.26 kg"略低，鎂濃度以"灌溉+0.62 kg"及"灌溉+0.26 kg"略低，磷、鈣、鐵各處理組之間均無差異，各微量元素濃度各處理組之間無規則可循；於果實成熟期，氮濃度以"灌溉+不施尿素"略低，鈣濃度以"不灌溉+0.26 kg"及"不灌溉+ 0.62 kg"較低，鐵濃度以"不灌溉+0.62 kg"較高，"灌溉+不施尿素"較低，錳濃度以"不灌溉+不施尿素"、"不灌溉+0.26 kg"較低，至於磷、鉀、銅、鋅、硼濃度，各處理組之間無差異。

討　論

本試驗期藉灌溉處理，以彰顯不同氮肥施用量的肥效，而以不灌溉代表本省芒果栽培的自然狀況，並藉此比較灌溉與不灌溉對芒果產量、果實品質及葉片礦物元素濃度的影響有何差別。

由試驗結果可知，本試驗灌溉的效果顯著，灌溉可增加單株產量（表一），若換算成大面積種植，以此估算每公頃可增加5,475 kg，由於灌溉與不灌溉間單果重並無差異，可知灌溉對增產的效果主要在於增加結果的數目；至於對葉片營養元素濃度造成影響的原因，通常於灌溉的情形下，於植物體多量元素中，磷及鉀的濃度會提高[6]，主要是磷在土壤中移動性很低，較多的水可使磷溶解，進而提高土壤水中磷的濃度，以供應植物需要[1]；而鉀在土壤中存在著三種型式；構造性的鉀，吸附於土壤膠體上的鉀離子及土壤溶液中的鉀離子，而以第三者對植物體的供應最重要，潮濕的土壤可促使較多非置換性的鉀解離[5]，本試驗在盛花期時，葉片中鉀濃度有反映此種變化，但磷濃度卻無類似趨向，至於鈣、鎂濃度於灌溉組濃度較低的原因，可能受到鉀離子拮抗作用而減少鈣、鎂離子吸收，此外，鎂離子在土壤中吸附能力較弱，長期灌溉易導致流失亦是重要原因。就氮濃度而言，灌溉與植物生長及葉片氮濃度彼此間有密切的關係[6]，灌溉雖促進氮的吸收亦促進植物的生長，由於植物生長所產生的稀釋效應，使得葉片中的氮濃度反而會有降低的情形，本試驗可能由於灌溉與不灌溉處理之間，植株體積及抽梢次數並無明顯差異，是以稀釋作用並不明顯，而使得灌溉處理葉片中氮濃度有上升的情形。至於葉片中微量元素濃度的變化與灌溉之間的關係，尚不非常清楚，Traynor曾指出[6]灌溉會降低葉片中硼的濃度，本灌溉試驗葉片中硼濃度的變化與此符合。在果實成熟期，各礦物元素濃度在灌溉與不灌溉處理之間均無差異的原因（表二），鑑於比較盛花期與採收期多量元素濃度數據，後者似較前者爲低（表二、三），因此推斷可能果實爲强大的積貯(Sink)，於幼果至成熟期間，養分自葉片移轉至果實，導致於葉片內濃度下降的現象，此影響力或許大過環境的因素，而掩蓋過灌溉的效應。

氮肥供應與芒果產量及葉片養分濃度有密切的關係。據Young等人對於"肯特"芒果的研究[7,8,9,10]，適當增加氮肥或鉀肥或氮、鉀肥合用，均能提高芒果的產量，其中以增加氮、鉀肥合用的效果最好，單獨增加氮肥次之[9]，單獨增加鉀肥雖可提高產量，但效果不明顯[7]，施用氮肥可提高氮濃度，但減少鉀、磷、鈣、鎂之濃度[9]，Chadha等人於"Dashehari"芒果試驗顯示在某一程度下，產量隨氮濃度的增加而上升，但過高的氮濃度將導致產量下降[3]，本試驗

不同氮肥施用量對產量、果實品質均無顯著的影響，在葉片營養元素濃度方面，盛花期之所有元素及果實成熟期除氮以外之各元素均無差異，與前人研究結果不符合，推斷可能的原因有二，㈠芒果係多年生作物，對肥料施用的反應較不敏感。㈡本試驗的氮肥施用量太少，不足展現肥效，因爲本結果數據僅爲第一年之試驗，斷言是何種原因，似嫌太早，但爲加速及確保試驗成果，往後試驗仍應採較大範圍差異及較多等級的設計爲宜。由於本試驗灌溉試驗有差異，但氮肥試驗無差異，且灌溉試驗與氮肥試驗彼此間交感作用不顯著，因此灌溉氮肥各複合處理組的差異（表七、八、九），也可能僅是灌溉處理所造成的結果了。

表七、灌溉及不同氮肥施用量對四年生愛文芒果單株產量及果實品質的影響

Table 7. Effect of irrigation and different nitrogen levels on yield and quality of four-year-old "Irwin" mango

Treatments	Average yield of single tree	Average fruit weight	Fruit length	Fruit diameter	Aril weight	Seed weight	Total soluble Solids	Acidity
	(kg)	(g)	(cm)	(cm)	(gm)	(gm)	(Brix°)	(%)
Irrigated+0.62kg urea	21.17ab[1]	296.94a	99.41a	76.98a	228.66a	22.16a	15.19a	0.29a
Irrigated+0.26kg urea	20.24ab	291.03a	99.50a	76.17a	219.56a	24.00a	15.23a	0.29a
Irrigated+no urea	25.29a	301.37a	99.50a	77.01a	230.31a	22.75a	14.97ab	0.36a
Nonirrigated+0.62kg urea	21.58ab	304.49a	99.88a	77.32a	232.86a	25.09a	13.72b	0.28a
Nonirrigated+0.26kg urea	14.19b	307.25a	100.52a	78.15a	234.07a	24.37a	15.04ab	0.29a
Nonirrigated+no urea	17.80ab	287.10a	98.58a	75.57a	216.88a	24.52a	14.40ab	0.28a

[1] Means separation within columns by Duncan's multiple range test at 5% level.

表八、灌溉及不同氮肥施用量對盛花期之四年生愛文芒果葉片營養要素濃度的影響

Table 8. Effect of irrigation and different nitrogen levels on leaf mineral elements concentrations of four-year-old "Irwin" mango at full bloom stage

Treatments	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B
	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Irrigated+0.62Kg urea	2.23a[1]	0.20a	1.40a	2.04b	0.170bc	77.5a	598.0ab	8.2a	68.3ab	24.39b
Irrigated+0.26Kg urea	2.08ab	0.17a	1.30abc	2.14ab	0.166bc	84.0a	662.5ab	7.2abc	66.6ab	27.81ab
Irrigated+no urea	2.22a	0.17a	1.37ab	2.19ab	0.178abc	77.6a	772.0a	8.1ab	67.8ab	27.31ab
Nonirrigated+0.62Kg urea	2.09ab	0.18a	1.3abc	2.42ab	0.188abc	85.1a	755.5a	7.1abc	60.8b	31.9a
Nonirrigated+0.26Kg urea	2.05ab	0.21a	1.27bc	2.38ab	0.200ab	95.3a	472.5b	6.9bc	75.5a	32.0a
Nonirrigated+no urea	1.98b	0.19a	1.23c	2.40a	0.204a	89.4a	512.0b	6.4c	61.1b	31.06a

[1] Means separation within columns by Duncan's multiple range test at 5% level.

表九、灌溉及不同氮肥施用量對果實成熟期之四年生愛文芒果葉片營養要素濃度的影響

Table 9. Effect of irrigation and different nitrogen levels on leaf mineral elements concentrations of four-year-old "Irwin" mango at fruit maturing stage

Treatments	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B
	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Irrigated+0.62Kg urea	1.65ab[1]	0.16a	1.12a	1.81a	0.18a	62.00ab	730.50a	5.0a	73.00a	24.70a
Irrigated+0.26Kg urea	1.63ab	0.16a	1.05a	1.53a	0.17a	66.00ab	756.25a	5.0a	85.00a	24.99a
Irrigated+no urea	1.32b	0.15a	1.09a	1.47a	0.17a	57.20b	808.50a	5.0a	79.00a	24.31a
Nonirrigated+0.62Kg urea	1.65ab	0.15a	1.03a	1.87c	0.18a	68.40a	755.00a	5.0a	73.00a	24.33a
Nonirrigated+0.26Kg urea	1.70a	0.18a	1.23a	1.89b	0.21a	63.13ab	544.37b	5.0a	78.75a	23.10a
Nonirrigated+no urea	1.39ab	0.17a	1.04a	1.82a	0.18a	61.80ab	529.00b	5.0a	75.00a	22.56a

[1] Means separation within columns by Duncan's multiple range test at 5% level.

誌　謝

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Effect of Irrigation and Different Levels of Nitrogen on Yield, Fruit Quality and Leaf Mineral Concentration of Irwin Mango (*Mangifera Indica* L.)

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ABSTRACT

Effect of irrigation and different levels of nitrogen on yield, fruit quality and mineral concentrations of four-year-old "Irwin" mango were investigated in an orchard at Chia-Yi Agricultural Experimant Station, Taiwan, during August 1992 to August 1993. The orchard was subdivided into irrigated and unirrigated area. Irrigated area was defined as the area with 40 liters water per tree applied on every Wednesday and Saturday. Urea was used as nitrogen source with 0.62kg, 0.26kg and no nitrogen (control) per tree. The average yield per tree in irrigated area was higher than nonirrigated area but the qualities as indicated by fruit weight, total soluble solids and acid were not significantly different. In full bloom stage N, K, Cu concentrations of leaves in irrigated area were higher than no irrigated area, but trends of Ca, Mg, Fe, B concentrations were reversed. No significant difference were found on P, Mn, Zn. However at fruit maturing stage, no significant difference were found in leaf mineral elements between areas. The average yield per tree and fruit qualities were not different among nitrogen treatments. Leaf mineral elements concentrations at full bloom stage and except N at fruit maturing stage among three nitrogen treatments were not significantly different. But N concentration in "control" was lower than the other two treatments. For combined treatments, the results were as follow: "Irrigated+ no urea" gave the highest average yield per tree, while "nonirrigated+ 0.26kg" showed the lowest. There were no singificant difference among all treatments in fruit weight and fruit acidity. "Nonirrigated+ 0.62kg" had lower total soluble solids in fruit than other treatments.

When comparing the leaf mineral concentrations in full bloom stage, "nonirrigated+ no urea" had thelowest N concentration, "nonirrigated+ no urea" and "nonirrigated+ 0.26kg"

0.26Kg" gave the lowest Mg concentration. There were no significant differences in P, Ca,Fe and no definite trends were found in Mn, Cu, Zn and B concentrations among all treatments. Whereas in fruit maturing stage, "irrigated+ no urea "had the lowest N concentration, "nonirrigated+ 0.26kg" and "nonirrigated+ 0.62kg" had lower Ca concentration, "irrigated no urea" had the lowest Fe concentration "nonirrigated+ no urea" and "nonirrigated+ 0.26kg" gave lower Mn concentration. No significant difference were found in P, K, Cu, Zn, B concentrations among all treatments. The fruit maturing stage as comparing with the full bloom stage had lower N, P, K, Ca concentrations in all treatments.

Key words: mango, nitrogen, irrigate, yield, fruit quality, mineral elements concentration.