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藥劑對柑橘粉介殼蟲 (*Planococcus citri* (Risso)) 及其天敵蒙氏瓢蟲 (*Cryptolaemus montrouzieri* Mulsant) 各生長期之毒性

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摘　　要

爲瞭解藥劑對害蟲及天敵之影響，選擇在番石榴園常用之藥劑，在室內利用噴藥塔 (Potter's tower)，以推薦濃度噴佈柑橘粉介殼蟲及其天敵蒙氏瓢蟲各生長期，結果顯示，Actellic、Anthio、Azodrin、Dimethoate、Diazinon、Lebaycid、Gusathion、Malathion、Parathion、Sumithion 等十種藥劑，對粉介殼蟲一及二齡若蟲之殺蟲率達96%，然對老齡若蟲之殺蟲率則稍差；而對卵之殺卵率僅爲 30.5%以下。對成蟲之殺蟲率，除Malathion、Diazinon.、Gusathion外，其餘藥劑殺蟲率均在95%以上。另以供試十二種殺蟲劑分別測試對蒙氏瓢蟲一～二齡幼蟲之毒殺率，亦達 98%以上；唯 Actellic、Dursban、Sumithion，對三～四齡幼蟲之毒殺率在 8.6 與 29.3%之間。而多數藥劑對蛹之毒效又較三～四齡幼蟲爲低 (2.8～37.4%)。供試藥劑對瓢蟲成蟲之毒殺率均高達96%以上，唯 Dursban 和 Sumithion 之毒殺率較低，即分別爲 15 及 50%；藥劑對卵之毒殺率除 Gusathion 及 Supracide 稍高外，餘者毒殺率僅爲 6.1～49.3%。

（關鍵字：番石榴、柑橘粉介殼蟲、蒙氏瓢蟲、藥劑毒性。）

ABSTRACT

Hwang, J. S., F. K. Hsieh and I. S. Wu. (1986) The Toxicity of Insecticides to the Various Life Stages of the Citrus Mealybug (*Planococcus citri* (Risso)) and its Predator, *Cryptolaemus montrouzieri* Mulsant Plant Prot. Bull. (Taiwan, R.O.C.) 28 : 155～161 (Pesticide Formulation Department, Taiwan Agricultural Chemicals and Toxic Substances Research Institute, Taichung, Taiwan 41301, R.O.C.)

This experiment was conducted to study the insecticidal toxicity to both the prey and the predator in Potter's tower apparatus by spraying the various stages of the citrus mealybug (*P. citri*) and its predacious coccinellid, *C. montrouzieri* with recommended concentration of the insecticides commonly used

in guava orchard.

Efficacy test on the mealybug indicated that the timing of application of the chemicals was extremely important. Ten insecticides tested showed above 96% mortality against the 1st and 2nd nymphal stages. Except gusathion and malathion, the others also showed above 95% mortality against the 3rd nymphal stage. While Percentage of mortality were decreased to 59.6～90% with gusathion, malathion, parathion, diazinon when applied against the adult stage. Percentage of mortality on egg was the least (1.7～30.5%) among all tested life stages of the mealybug.

Twelve insecticides tested were also demonstrated above 98% mortality against the 1st and 2nd instars of the predacious coccinellid. Mortality were decreased to only 9～29% with actellic, dursban, or sumithion when appled against the 3rd and 4th instars. Except azodrin, most insecticides tested were found to be less toxic to the pupal stage (2.8～37.4%) than the 3rd and 4th instar, but the adults of ladybeetle were highly susceptible to the insecticides. The toxicity of insecticides to the egg stage was found to be relatively less toxic.

(Key words: guava, citrus mealybug, *Planococcus citri*, ladybeetle, *Cryptolaemus montrouzieri*, insecticidal toxicity)

前　　言

柑橘粉介殼蟲(*Planococcus citri*(Risso))爲分佈全球重要害蟲之一，在本省可加害柑橘、番石榴、檬果、梨、釋迦等多種經濟果樹[2]。每年秋、冬、春三季時值番石榴盛產期，柑橘粉介殼蟲於番石榴園內大量滋生繁衍，其成蟲及若蟲皆性喜群集寄生於葉背、枝條葉腋及果實等部位，吸食汙液，並分泌蜜露而誘發煤病，致使被害枝葉生長不良、果味變酸，影響果產與品質；嚴重發生時，植株生長勢減弱，導致果園廢耕[2,3,4]。蒙氏瓢蟲(*Cryptolaemus montrouzieri*（Mulsant）），爲捕食粉介殼蟲的重要天敵，國內外有多篇文獻對於引進（introduction)，定期釋放（periodic release)，及適時保育（proper manipulation）蒙氏瓢蟲以進行生物防治，或利用本天敵與化學藥劑配合綜合防治粉介殼蟲，達到部分或完全成功的範例[5,6,7,8,9,10,11]。

近年來害蟲之防治多偏重化學藥劑的使用，但藥劑對害蟲及天敵之毒性差異常未能充份瞭解，致選用藥劑不當或施藥時機不對，不僅未能有效防治害蟲，甚且因毒害天敵，造成自然生態變異，導致害蟲更加猖獗發生。因此，爲瞭解目前政府推薦及農民慣用於番石榴園之農藥對粉介殼蟲及其捕食性瓢蟲之毒性，進行本項研究，希冀所得結果成爲粉介殼蟲防治時，選用藥劑及適期施藥之參考，並能配合未來天敵保護、釋放或與耕作法之運用，達到較佳防治效果。

材 料 與 方 法

㈠供試藥劑：本試驗所使用藥劑種類及濃度列於表一。

㈡供試昆蟲：

1.柑橘粉介殼蟲：試驗之柑橘粉介殼蟲採自社頭番石榴園，以盆栽番石榴（梨仔拔品種）養殖於網室內（溫度 20～28°C）作爲試驗之原始種源（stock colony）。

2.蒙氏瓢蟲：蒙氏瓢蟲係採自本試驗所農場之番石榴園。以南瓜大量繁殖之粉介殼蟲，爲瓢蟲之飼料，並置於 20～28°C 實驗室內飼育，作爲藥劑試驗之蟲源。

表 一、供試藥劑種類

Table 1. Insecticides tested

Insecticide[1)]	A.I. (%)	Dilution rate (X)	Manufactory
Actellic E.C. (Pirimiphos-methyl)	26.3	500	Imperial Chemical Industries Ltd.
Anthio E.C. (Formothion)	33	500	Sandoz Ltd.
Azodrin S. (Monocrotophos)	55	1000	Shing Nung Chemical Co., Ltd.
Diazinon E.C.	60	1500	Shing Nung Chemical Co., Ltd.
Dimethoate E.C.	44	1000	Tarsis Agricultural & Industrial Chemical Co., Ltd.
Dursban E.C. (Chlorpyrifos)	40.8	1000	Hui Kwang Chemical Co., Ltd.
Lebaycid E.C. (Fenthion)	50	1000	Shing Nung Chemical Co., Ltd.
Folimat S. (Omethoate)	50	1000	Shing Nung Chemical Co., Ltd.
Gusathion E.C. (Azinphos-methyl)	20	500	Shing Nung Chemical Co., Ltd.
Malathion E.C.	50	500	Min Hong Chemical Co., Ltd.
Parathion E.C.	47	1000	Her Nung Chemical Co., Ltd.
Sumithion E.C. (Fenitrothion)	50	1000	Ruey Hong Chemical Co., Ltd.
Supracide E.C. (Methidathion)	40	1000	Jia Nung Chemical Co., Ltd.

1) Words in parentheses were common names of tested insecticides.

㈢**試驗方法：**

1.藥劑對柑橘粉介殼蟲各生長期之藥效試驗

自原始種源中，以細毛筆挑取供試蟲體（分別爲一日齡卵，一、二、三齡若蟲及成蟲各約20隻）置於培養皿中新鮮番石榴葉上，靜置一夜後，挑除不健康者並補足蟲數爲20隻。即以噴藥塔(Potter's tower)噴灑處理藥液 4 cc，供試藥劑之種類及濃度如表二，每藥劑處理重覆五次，並設一噴水之對照組。經處理後之粉介殼蟲置於抽氣櫃（hood）中陰乾，並置於 25°C 之室溫中，每日觀察、記錄存活蟲隻或孵化幼蟲數，並以 Mount *et. al* (1976)[12] 之公式計算其防治率，防治率經 arc sin $\sqrt{x}$ 轉換後，再以鄧肯氏（Duncan's）多變域測驗法分析其顯著性。

2.藥劑對蒙氏瓢蟲各生長期之毒效試驗

首先準備附有粉介殼蟲卵塊之新鮮番石榴葉片，再自供試蟲源中，分別挑取一日齡卵，一～二齡、三～四齡幼蟲，三～五日齡蛹，及二週齡成蟲各10隻，接於該葉片上。並依粉介殼蟲之方法以噴藥塔處理，供試藥劑之種類及濃度如表三，每藥劑處理重覆10次，並設一噴水對照組。處理後觀察、記錄、統計分析之方法概與粉介殼蟲時相同。

結 果 與 討 論

1.藥劑對柑橘粉介殼蟲各生長期之藥效

十種供試殺蟲劑對粉介殼蟲卵，各齡期若

蟲、成蟲之藥效測定結果如表二。資料顯示十種藥劑對粉介殼蟲初齡及二齡若蟲之殺蟲率均達 96～100%，防治效果甚優；對三齡若蟲之殺蟲率，除 Gusathion 及 Malathion 較低（87～88%）外，其餘藥劑之藥效仍達95%以上。對成蟲之殺蟲率，供試多數藥劑 Actellic、Anthio、Azodrin、Dimethoate、Lebaycic、Sumithion 等之殺蟲率仍爲 95～100%；其餘藥劑 Diazinon、Gusathion、Malathion、Parathion 等之殺蟲率則降至 59.6～90% 之間。一般而言，供試藥劑對齡期較高之粉介殼蟲，其殺蟲效果有降低之趨勢，推測其原因與老齡蟲體型較大且被覆較多的蠟粉，致藥液不易滲透有關。十種供試藥劑之殺卵率僅爲 1.7～30.5%，藥效甚差（表二）；但以藥劑對卵之毒效及對初孵化若蟲之殘效來評估藥效，則除 Malathion 及 Parathion 處理組之殺蟲率較差，分別爲 26 及 74.7%外，其餘藥劑之殺蟲效果可達 91.3～100%（表四）。從此亦知，爲了有效防治粉介殼蟲，應針對其幼齡若蟲期施藥爲宜，若須防治產卵期之成蟲時，則按生活史資料推斷，以每 10～14 日之間隔連續施藥二次爲宜[3,4]。

表 二、藥劑對柑橘粉介殼蟲各生長期之藥效

Table 2. Effectiveness of insecticides against various life stages of the citrus mealybug (*Planococcus citri*)[1]

Insecticide Dilution rate (fold)	% Mortaliy[2]				
	Egg	1st instar	2nd instar	3rd instar	Adult(♀)
Actellic 500X	1.7^{bc}	100.0^{a}	100.0^{a}	98.0^{ab}	95.0^{a}
Anthio 500X	30.5^{ab}	98.9^{a}	100.0^{a}	99.0^{a}	100.0^{a}
Azodrin 1000X	0.9^{bc}	98.9^{a}	99.0^{a}	98.0^{ab}	98.0^{a}
Diazinon 1500X	3.4^{abc}	100.0^{a}	95.8^{b}	96.0^{ab}	81.8^{b}
Dimethoate 1000X	25.5^{a}	100.0^{a}	100.0^{a}	100.0^{a}	100.0^{a}
Lebaycid 1000X	6.9^{abc}	100.0^{a}	100.0^{a}	99.0^{a}	98.0^{a}
Gusathion 500X	29.2^{a}	100.0^{a}	100.0^{a}	87.9^{bc}	59.6^{c}
Malathion 500X	4.0^{bc}	100.0^{a}	100.0^{a}	87.0^{c}	83.0^{b}
Parathion 1000X	1.8^{bc}	100.0^{a}	100.0^{a}	95.0^{ab}	90.0^{ab}
Sumithion 1000X	7.8^{abc}	99.0^{a}	100.0^{a}	97.0^{ab}	95.1^{a}
CK (water)	0.0^{c}	0.0^{b}	0.0^{c}	0.0^{d}	0.0^{d}

1) All sprays were applied once by Potter's tower apparatus and evaluations for control were made 3 days or 10 days (for eggs) after treatment on an average of 5 replicates.

2) Data were transformed (arc sine $\sqrt{x}$) before analysis. Means in each column followed by the same letter are not significantly different ($P<0.05$, DMRT)

2.藥劑對蒙氏瓢蟲各生長期之毒效

十二種供試藥劑對蒙氏瓢蟲卵，一～二齡、三～四齡幼蟲，蛹及成蟲之毒效測定結果如表三。資料顯示，十二種供試藥劑之推薦濃度對一～二齡幼蟲之毒殺率均達 98.9～100%，對瓢蟲若齡幼蟲之毒性甚強。多數藥劑對齡期

較高之三～四齡幼蟲之毒殺率仍高達 68.3～100%，惟部分藥劑如：Actellic、Dursban、Sumithion 對三～四齡幼蟲之毒殺率僅及 8.6～29.3%；而十二種供試藥劑（Azodrin 除外），對蛹之毒效又較三～四齡幼蟲爲低（2.8～37.4%）。供試藥劑對成蟲之毒殺力均高達96～100%，僅 Dursban 和 Sumithion 較低，毒殺率分別爲15及50%。藥劑對卵之毒殺率，除 Gusathion 與 Supracide 稍高，分別爲77.7%及54.5%外，其餘藥劑對卵之毒殺率僅爲 6.1～49.3%；若以藥劑對卵之毒效及對初孵化幼蟲之殘效評估，則除 Actellic, Anthio 及 Dimethoate 仍低爲13.7～35.5%外，其餘藥劑之殺卵率可達53.4～91.8%（表四）。因此，於田間施藥防治粉介殼蟲時，可選用對天敵較低毒之藥劑，或選擇天敵之卵期，蛹期或老齡幼蟲期作適時施藥，應可減低藥劑對天敵的毒害，如此，能夠有效防治害蟲外，亦可避免農藥對天敵造成不良影響，而達到生態選擇性（ecological selectivity）施藥之目的。

表 三、藥劑對蒙氏瓢蟲各生長期之毒效

Table 3. Toxicity of insecticides to the ladybeetle, *Cryptolaemus montrouzieri* in the laboratory.[1)]

Insecticide Dilution rate (fold)	% Mortality[2)]				
	Egg	1st & 2nd instar	3rd & 4th instar	Pupa	Adult
Actellic 500X	13.4^{de}	100.0^{a}	29.3^{d}	2.8^{ef}	96.0^{a}
Anthio 500X	6.1^{e}	100.0^{a}	87.5^{b}	4.6^{def}	100.0^{a}
Azodrin 1000X	44.3^{bc}	100.0^{a}	100.0^{a}	99.0^{a}	100.0^{a}
Dimethoate 1000X	11.1^{de}	100.0^{a}	94.5^{ab}	16.0^{cde}	100.0^{a}
Dursban 1000X	27.8^{cd}	97.9^{b}	18.4^{de}	3.0^{def}	15.0^{c}
Lebaycid 1000X	42.7^{bc}	100.0^{a}	68.3^{c}	3.1^{def}	100.0^{a}
Folimate 1000X	9.8^{e}	100.0^{a}	100.0^{a}	27.9^{bc}	100.0^{a}
Gusathion 500X	77.7^{a}	100.0^{a}	100.0^{a}	37·4^{b}	100.0^{a}
Malathion 500X	25.8^{cd}	100.0^{a}	100.0^{a}	27.0^{bc}	100.0^{a}
Parathion 1000X	49.3^{bc}	100.0^{a}	73.1^{c}	8.3^{def}	100.0^{a}
Sumithion 1000X	10.7^{de}	98.9^{ab}	8.6^{ef}	3.0^{def}	50.0^{b}
Supracide 1000X	54.5^{b}	100.0^{a}	89.5^{b}	17.7^{cd}	100.0^{a}
CK (water)	0.0^{e}	0.0^{c}	0.0^{f}	0.0^{f}	0.0^{d}

1) All sprays were applied once by Potter's tower apparatus and evaluations for control were made 7 days or 10 days (for eggs) after treatment on an average of 10 replicates.

2) The same as table 2.

表 四、藥劑對柑橘粉介殼蟲及蒙氏瓢蟲卵之殘效性

Table 4. Residual effects of insecticides on eggs of the citrus mealybug (*Planococcus citri*) and its predator, (*Cryptolaemus montrouzieri*)[1)]

Insecticide Dilution rate (fold)	% Mortality[2,3)]	
	Egg of *P. citri*	Egg of *C. montrouzieri*
Actellic 500X	100 [a]	32.9[d]
Anthio 500X	92.5[a]	13.7[e]
Azodrin 1000X	99.0[a]	69.8[bc]
Diazinon 1500X	96.2[a]	—
Dimethoate 1000X	95.9[a]	35.5[d]
Dursban 1000X	—	66.7[bc]
Lebaycid 1000X	96.9[a]	75.8[b]
Folimat 1000X	—	49.8[cd]
Gusathion 500X	97.4[a]	91.8[a]
Malathion 500X	26.0b	78.6[ab]
Parathion 1000X	74.7[a]	71.8[b]
Sumithion 1000X	91.3[a]	53.4[d]
Supracide 1000X	—	85.5[a]
CK (water)	0.0[b]	0.0[f]

1) All sprays were applied once by Potter's tower apparatus and evaluations for control were made 10 days after treatment on an average of 5 or 10 (for *C. montrouzieri*) replicates.

2) Percentages of control included total mortalities of eggs and newly-hatched first instars.

3) The same as table 2.

目前本省推薦於番石榴及柑橘上防治粉介殼蟲之藥劑，包括有 Gusathion、Tokuthion、Folimat、Methidathion、Malathion、Dimethoate、Formothion 等七種藥劑[1)]，惟果農實際購用藥劑時，端視藥劑價格，藥商之建議或果農自身之經驗而定，甚少依照政府推薦之藥劑及方法使用。綜觀試驗結果，大多數供試藥劑對粉介殼蟲各生長期（除卵期外）均有良好的毒效，僅 Diazinon、Gusathion、Malathion、Parathion 等藥劑對老齡若蟲及成蟲之藥效較差。就藥劑對蒙氏瓢蟲的毒效而言，大多數供試藥劑對其蛹期或卵期之毒性較其他蟲期爲低，而 Azodrin、Gusathion、Supracide 等藥劑對瓢蟲之毒性則頗高，故若兼顧藥劑對粉介殼之高藥效及對瓢蟲之低毒性，則Actellic、Anthio、Dimethoate、Lebaycid 及 Sumithion 不失爲較理想之藥劑。此外，番石榴栽培面積在本省中部爲最大，有專業區

之規模，其病蟲害相較單純，如能嘗試利用粉介殼蟲性費洛蒙偵測害蟲發生，定期釋放蒙氏瓢蟲，並配合選用對害蟲有效而對天敵低毒之藥劑，重點適期施藥，再與耕作剪枝其他方法聯合運用，或可達成較安全、經濟、有效地綜合防治番石榴上之粉介殼蟲，以確保環境生態之品質。

謝　　辭

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