

評估水楊酸甲酯對捕食性天敵的誘引效果

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摘要

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本試驗於 2015–2016 年間，以黃色黏板搭配不同濃度的水楊酸甲酯，於行政院農業委員會農業試驗所果園區進行調查可誘捕到的捕食性天敵種類。試驗結果顯示，水楊酸甲酯處理組較對照組顯著誘引瓢蟲科 (Coccinellidae, 99、10 及 0.1% 水楊酸甲酯處理組全年調查)、草蛉科 (Chrysopidae, 10、1 及 0.1% 水楊酸甲酯處理組全年調查)、食蚜蠅科 (Syrphidae, 99、0.1 及 0.01% 水楊酸甲酯處理組夏季調查)、花蝽科 (Anthocoridae, 所有水楊酸甲酯處理組全年調查)、盲蝽科 (Miridae, 99、10、0.1 及 0.01% 水楊酸甲酯處理組全年調查) 及隱翅蟲科 (Staphylinidae, 99% 水楊酸甲酯處理組春季調查) 捕食性天敵。但水楊酸甲酯對捕食性天敵的誘引效果，取決於施用濃度，而且捕食性天敵對水楊酸甲酯的反應存在季節差異性。

關鍵詞：水楊酸甲酯、捕食性天敵、生物防治。

前言

水楊酸甲酯 (methyl salicylate) 又名冬青油 (wintergreen oil) 是一種酚類化合物 (phenolic compound)，前人研究中水楊酸甲酯參與植物防禦反應以對抗病原及植食昆蟲。水楊酸甲酯經由水楊酸合成路徑活化後，液態水楊酸甲酯累積於植物體內，隨後高濃度的氣態水楊酸甲酯釋放於空氣中 (Shulaev *et al.* 1997; Kessler & Baldwin 2001, 2002; Park *et al.* 2007; Vlot *et al.* 2008)。

目前已知至少 10 種以上作物受害蟲/蟎危害時會釋放水楊酸甲酯，其中包括：菜豆受二點葉蟎 (*Tetranychus urticae* Koach) 危害 (Dicke *et al.* 1990)、番茄受二點葉蟎危害 (Dicke *et al.* 1998)、苦瓜受二點葉蟎危害 (Agrawal *et al.* 2002)、甘藍遭受紋白蝶 (*Pieris* spp.) 危害 (Geervliet *et al.* 1997)、梨遭受木蝨科 (Psyllidae) 害蟲危害 (Scutareanu *et al.* 1997)、啤酒花遭受指頭蚜 (*Phorodon humuli* Schrank) 危害 (Campbell

et al. 1993)、稠李 (bird cherry) 遭受禾谷麥蚜危害 (Glinwood & Pettersson 2000; Ninkovic *et al.* 2003)、馬鈴薯遭受科羅拉多金花蟲 (*Leptinotarsa decemlineata* Say) 危害 (Bolter *et al.* 1997)、菸草 (*Nicotiana attenuate*) 遭受鱗翅目害蟲及葉蚤危害 (Kessler & Baldwin 2001) 及 *Lotus japonicas* 遭受二點葉蟎危害 (Ozawa *et al.* 2000)。因此水楊酸甲酯被稱為蟲害誘導揮發性成分。

前人研究中水楊酸甲酯可吸引多種天敵，James (2003a, 2003b, 2005, 2006) 以黃色黏板搭配水楊酸甲酯於啤酒花田及葡萄田證實顯著誘捕食蚜蠅 (hover flies)、大眼長蝽 (*Geocoris pallens* Stal)、食蟎瓢蟲 (*Stethorus punctum picipes* Casey)、綠草蛉 (*Chrysopa nigricornis* Burmeister 及 *Chrysopa oculata* Say)、小黑花椿象 (*Orius tricolor* White)。Lee (2010) 以白色黏板搭配水楊酸甲酯於草莓田顯著誘捕草蛉 (Chrysopidae) 及小黑花椿象。James & Price (2004) 於葡萄田以黃色黏板搭配水楊酸甲酯顯著誘捕綠草蛉 (*C. nigricornis*)、褐草蛉 (*Hemerobius* sp.)、盲蝽 (*Der-*

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aeocoris brevis Uhler)、食蟻瓢蟲及小黑花椿象等 5 種捕食性天敵。James & Grasswitz (2005) 於葡萄田以黃色黏板搭配水楊酸甲酯顯著誘捕跳小蜂科 (Encyrtidae) 寄生蜂 *Metaphycus* sp. 及繆小蜂科 (Mymaridae) 寄生蜂 *Anagrus* spp.。Rodriguez-Saona *et al.* (2011) 於蔓越莓田以黃色黏板搭配水楊酸甲酯證實可顯著誘捕食蚜蠅科 (Syrphidae)、瓢蟲科 (Coccinellidae) 及草蛉科 (Chrysopidae) 等捕食性天敵。Zhu & Park (2005) 於大豆田以黃色黏板搭配水楊酸甲酯顯著誘引七星瓢蟲 (*Coccinella septempunctata* L.)。除此之外, Shimoda *et al.* (2002) 發現萊豆 (lima bean) 葉片經水楊酸甲酯處理顯著誘引高橋食蟻薊馬 (*Scolothrips takahashii* Priesner)。De Boer & Dicke (2004) 於 Y 型管試驗中證實智利捕植蟻 (*Phytoseiulus persimilis* Athias-Henriot) 顯著受水楊酸甲酯誘引。

除吸引害蟲天敵外, 在有機大豆田 Mallinger *et al.* (2011) 證實施用水楊酸甲酯吸引食蚜蠅及草蛉並降低大豆蚜族群。Gadino *et al.* (2012) 在葡萄園懸掛低密度 (260 lures ha⁻¹) 水楊酸甲酯顯著降低田間薊馬族群。Woods *et al.* (2011) 在啤酒花田施用水楊酸甲酯顯著誘引食蟻瓢蟲並較對照區降低 40–91% 二點葉蟻數量。上述結果顯示, 應用水楊酸甲酯增強害蟲/蟻生物防治的潛力。

農產品的農藥殘留問題, 一直是消費者在意的食安問題, 因此傳統施用農藥防治害蟲的替代方式成為研究方向。生物防治本自然發生, 利用天敵防治害蟲是一種安全、有效及永續的防治方法 (Peñaflor & Bento 2013)。但生物防治常面臨害蟲族群數量高而天敵數量少, 達不到壓制害蟲族群效果。如何於害蟲初來臨時, 便能吸引天敵前來, 是田間生物防治成功的關鍵 (Stenberg *et al.* 2015)。水楊酸甲酯作為一種廣效可誘引多種害蟲天敵的蟲害誘導揮發性成分, 並且有應用於田間壓制害蟲族群的實例, 具有應用於田間的潛力。惟國內目前並無詳盡的水楊酸甲酯吸引天敵研究。因此, 本研究於農業試驗所果樹區以黃色黏板搭配不同濃度水楊酸甲酯, 於 2015–2016 年調查所能誘捕到的捕食性天敵的種類, 並探討不同季節間的差異。藉

由此項研究我們期望能明瞭水楊酸甲酯於田間吸引捕食性天敵的效果及未來發展利用水楊酸甲酯增強害蟲生物防治的潛力。

材料與方法

本試驗所使用的水楊酸甲酯 (99%) 及無水酒精 (ethanol), 均購買自台灣默克股份有限公司 (台灣台北市)。透明玻璃瓶 (1.9 cm × 6 cm) 購自 Kimble 公司 (Vineland, NJ, USA), 黃色黏板 (37 cm × 19 cm) 及單螺線 (直徑 0.1 cm) 均購買自振詠興業公司 (台灣台中市)。

本試驗所使用的水楊酸甲酯釋器具為參考 James (2003b) 的方法, 將透明玻璃瓶內分別裝入 99、10、1、0.1、0.01% 水楊酸甲酯 (以無水酒精調製)、無水酒精 (以下稱 Ethanol 處理組) 及維持空白不添加任何東西 (以下稱 Blank 處理組)。玻璃瓶上方瓶蓋正中央有一直徑 0.3 cm 圓孔讓水楊酸甲酯氣味自然散出。整個玻璃瓶以黑色膠帶包覆, 以避免陽光照射造成的影響。

水楊酸甲酯搭配黃色黏板的方法參照 Dong & Hwang (2016), 將水楊酸甲酯釋放器以單螺線綁定後, 單螺線穿過黃色黏板上方的開孔, 並將水楊酸甲酯釋放器附於黃色黏板上後, 整個含釋放器的黃色黏板懸掛於田間用於捕食性天敵的調查。

捕食性天敵的調查為將含釋放器 (內含 99、10、1、0.1、0.01% 水楊酸甲酯、Ethanol 或 Blank) 的黃色黏板懸掛於農業試驗所試驗果樹區 (24°01'44.6"N, 120°41'41.7"E), 果樹區面積約為 10 ha, 主要種植果樹分別為芒果、桃、梨、李等, 果樹區採人工除草但視病蟲害程度不定期噴施藥劑 (殺菌劑, 試驗期間未有大發生蟲害故無噴施殺蟲劑情事)。含釋放器黃色黏板直接懸掛於作物枝條上或是懸掛於支撐架上 (Dong & Hwang 2016), 各黃色黏板間隔至少 25 m。於 2015–2016 年間進行調查, 每隔 2 wk 更換 1 次黃色黏板及釋放器, 並於試驗室內檢視記錄黃色黏板捕獲的捕食性天敵種類 (鑑定至科) 及數量, 每處理 20 重複。調查資料除全年統計外, 另依春夏秋冬四季 (Shin 2011) 分別統計調查資料。

試驗所得各項資料先以 SAS-EG (Version

7.1, 2014) 統計分析軟體，進行變方分析 (analysis of variance; ANOVA) 後，再以最小顯著差異性測驗 (least significant difference test; LSD test) 分析其差異顯著性。水楊酸甲酯處理組所得資料經分析後，同時與 Ethanol 及 Blank 有顯著差異，方視為與對照組有顯著差異。

結果

所有水楊酸甲酯處理組於 2015–2016 年調查中，顯著較對照組誘捕更多的捕食性天敵，

其中以 0.1% 水楊酸甲酯處理組數量最高。於個別季節中，水楊酸甲酯處理組於夏季及冬季顯著較對照組誘捕更多的捕食性天敵，於秋季僅 0.1% 水楊酸甲酯處理組較對照組顯著誘捕更多的捕食性天敵。在濃度方面，0.1% 水楊酸甲酯於全年及個別季節中，均較對照組誘捕更多的捕食性天敵效果最好 (表 1)。本試驗中以水楊酸甲酯搭配黃色黏板進行捕食性天敵的調查，發現此資材對花蝽科捕食性天敵的誘捕效果最佳 (所有水楊酸處理組，2015–2016 全年度對花蝽科捕食性天敵誘引效果顯著高於對照組，表 2)，

表 1. 2015–2016 年不同濃度之水楊酸甲酯於果園中誘引捕食性天敵之效果。

Table 1. The effectiveness [means (\pm SE)] of methyl salicylate (MeSA) at different concentrations on attracting predators in fruit orchards in 2015–2016^z.

Treatment	Mean number of predators (\pm SE)				
	2015–2016				
	Full year	Spring	Summer	Autumn	Winter
99% MeSA	826.2 (24.5) b	278.8 (18.8) a	267.8 (9.3) bc	136.6 (9.1) b	143.0 (9.8) bc
10% MeSA	840.6 (24.0) b	267.8 (20.9) a	274.2 (5.7) b	142.4 (11.6) b	156.2 (9.0) b
1% MeSA	791.4 (27.2) b	238.8 (26.4) a	241.8 (11.4) cd	154.2 (6.3) b	156.6 (7.8) b
0.1% MeSA	950.4 (13.3) a	254.0 (23.5) a	317.4 (12.9) a	193.6 (11.2) a	185.4 (11.1) a
0.01% MeSA	810.2 (22.1) b	249.4 (25.7) a	266.2 (11.9) bc	143.0 (14.8) b	151.6 (5.3) b
Ethanol	644.8 (18.8) d	169.4 (16.2) b	212.8 (5.5) de	140.6 (10.4) b	122.0 (11.2) c
Blank	715.6 (34.1) c	222.6 (16.8) ab	211.6 (13.9) e	161.4 (11.8) b	120.0 (3.3) c

^z Experiments conducted in an orchard at Taiwan Agricultural Research Institute. For each natural enemy, means followed by the same letter are not significantly different at $P < 0.05$ (Fisher's protected LSD test). Spring: February–April; Summer: May–July; Autumn: August–October; and Winter: November–January.

表 2. 2015–2016 年不同濃度之水楊酸甲酯於果園中誘引花蝽科天敵之效果。

Table 2. The effectiveness [means (\pm SE)] of methyl salicylate (MeSA) at different concentrations on attracting Anthocoridae in fruit orchards in 2015–2016^z.

Treatment	Mean number of Anthocoridae (\pm SE)				
	2015–2016				
	Full year	Spring	Summer	Autumn	Winter
99% MeSA	98.6 (4.7) b	12.4 (1.9) ab	63.4 (1.9) b	14.4 (1.3) bc	8.4 (1.1) bc
10% MeSA	103.4 (6.1) b	9.8 (1.5) bc	68.2 (2.0) b	17.8 (2.5) ab	7.6 (0.3) bc
1% MeSA	85.4 (7.4) c	3.6 (1.0) d	61.0 (5.6) b	14.6 (1.9) bc	6.2 (0.7) c
0.1% MeSA	145.6 (2.5) a	13.8 (1.8) a	91.0 (3.2) a	23.8 (1.2) a	17.0 (1.2) a
0.01% MeSA	101.8 (6.2) b	5.0 (0.3) c	70.6 (4.7) b	16.6 (3.0) bc	9.6 (1.5) b
Ethanol	63.6 (3.3) d	2.8 (0.7) d	35.8 (3.4) c	18.8 (3.8) ab	6.2 (1.2) c
Blank	67.2 (2.7) d	3.2 (0.7) d	47.2 (4.6) c	10.4 (2.2) c	6.4 (0.9) bc

^z Experiments conducted in an orchard at Taiwan Agricultural Research Institute. For each column, means followed by the same letter are not significantly different at $P < 0.05$ (Fisher's protected LSD test). Spring: February–April; Summer: May–July; Autumn: August–October; and Winter: November–January.

其次依序為盲蝽科 (表 3)、瓢蟲科 (表 4)、草蛉科 (表 5)、食蚜蠅科 (表 6) 及隱翅蟲科 (表 7)。

10% 水楊酸甲酯處理組及 0.1% 水楊酸甲酯處理組於 2015–2016 年調查中，較對照組顯著誘捕更多的瓢蟲科捕食性天敵。於個別季節中，除 99% 水楊酸甲酯處理組外，其餘水楊酸甲酯處理組於冬季較對照組顯著誘捕更多的瓢蟲科捕食性天敵，其中以 0.1% 水楊酸甲酯效果最好。但在春、夏及秋季中，水楊酸甲酯對瓢蟲科捕食性天敵誘引效果不顯著 (表 4)。

10% 水楊酸甲酯處理組、1% 水楊酸甲酯處

理組及 0.1% 水楊酸甲酯處理組於 2015–2016 年調查中，較對照組顯著誘捕更多的草蛉科捕食性天敵。於個別季節中，所有水楊酸甲酯處理組於夏季較對照組顯著誘捕更多的草蛉科捕食性天敵，其中以 0.1% 水楊酸甲酯效果最好。但在春、秋及冬季中，水楊酸甲酯對草蛉科捕食性天敵誘引效果不顯著 (表 5)。

所有水楊酸甲酯處理組於 2015–2016 年調查中，較對照組並未顯著誘捕更多的食蚜蠅。於個別季節中，99% 水楊酸甲酯處理組、0.1% 水楊酸甲酯處理組及 0.01% 水楊酸甲酯處理組於

表 3. 2015–2016 年不同濃度之水楊酸甲酯於果園中誘引盲蝽科天敵之效果。

Table 3. The effectiveness [means (\pm SE)] of methyl salicylate (MeSA) at different concentrations on attracting Miridae in fruit orchards in 2015–2016².

Treatment	Mean number of Miridae (\pm SE)				
	2015–2016				
	Full year	Spring	Summer	Autumn	Winter
99% MeSA	35.2 (2.4) b	3.8 (0.6) ab	23.8 (1.9) b	6.4 (1.1) bc	1.2 (0.3) cd
10% MeSA	33.0 (1.1) b	3.2 (0.7) bc	20.4 (1.2) b	7.2 (1.0) b	2.2 (0.4) bc
1% MeSA	22.8 (1.4) c	0.6 (0.3) d	14.8 (1.2) c	5.4 (0.7) bc	2.0 (0.6) c
0.1% MeSA	61.6 (3.1) a	4.4 (0.4) a	37.6 (3.4) a	13.8 (0.8) a	5.8 (0.4) a
0.01% MeSA	31.6 (2.5) b	2.2 (0.4) c	21.4 (2.0) b	7.0 (1.3) b	1.0 (0.5) cd
Ethanol	11.2 (1.1) d	0.0 (0.0) d	8.8 (0.6) d	2.4 (0.5) d	0.0 (0.0) d
Blank	19.8 (3.2) c	0.0 (0.0) d	12.2 (2.2) d	4.2 (1.0) cd	3.4 (0.7) b

² Experiments conducted in an orchard at Taiwan Agricultural Research Institute. For each column, means followed by the same letter are not significantly different at $P < 0.05$ (Fisher's protected LSD test). Spring: February–April; Summer: May–July; Autumn: August–October; and Winter: November–January.

表 4. 2015–2016 年不同濃度之水楊酸甲酯於果園中誘引瓢蟲科天敵之效果。

Table 4. The effectiveness [means (\pm SE)] of methyl salicylate (MeSA) at different concentrations on attracting Coccinellidae in fruit orchards in 2015–2016².

Treatment	Mean number of Coccinellidae (\pm SE)				
	2015–2016				
	Full year	Spring	Summer	Autumn	Winter
99% MeSA	609.8 (21.8) abc	238.6 (18.9) a	152.8 (6.8) ab	101.8 (8.9) bc	116.6 (8.4) bc
10% MeSA	621.6 (15.4) ab	237.0 (19.5) a	160.0 (5.1) a	96.2 (9.9) c	128.4 (6.9) ab
1% MeSA	588.0 (30.2) bc	210.0 (27.8) ab	138.8 (9.8) bc	108.0 (7.8) abc	131.2 (7.1) ab
0.1% MeSA	657.6 (10.6) a	221.6 (23.0) a	158.0 (10.9) ab	131.4 (13.7) a	146.6 (10.3) a
0.01% MeSA	597.6 (22.3) abc	224.6 (25.0) a	149.4 (7.1) ab	97.8 (12.8) bc	125.8 (5.3) ab
Ethanol	487.6 (23.2) d	151.2 (16.4) b	142.4 (7.0) abc	95.0 (8.3) c	99.0 (11.4) c
Blank	554.6 (28.8) c	200.0 (16.9) a	127.4 (9.2) c	126.6 (11.5) ab	100.6 (3.0) c

² Experiments conducted in an orchard at Taiwan Agricultural Research Institute. For each natural enemy, means followed by the same letter are not significantly different at $P < 0.05$ (Fisher's protected LSD test). Spring: February–April; Summer: May–July; Autumn: August–October; and Winter: November–January.

表 5. 2015–2016 年不同濃度之水楊酸甲酯於果園中誘引草蛉科天敵之效果。

Table 5. The effectiveness [means (\pm SE)] of methyl salicylate (MeSA) at different concentrations on attracting Chrysopidae in fruit orchards in 2015–2016^z.

Treatment	Mean number of Chrysopidae (\pm SE)				
	2015–2016				
	Full year	Spring	Summer	Autumn	Winter
99% MeSA	4.0 (0.8) ab	1.6 (0.7) a	1.8 (0.3) a	0.6 (0.3) bc	0.0 (0.0) b
10% MeSA	5.2 (1.1) a	0.6 (0.3) ab	2.2 (0.7) a	1.8 (0.6) a	0.6 (0.3) ab
1% MeSA	4.8 (0.7) a	1.2 (0.3) a	1.8 (0.3) a	0.6 (0.3) bc	1.2 (0.3) a
0.1% MeSA	4.2 (0.6) a	0.6 (0.3) ab	3.0 (0.6) a	0.0 (0.0) c	0.6 (0.3) ab
0.01% MeSA	3.6 (0.5) ab	1.2 (0.3) a	1.8 (0.6) a	0.0 (0.0) c	0.6 (0.3) ab
Ethanol	2.4 (0.5) b	0.6 (0.3) ab	0.0 (0.0) b	1.2 (0.6) ab	0.6 (0.3) ab
Blank	0.0 (0.0) c	0.0 (0.0) b	0.0 (0.0) b	0.0 (0.0) c	0.0 (0.0) b

^z Experiments conducted in an orchard at Taiwan Agricultural Research Institute. For each column, means followed by the same letter are not significantly different at $P < 0.05$ (Fisher's protected LSD test). Spring: February–April; Summer: May–July; Autumn: August–October; and Winter: November–January.

表 6. 2015–2016 年不同濃度之水楊酸甲酯於果園中誘引食蚜蠅科天敵之效果。

Table 6. The effectiveness [means (\pm SE)] of different concentrations of methyl salicylate (MeSA) on attracting Syrphidae in fruit orchards in 2015–2016^z.

Treatment	Mean number of Syrphidae (\pm SE)				
	2015–2016				
	Full year	Spring	Summer	Autumn	Winter
99% MeSA	9.8 (0.8) a	2.2 (0.4) ab	4.8 (0.3) a	0.0 (0.0) c	2.8 (0.4) b
10% MeSA	11.8 (1.6) a	2.8 (0.4) ab	2.8 (0.8) bc	1.8 (0.6) a	4.4 (0.8) a
1% MeSA	6.6 (1.5) b	3.6 (1.3) a	1.2 (0.6) d	0.0 (0.0) c	1.8 (0.3) bc
0.1% MeSA	7.4 (0.4) ab	1.2 (0.3) b	3.0 (0.3) ab	0.6 (0.3) bc	2.6 (0.6) b
0.01% MeSA	11.0 (1.2) a	3.6 (0.9) a	4.0 (0.6) a	1.2 (0.6) ab	2.2 (0.4) b
Ethanol	7.6 (0.9) ab	1.6 (0.7) b	1.8 (0.6) cd	0.0 (0.0) c	4.2 (0.2) a
Blank	5.2 (0.4) b	2.8 (0.7) ab	0.6 (0.3) d	1.2 (0.6) ab	0.6 (0.3) c

^z Experiment conducted in an orchard at Taiwan Agricultural Research Institute. For each column, means followed by the same letter are not significantly different at $P < 0.05$ (Fisher's protected LSD test). Spring: February–April; Summer: May–July; Autumn: August–October; and Winter: November–January.

夏季較對照組顯著誘捕更多的食蚜蠅，以 99% 水楊酸甲酯效果最好。但在春、秋及冬季中，水楊酸甲酯對食蚜科捕食性天敵誘引效果不顯著 (表 6)。

所有水楊酸甲酯處理組於 2015–2016 年調查中，顯著較對照組誘捕更多的花蝽科捕食性天敵，其中以 0.1% 水楊酸甲酯處理組數量最高。於個別季節中，所有水楊酸甲酯處理組於春季及夏季，顯著較對照組誘捕更多的花蝽科捕食性天敵，其中亦以 0.1% 水楊酸甲酯效果最好。於冬季，僅 0.1% 水楊酸甲酯處理組顯著較對照

組誘捕更多的花蝽科捕食性天敵，但水楊酸甲酯於秋季對花蝽科捕食性天敵誘引效果不顯著 (表 2)。

除 1% 水楊酸甲酯處理組外，其餘水楊酸甲酯處理組於 2015–2016 年調查中，顯著較對照組誘捕更多的盲蝽科捕食性天敵，其中以 0.1% 水楊酸甲酯效果最好。於個別季節中，水楊酸甲酯處理組於春、夏及秋季，顯著較對照組誘捕更多的盲蝽科捕食性天敵，其中以 0.1% 水楊酸甲酯效果最好。於冬季，僅 0.1% 水楊酸甲酯較對照組誘捕更多的盲蝽科捕食性天敵 (表 3)。

表 7. 2015–2016 年不同濃度之水楊酸甲酯於果園中誘引隱翅蟲科天敵之效果。

Table 7. The effectiveness [means (\pm SE)] of different concentrations of methyl salicylate (MeSA) on attracting Staphylinidae in fruit orchards in 2015–2016².

Treatment	Mean number of Staphylinidae (\pm SE)				
	2015–2016				
	Full year	Spring	Summer	Autumn	Winter
99% MeSA	68.8 (1.8) b	20.2 (0.4) a	21.2 (1.1) a	13.4 (0.4) d	14.0 (1.2) a
10% MeSA	65.6 (3.8) b	14.4 (1.1) cd	20.6 (0.9) a	17.6 (2.3) cd	13.0 (1.1) a
1% MeSA	83.8 (5.1) a	19.8 (1.9) ab	24.2 (2.7) a	25.6 (2.0) a	14.2 (0.7) a
0.1% MeSA	74.0 (6.3) ab	12.4 (0.9) d	24.8 (1.7) a	24.0 (4.3) abc	12.8 (1.8) a
0.01% MeSA	64.6 (2.7) b	12.8 (1.3) d	19.0 (1.8) a	20.4 (1.9) abc	12.4 (0.7) a
Ethanol	72.4 (4.8) ab	13.2 (1.0) d	24.0 (3.4) a	23.2 (1.9) ab	12.0 (1.2) ab
Blank	68.8 (2.7) b	16.6 (1.3) bc	24.2 (1.8) a	19.0 (1.8) bcd	9.0 (1.2) b

² Experiments conducted in an orchard at Taiwan Agricultural Research Institute. For each column, means followed by the same letter are not significantly different at $P < 0.05$ (Fisher's protected LSD test). Spring: February–April; Summer: May–July; Autumn: August–October; and Winter: November–January.

所有水楊酸甲酯處理組於 2015–2016 年調查中，所誘捕隱翅蟲科捕食性天敵數量與對照組間無顯著差異。於個別季節中，僅 99% 水楊酸甲酯處理組於春季顯著較對照組誘捕更多的隱翅蟲科捕食性天敵，水楊酸甲酯於夏、秋及冬季，對隱翅蟲科捕食性天敵誘引效果不顯著 (表 7)。

討論

水楊酸甲酯於前人研究中證實，多種捕食性天敵包括瓢蟲、草蛉、花椿象、盲蝽、大眼長蝽、食蚜蠅及捕植蟻等，會受水楊酸甲酯誘引 (Drukker *et al.* 2000; James 2003b; James & Price 2004; James 2005; Zhu & Park 2005; James 2006; Woods *et al.* 2011; Gadino *et al.* 2012)。本試驗 2015–2016 年調查結果，亦證實所有水楊酸甲酯處理組於全年度顯著較對照組捕獲更多的捕食性天敵。依全年度及個別季節調查資料來看，水楊酸甲酯對花椿科捕食性天敵的誘捕效果最好，其次依序為盲蝽科、瓢蟲科、草蛉科、食蚜蠅科及隱翅蟲科。而濃度方面，則以 0.1% 水楊酸甲酯最佳 (除對草蛉、食蚜蠅及隱翅蟲)，顯示水楊酸甲酯亦有應用於台灣的農業環境誘引捕食性天敵的潛力。

本試驗結果不同濃度水楊酸甲酯處理對不

同捕食性天敵誘引效果存在差異性外，水楊酸甲酯對捕食性天敵的誘引效果，於濃度間並未成比例增加或減少。Zhu & Park (2005) 研究水楊酸甲酯對七星瓢蟲的誘引效果，結果七星瓢蟲受 10、100 及 300 mg 水楊酸甲酯誘引的效果，顯著高於 30 mg 及 1 g 處理組，亦顯示出並非伴隨水楊酸甲酯施用濃度提高增加對七星瓢蟲的誘引效果。顯示水楊酸甲酯對捕食性天敵誘引效果，取決於使用濃度，因此田間使用水楊酸甲酯時選擇對標的天敵合適的使用濃度，是必須要考慮的因素。於本試驗中，0.1% 水楊酸甲酯於全年中對捕食性天敵誘引效果最好。而個別季節中的夏、秋及冬季，均誘引最多的捕食性天敵，於春季中雖然 0.1% 水楊酸甲酯誘引效果不是最好，但仍顯著高於對照組。在個別捕食性天敵方面，除隱翅蟲科捕食性天敵外，其餘捕食性天敵均可受 0.1% 水楊酸甲酯誘引，其中瓢蟲冬季及全年度、草蛉夏季及全年度、食蚜蠅夏季、花椿春、夏、冬及全年度、盲蝽四季及全年度。

除了水楊酸甲酯濃度不同會影響對捕食性天敵誘引的效果外，不同捕食性天敵於不同季節間對不同濃度水楊酸甲酯的反應亦存在差異。以瓢蟲科捕食性天敵為例，0.1% 水楊酸甲酯於冬季較對照組顯著誘捕更多的瓢蟲，但在春季、夏季及秋季所誘捕的瓢蟲數量雖然比對照組多但並無顯著差異。類似的情形亦存在草蛉、食

蚜蠅、花蝽及盲蝽的調查結果，其中盲蝽於全年四季中均受 0.1% 水楊酸甲酯誘引，而花蝽除秋季（雖然無顯著差異但 0.1% 水楊酸甲酯所誘捕花蝽數量仍較對照組多）外，亦均顯著受 0.1% 水楊酸甲酯誘引，顯示 0.1% 水楊酸甲酯具有應用於田間吸引花蝽及盲蝽科捕食性天敵潛力。

前人研究中作物、季節及天敵生理狀態等內外不同因子，皆有可能影響水楊酸甲酯對天敵的誘引效果 (James 2005)。小黑花椿象 (*O. tristicolor*) 於夏季試驗中，明顯受水楊酸甲酯誘引，但在秋季試驗中，則對水楊酸甲酯無反應。此外，於田間試驗中水楊酸甲酯於九月上旬可誘捕食蟻瓢蟲 (*S. punctum picipes*)，但於九月下旬及十月水楊酸甲酯對食蟻瓢蟲無誘引效果。可能的原因，作者推測為此時期食蟻瓢蟲進入冬眠期 (James 2003b; James & Price 2004; James 2005)。本試驗中捕食性天敵對水楊酸甲酯反應季節差異性的原因，目前尚未明瞭仍需要進一步研究。

Lee (2010) 以水楊酸甲酯搭配白色黏板於草莓田進行天敵調查，試驗結果水楊酸甲酯對隱翅蟲科捕食性天敵無明顯的誘引效果。雖然本試驗 2015–2016 年全年度調查結果，水楊酸甲酯對隱翅蟲科捕食性天敵亦無顯著誘引效果，但於春季時，99% 水楊酸甲酯處理組較對照組顯著誘捕更多的隱翅蟲科捕食性天敵。本試驗調查作物非草莓，且前人研究調查期間分別為 5–7 月及 6–8 月，非本試驗有顯著差異的春季 (2–4 月)，可能因與前人試驗作物與季節之不同而產生差異。

綜合上述結果，水楊酸甲酯於本試驗條件下，證實對多種捕食性天敵具有誘引效果，其中以花椿科及盲蝽科捕食性天敵效果最好。但水楊酸甲酯對捕食性天敵的誘引效果，取決於施用濃度 (0.1% 水楊酸甲酯效果較佳)，而且捕食性天敵於不同季節對水楊酸甲酯的反應亦存在差異性。未來研究針對不同作物環境下標的天敵的發生動態，與對不同濃度水楊酸甲酯的反應，可明瞭水楊酸甲酯的最適施用時機與濃度，進一步達到利用水楊酸甲酯增進作物害蟲生物防治效果。

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Evaluating the Effectiveness of Methyl Salicylate on Attracting Predators

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Abstract

Dong, Y. J. and B. C. Hsiu. 2018. Evaluating the effectiveness of methyl salicylate on attracting predators. *J. Taiwan Agric. Res.* 67(3):283–291.

The yellow sticky paper baited with different concentrations of methyl salicylate (MeSA) was field-tested for the effectiveness of attracting natural enemies in fruit orchards of the Taiwan Agricultural Research Institute during 2015–2016. The results showed that yellow sticky paper baited with MeSA significantly attracted more predators in Coccinellidae (99, 10, and 0.1% MeSA treatments, 2015–2016 full year), Chrysopidae (10, 1, and 0.1% MeSA treatments, 2015–2016 full year), Syrphidae (99, 0.1, and 0.01% MeSA treatments, 2015–2016 summer season), Anthocoridae (all MeSA treatments, 2015–2016 full year), Miridae (99, 10, 0.1, and 0.01% MeSA treatments, 2015–2016 full year), and Staphylinidae (99% MeSA treatment, 2015–2016 Spring season) than the control, but the attractions were varied with different concentrations and response of predators to different concentrations of MeSA was found variable in different seasons.

Key words: Methyl Salicylate, Predators, Biological Control.

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