

# 利用碳酸氫鉀與聚電解質防治作物白粉病

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## 摘要

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測試 0.5、1.0 及 2.0% (w/v) 碳酸氫鈉、碳酸氫鉀及碳酸氫銨等三種重碳酸鹽對番茄白粉病菌 (*Oidium neolycopersici*)、豌豆白粉病菌 (*Erysiphe pisi*) 及玫瑰白粉病菌 (*Sphaerotheca pannosa*) 等孢子發芽的影響, 發現均可有效降低孢子發芽率, 其中以碳酸氫鈉與碳酸氫鉀的效果最佳, 且在 0.5% (w/v) 時即可表現顯著 ( $p < 0.05$ ) 的抑菌效果。以切離葉測試重碳酸鹽類與聚電解質 FO4490SH 抑制番茄白粉病的效果, 顯示 0.5% (w/v) 碳酸氫鈉、碳酸氫鉀與 0.03% (w/v) FO4490SH 均可有效降低白粉病的發生, 其中以前兩者的抑病效果最明顯, 而碳酸氫銨則無法有效降低白粉病。田間測試 0.5% (w/v) 碳酸氫鉀、0.03% (w/v) 聚電解質 FO4490SH、二者混合液及化學藥劑等對番茄、豌豆及玫瑰白粉病的防治效果, 發現碳酸氫鉀、碳酸氫鉀與聚電解質混合均可有效降低白粉病的發生, 防病效果與化學藥劑之間呈不明顯差異 ( $p > 0.05$ ), 三者的防治率均達 83.2% 以上; 而聚電解質的抑病效果則較其他三種處理的效果為差, 且聚電解質與碳酸氫鉀混合液並未能增進病害防治效果。由豌豆白粉病的田間試驗發現, 噴水處理亦具有抑制白粉病的效果, 與對照不噴水處理之間呈顯著差異 ( $p < 0.05$ )。綜合三個田間試驗結果, 顯示 0.5% (w/v) 碳酸氫鉀的防病效力與化學藥劑無異, 可推薦給農民使用。

關鍵詞: 番茄、豌豆、玫瑰、白粉病、重碳酸鹽、聚電解質、防治

## 緒言

白粉病為世界性的植物病害, 尤其在溫帶地區常造成嚴重的產量損失, 例如由 *Leveillula taurica* (Lev.) Arn. 引起的番茄白粉病可造成 40% 的產量損失<sup>(15)</sup>。在台灣本病好發於秋末春初, 尤其在設施內栽培番茄、洋香瓜<sup>(32)</sup>、胡瓜、玫瑰<sup>(19)</sup>等作物時, 常造成嚴重的為害。

防治本病多仰賴化學藥劑防治<sup>(1, 5, 21)</sup>, 缺點是極易產生抗藥性<sup>(20, 23, 32)</sup>及農藥殘留等問題。有鑑於此, 開發替代性方法如栽植抗病品種<sup>(9, 32)</sup>、生物防治<sup>(16, 21, 29, 30, 34)</sup>、以矽化合物<sup>(24)</sup>與磷或鉀鹽<sup>(28)</sup>誘導抗病性、噴佈抗蒸散劑或高分子薄膜<sup>(8, 13, 36, 37, 38, 39)</sup>、核胺光動素<sup>(33)</sup>、礦物油或植物油<sup>(17, 21, 22, 27)</sup>、重碳酸鹽<sup>(21, 39)</sup>、植物萃取液<sup>(4, 18, 26)</sup>, 以及噴水<sup>(16, 19)</sup>等方式來防治白粉病的發生, 一時蔚為風氣, 而且具有相當良好的成效。

台灣秋冬季常見 *Oidium neolycopersici* L. Kiss 引起

番茄白粉病、*Erysiphe pisi* DC. 引起豌豆白粉病及 *Sphaerotheca pannosa* (Wallr.) Lev 引起玫瑰白粉病。研究指出在葉表噴佈抗蒸散劑及重碳酸鹽, 可有效降低白粉病的發生<sup>(39)</sup>; 謝和黃兩氏曾報導陽離子型聚電解質可在葉表上形成薄膜, 並降低百合灰黴病的發生<sup>(14)</sup>。因此, 本研究的目的擬評估碳酸氫鉀與聚電解質於田間防治上述三種作物白粉病發生的可行性, 以提供農民除化學藥劑之外的另一項選擇。

## 材料與方法

### 病原菌的製備

由田間取回自然感染白粉病的番茄 (*Lycopersicon esculentum* Mill.)、豌豆 (*Pisum sativum* L.) 及玫瑰 (*Rosa rugosa* Thunb.) 罹病葉片, 其病原菌分別為

*Oidium neolycopersici*、*Erysiphe pisi* 及 *Sphaerotheca pannosa*，以無菌水將葉表面的白粉病菌先行沖洗下來，再將罹病葉之葉柄以濕棉花包被，置於 100% 相對濕度的濕室中，於 24 小時下培養四至七天。俟新的孢子產生後，以無菌水將孢子洗下，經二層紗布過濾，再以離心機 (Sigma 3K12, Laboratory centrifuges, Martin Christ, West Germany) 3000g 離心 10 分鐘，去除上層液，加入無菌水再離心，連續二次，然後以血球計數器 (hemacytometer) 計量，並加水調整孢子濃度為  $1 \times 10^5$  spore/ml 備用。

### 重碳酸鹽與聚電解質的製備

將試藥級碳酸氫鈉 ( $\text{NaHCO}_3$ )、碳酸氫鉀 ( $\text{KHCO}_3$ ) 及碳酸氫銨 ( $\text{NH}_4\text{HCO}_3$ ) (Yakuri Pure Chemicals Co. Ltd., Osaka, Japan) 等三種重碳酸鹽與無菌水分別配成 1.0%、2.0% 及 4.0% (w/v) 溶液，貯藏於 5 度定溫箱中備用。

稱取陽離子型聚電解質 FO4490SH [polyelectrolyte, poly(acrylamide / dimethylamino ethyl-methacrylate cationic monomer)] (SNF, St-Etienne cedex, France)，於使用前 24 小時先以無菌水配成 0.2% (w/v) 母液備用。

### 重碳酸鹽與聚電解質對三種白粉病菌孢子發芽的影響

取  $15 \mu\text{l}$  上述不同濃度的三種重碳酸鹽分別與上述等量的 *O. neolycopersici*、*E. pisi* 及 *S. pannosa* 等三種白粉病菌孢子懸浮液混合，另以稀釋成 0.04% 和 0.06% (w/v) 的聚電解質 FO4490SH 與等量的 *O. neolycopersici* 孢子懸浮液混合，滴於 8 孔載玻片上，每處理四重複，以無菌水作為對照組。載玻片以三角玻璃環墊高，置於含 10 毫升無菌水的 9 公分培養皿內，蓋上皿蓋，套上封口袋保濕，置於 24 度黑暗定溫箱下 48 小時後，取出玻片以顯微鏡觀察孢子發芽情形，發芽管長度超過孢子寬度始判定為發芽，每重複記錄 100 個孢子。

### 切離葉評估重碳酸鹽與聚電解質防治番茄白粉病的效果

由溫室取回生長一個月的番茄 (農友 301 品種) 植株葉片，以自來水沖洗乾淨後，以吸水紙吸乾葉片表面的水滴，葉柄以濕棉花包裹，將葉片葉表朝上，並以三角玻璃環墊高，置於含 10 毫升無菌水的 9 公分培養皿內。處理時每片葉片表面以中脈分為兩部份，一部份分別處理 0.5% (w/v) 三種重碳酸鹽溶液或 0.03% (w/v) 聚電解質 FO4490SH 溶液，另一部份則處理無菌

水做為對照組。將各處理之番茄葉片以取自田間之番茄白粉病菌孢子進行噴霧接種，孢子懸浮液製備如上述，接種時以葉片結 0.2-0.5mm 大小之水珠為度，處理後蓋上皿蓋保濕，置於 24 度黑暗定溫箱下 10 天後，記錄葉片罹白粉病的面積率。

### 作物白粉病罹病度的調查與計算

記錄番茄白粉病的罹病度 (disease severity) 時，由上而下估算五個枝條，每個枝條記錄五個複葉，每個複葉計有七個葉片；調查玫瑰白粉病的罹病度時，先由小區選取中央 15 株，每株由頂端葉開始調查 10 組複葉，記錄發病葉數及罹病度。將葉片罹病度分成 5 級：0 = 無病斑；1 = 1-5 個病斑；2 = 6-15 個病斑；3 = 16-30 個病斑，4 = 31-50 個病斑；5 = 50 個病斑以上，再依公式「罹病度 % = (罹病指數  $\times$  該指數罹病葉數) / (5  $\times$  總調查葉數)  $\times$  100%」計算出罹病度。

記錄豌豆白粉病的罹病度時，由小區隨機選取 10 株植株，每株由基部開始調查 10 組複葉，每個複葉共二個葉片，記錄葉片罹病情形。罹病度之計算係將葉片罹病面積分成 4 級：0 = 無病斑；1 = 1-10% 葉片面積罹病；2 = 11-25% 面積罹病；3 = 26-50% 面積罹病，4 = 51% 以上面積罹病，再依公式「罹病度 % = (罹病指數  $\times$  該指數罹病葉數) / (4  $\times$  總調查葉數)  $\times$  100%」計算出罹病度。

### 碳酸氫鉀與聚電解質防治番茄白粉病的效果

田間防治試驗於西元 2000 年 4-6 月份在農試所試驗田的塑膠布簡易溫室中進行。試驗採逢機完全區集設計，將種植 1.5 個月的番茄栽培田各劃分成 20 小區，每小區大小為  $3.0 \times 0.6 \text{ m}$ 。於發病初期 (5月16日) 分別處理 0.5% (w/v) 碳酸氫鉀水溶液、0.03% (w/v) 聚電解質 FO4490SH 溶液、兩者混合液及 5% 三泰隆可濕性粉劑 (5% Triadimenol WP, 興農股份有限公司, 台中縣) 2000 倍稀釋液共四處理，並以自來水處理為對照組，每處理四重複。每星期噴施一次，噴佈藥液以整株葉片濕潤至滴落為度，連續三次，並於第 2 次噴施前 (5 月 23 日) 及第 3 次噴施後第 7 天 (6 月 6 日) 依上述罹病度調查方法記錄病害之罹病度。

### 碳酸氫鉀與聚電解質防治豌豆白粉病的效果

田間試驗於西元 2000 年 2-3 月份在農試所試驗田的塑膠布簡易溫室中進行。試驗採逢機完全區集設計，將栽培田各劃分成 24 小區，每小區以栽培土 (滿地王 2 號介質, 農友種苗公司) 種植 20 株豌豆 (黑目品種)，每包栽培土種植四株豌豆，並以立網固定植株，

每處理四重複。於發病初期 (3 月 4 日) 開始處理 0.5% (w/v) 碳酸氫鉀水溶液、0.03% (w/v) 聚電解質 FO4490SH 溶液、兩者混合液及 5% 三泰隆可濕性粉劑 (Triadimenol) 2000 倍稀釋液共四處理，每處理四重複，並以噴水與不噴水處理作為對照組。每隔 7 天噴施 1 次，連續 3 次。並依前述罹病度調查方法於第 2 次噴施前 (3 月 11 日) 及第 3 次噴施後第 7 天 (3 月 25 日) 記錄葉片罹病度。

### 碳酸氫鉀與聚電解質防治玫瑰白粉病的效果

在西元 2000 年 3 月份，於南投縣草屯鎮玫瑰栽培區進行防治白粉病的田間試驗。玫瑰品種為加娜紅。田間試驗採逢機完全區集設計，每小區 20 株，四重複。於發病初期 (3 月 7 日) 開始處理 0.5% (w/v) 碳酸氫鉀水溶液、0.03% (w/v) 聚電解質 FO4490SH 溶液、兩者混合液及 30% 白粉松乳劑 (30% Pyrazophos EC, 興農股份有限公司, 台中縣) 2000 倍稀釋液加展著劑「全透力」1000 倍，共四處理，並以水作為對照組。每隔 7 天噴施 1 次，連續 3 次。並依前述罹病度調查方法於第 2 次噴施前 (3 月 14 日) 及第 3 次噴施後第 7 天 (3 月 28 日) 記錄葉片罹病度。

## 結 果

### 重碳酸鹽與聚電解質對三種白粉病菌孢子發芽的影響

在 24 下經 48 小時的觀察，*O. neolycopersici*、

*E. pisi* 及 *S. pannosa* 等三種白粉病菌的發芽率均不高，介於 29.8 - 35.0% 之間。以 0.5、1.0、2.0% (w/v) 三種重碳酸鹽處理孢子，發現均可降低孢子發芽率，其中以碳酸氫鈉與碳酸氫鉀的抑菌效果最佳 (表一)。在不同重碳酸鹽濃度處理下，碳酸氫鉀抑制白粉病菌的能力會隨著使用濃度的增加而增加；而碳酸氫鈉與碳酸氫鉀的抑菌效果則在三種濃度處理間無顯著差異性 ( $p>0.05$ )，亦即在 0.5% (w/v) 下即可表現顯著的抑菌效果 (表一)。聚電解質 FO4490SH 亦能降低番茄白粉病菌的孢子發芽率，惟抑菌效力較碳酸氫鈉或碳酸氫鉀為差 (表一)。

### 切離葉評估重碳酸鹽與聚電解質防治番茄白粉病的效果

番茄切離葉處理三種重碳酸鹽類與聚電解質 FO4490SH 十天後觀察白粉病的感染情形，顯示 0.5% (w/v) 碳酸氫鈉、碳酸氫鉀與 0.03% (w/v) FO4490SH 溶液均可有效降低白粉病的發生，其中以前兩者的抑病效果最明顯，而碳酸氫鉀則無法有效降低白粉病 (圖一)。

### 碳酸氫鉀與聚電解質防治番茄白粉病的效果

田間塑膠布簡易溫室中番茄白粉病於三月初自然發病，發病時由下位葉開始出現白粉病的病斑。於第一次噴藥前調查白粉病的罹病度，發現各區罹病度之間無明顯差異性。在第二次噴藥前，即處理後一星期調查各處理之白粉病罹病度，發現 0.5% (w/v) 碳酸氫

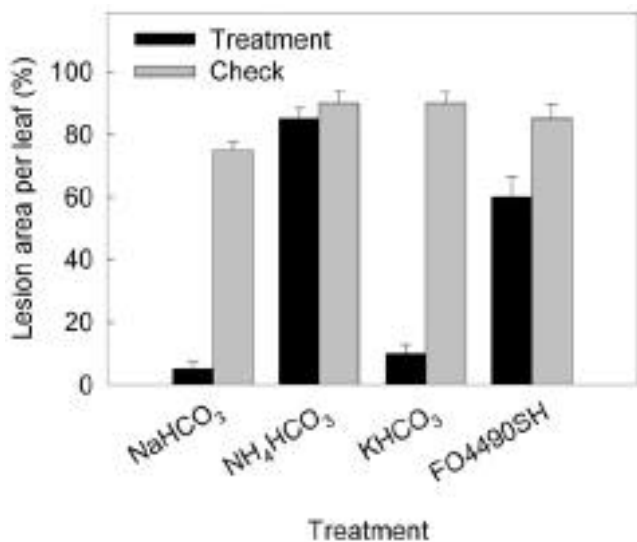
表一、碳酸氫鹽與聚電解質 (FO4493SH) 對三種白粉病菌孢子發芽的影響

Treatment	Concentration (%)	Spore germination (%) <sup>1</sup>		
		<i>Oidium neolycopersici</i>	<i>Erysiphe pisi</i>	<i>Sphaerotheca pannosa</i>
Water (Check)		35.0 a <sup>2</sup>	32.5 a	29.8 a
NaHCO <sub>3</sub>	0.5	3.0 e	1.5 d	3.0 d
	1.0	0.3 e	1.0 d	3.0 d
	2.0	0.3 e	0.7 d	2.0 d
KHCO <sub>3</sub>	0.5	2.3 e	1.0 d	3.5 d
	1.0	0.5 e	0.5 d	1.0 d
	2.0	0.8 e	0.3 d	1.0 d
NH <sub>4</sub> HCO <sub>3</sub>	0.5	17.8 c	20.8 b	24.5 b
	1.0	8.5 d	10.3 c	15.5 c
	2.0	3.0 e	3.7 d	12.0 c
FO4490SH	0.03	20.0 c	ND	ND
	0.02	28.0 b	ND	ND

<sup>1</sup> The percentage of spore germination was determined 48 hr after incubation at 24 .

<sup>2</sup> Data in the same column followed by the same letter are not significantly different ( $p>0.05$ ) according to Duncan's multiple range test.

<sup>3</sup> ND: Not determined.



圖一、以切離葉評估重碳酸鹽與聚電解質防治番茄白粉病的效果。

Fig. 1. Effect of bicarbonates and polyelectrolyte FO4490SH on disease severity of tomato powdery mildew. Detached leaf method was performed at 24 for 10 days as described in materials and methods. The concentrations of chemicals were 0.5% (w/v) for three bicarbonates and 0.03% (w/v) for polyelectrolyte FO4490SH.

鉀、0.03% (w/v) 聚電解質 FO4490SH、碳酸氫鉀與聚電解質混合液、5% 三泰隆可濕性粉劑 2000 倍等四種處理均可有效降低白粉病的發生；惟聚電解質的抑病效果較其他三種處理的效果為差，但與對照噴水處理之間呈明顯差異性 ( $p < 0.05$ ) (表二)。第三次噴施後 7 天，即第一次處理後三星期之調查結果亦顯示，各種處理間的番茄白粉病罹病度與對照組噴水處理間呈明顯差異性 ( $p < 0.05$ )，其結果與處理後一星期之調查結果相似。對照組噴水處理的白粉病罹病度達 30.0%，處理聚電解質者罹病度為 14.3%，而其餘處理的罹病度則低於 4.0% (表二)。

#### 碳酸氫鉀與聚電解質防治豌豆白粉病的效果

豌豆在種植一個月左右即開始由下位葉發生白粉病，在發病初期調查各區白粉病的罹病度之間並無差異性存在。在第二次噴施前調查各處理間白粉病發生的情形，顯示各種處理的白粉病罹病度皆比對照不噴水處理的罹病度低，其中 0.5% (w/v) 碳酸氫鉀、碳酸氫鉀與聚電解質混合液、5% 三泰隆可濕性粉劑等三種處理的防病效果最為顯著 ( $p < 0.05$ )；而噴水與聚電解質二處理的防病效果稍差，但亦與對照不噴水處理之間呈顯著差異 ( $p < 0.05$ ) (表三)。第三次噴施後 7 天之調查結果亦顯示，各種處理間的白粉病罹病度與對照不噴

水處理間呈明顯差異性 ( $p < 0.05$ )，其結果與處理後一星期之調查結果相仿，不噴水對照組的罹病度達 69.8%，而 0.5% (w/v) 碳酸氫鉀、碳酸氫鉀與聚電解質混合液、5% 三泰隆可濕性粉劑等三種處理的白粉病罹病度則在 5.0% 以下 (表三)。

#### 碳酸氫鉀與聚電解質防治玫瑰白粉病的效果

在噴藥前調查玫瑰白粉病的發生情形，顯示未處理前之白粉病罹病度並無顯著差異 ( $p = 0.05$ )；第二次噴施前調查結果顯示，各種處理的白粉病罹病度皆比對照噴水處理的罹病度低，其中碳酸氫鉀與聚電解質混合液已具明顯的 ( $p < 0.05$ ) 防治功效；第三次噴施後 7 天之調查顯示，30% 白粉松乳劑 2000 倍稀釋液、0.5% (w/v) 碳酸氫鉀溶液及碳酸氫鉀與聚電解質混合液均具有明顯的防治功效，而聚電解質 FO4490SH 雖可降低罹病度，然在分析上與對照組之差異不明顯 (表四)。

## 討 論

本研究於實驗室中測試碳酸氫鈉 ( $\text{NaHCO}_3$ ) 或稱小蘇打、碳酸氫鉀 ( $\text{KHCO}_3$ )、碳酸氫銨 ( $\text{NH}_4\text{HCO}_3$ ) 等三種含有重碳酸根 ( $\text{HCO}_3^-$ ) 之重碳酸鹽 (bicarbonates)，以及聚電解質 FO4490SH 對作物白粉病菌孢子發芽及病害發生的影響，發現其中的碳酸氫鈉與碳酸氫鉀最具抑制病原菌發芽及白粉病發生的功效。田間測試結果亦顯示 0.5% (w/v) 碳酸氫鉀具有明顯降低番茄、豌豆及玫瑰等白粉病發生的能力，其效果與推薦藥劑無異。

重碳酸鹽類之中的碳酸氫鈉 (sodium bicarbonate) 最先被用於作物病害防治上<sup>(11, 12)</sup>。隨後，植物病理學家即展開利用重碳酸鹽類防治作物病害的研究，期作為除化學藥劑之外的另一項病害防治的選擇<sup>(2, 3, 6, 7, 12, 21, 25, 38, 39)</sup>。重碳酸鹽以防治作物白粉病為主，作物包括甜椒<sup>(7)</sup>、番茄<sup>(6)</sup>、瓜類<sup>(3, 21, 28, 39)</sup>、葡萄<sup>(10)</sup>、蘋果<sup>(2)</sup>、木瓜<sup>(31)</sup>、玫瑰<sup>(12, 27)</sup>、日衛茅<sup>(38)</sup>、迷迭香<sup>(25)</sup>等。重碳酸鹽類對人體無害，而且對環境的衝擊非常小，在作物有機栽培的體系中，成為病害防治不可或缺的一項利器。由於它具有明顯的抑菌功效，已被全世界有機農園廣泛地接受與應用。

Gale 與 Poljakoff-Mayber 兩氏 (1962) 利用抗蒸散劑 (S-789: a vinyl acetate-acrylate copolymer emulsion) 在葉表形成薄膜的特性，有效降低甜菜白粉病的發生，首先證明抗蒸散劑具有預防葉部病害發生的潛力<sup>(8)</sup>。近年來，植病學者陸續證實利用此種類似角質層特性之抗蒸散劑，可有效阻斷病原菌的入侵，進而達到預防

表二、田間利用碳酸氫鉀和聚電解質 (FO4490SH) 防治番茄白粉病的效果

Table 2. Effect of potassium bicarbonate and polyelectrolyte (FO4490S) on control of tomato powdery mildew caused by *Oidium neolycopersici* in the field test

Treatment	Disease severity (%) <sup>1</sup>	
	1 wk	3 wk
Water (Check)	29.2 a <sup>2</sup>	33.0 a
0.5% KHCO <sub>3</sub>	4.2 c	4.0 c
0.03% FO4490SH	20.9 b	14.3 b
0.5% KHCO <sub>3</sub> + 0.03% FO4490SH	2.6 c	0.7 c
5% Triadimenol 2000X	2.4 c	0.8 c

<sup>1</sup> The disease severity rating was based on a scale of 0 to 5: 0 = healthy leaf; 1 = 1 to 5 spots on leaf; 2 = 6 to 15 spots on leaf; 3 = 16 to 30 spots on leaf; 4 = 31-50 spots on leaf, and 5 = over 50 spots on leaf. A disease severity (DS) for each replicate was calculated using the formula: DS % = (nd)/T, where n = number of leaves in each rating, d = disease rating (0 to 5), and T = total number of leaves in each replicate. Data were determined 1 wk after first spray (on May 23, 2000), and 3 wk after first spray (on June 6, 2000), respectively.

<sup>2</sup> Means (n=4) in the same column followed by the same letter are not significantly different (p>0.05) according to Duncan's multiple range test.

表三、田間利用碳酸氫鉀和聚電解質 (FO4490SH) 防治豌豆白粉病的效果

Table 3. Effect of potassium bicarbonate and polyelectrolyte (FO4490S) on control of pea powdery mildew caused by *Erysiphe pisi* DC. in the field test

Treatment	Disease severity (%) <sup>1</sup>	
	1 wk	3 wk
No Water (Check)	54.8 a <sup>2</sup>	69.8 a
Water (Check)	13.3 b	46.7 b
0.5% KHCO <sub>3</sub>	0.0 c	1.2 c
0.03% FO4490SH	20.1 b	36.4 b
0.5% KHCO <sub>3</sub> + 0.03% FO4490SH	1.0 c	5.0 c
5% Triadimenol 2000X	0.8 c	3.2 c

<sup>1</sup> The disease severity rating was based on a scale of 0 to 4: 0 = healthy leaf; 1 = 1 to 10% leaf area infection by powdery mildew; 2 = 11 to 25% leaf area infection; 3 = 26 to 50% leaf area infection; and 4 = over 50% leaf area infection. A disease severity (DS) for each replicate was calculated using the formula: DS % = (nd)/T, where n = number of leaves in each rating, d = disease rating (0 to 4), and T = total number of leaves in each replicate. Data were determined 1 wk after first spray (on March 11, 2000), and 3 wk after first spray (on March 25, 2000), respectively.

<sup>2</sup> Means (n=4) in the same column followed by the same letter are not significantly different (p>0.05) according to Duncan's multiple range test.

表四、田間利用碳酸氫鉀和聚電解質 (FO4490SH) 防治玫瑰白粉病的效果

Table 4. Effect of potassium bicarbonate and polyelectrolyte (FO4490SH) on control of rose powdery mildew caused by *Sphaerotheca pannosa* in the field test

Treatment	Disease severity (%) <sup>1</sup>	
	1 wk	3 wk
Water (Check)	13.1 a <sup>2</sup>	14.9 a
0.5% KHCO <sub>3</sub>	6.3 ab	2.0 b
0.03% FO4490SH	8.0 ab	7.1 ab
0.5% KHCO <sub>3</sub> + 0.03% FO4490SH	4.8 b	2.1 b
30% Pyrazophos 2000X	6.3 ab	2.5 b

<sup>1</sup> The footnote was the same as Table 2. Data were determined 1 wk after first spray (on March 14, 2000), and 3 wk after first spray (on March 28, 2000), respectively.

<sup>2</sup> Means (n=3) in the same column followed by the same letter are not significantly different (p>0.05) according to Duncan's multiple range test.

植物病害發生的功效<sup>(36)</sup>。例如抗蒸散劑可降低高粱、玉米及小麥<sup>(36)</sup>、大麥<sup>(35)</sup>、繡球花與紫薇<sup>(37)</sup>等白粉病的發生。另外，謝和黃氏（1999）發現陽離子型聚電解質 FO4490SH 不但可以降低百合灰黴病菌孢子發芽，並使發芽的孢子不易侵入表皮組織，而且可有效抑制發芽管中酯化酵素的分泌，以達到降低病害的目的<sup>(14)</sup>。本研究發現聚電解質 FO4490SH 亦可降低番茄白粉病菌孢子的發芽率與白粉病的發生率，惟抑菌及防病效力不若碳酸氫鉀顯著。

很多研究報告顯示重碳酸鹽配合抗蒸散劑或礦物油可有效降低玫瑰<sup>(12)</sup>、瓜類<sup>(39)</sup>及日衛茅<sup>(38)</sup>的白粉病。本研究亦發現碳酸氫鉀配合聚電解質可顯著降低田間番茄與豌豆白粉病的發生，但並未有加成的效果。然而，試驗發現單獨使用碳酸氫鉀偶而會造成作物葉片產生灼傷小藥斑的情形，而碳酸氫鉀添加聚電解質的處理則不易產生葉片灼傷。綜合實驗室及田間各項試驗結果得知碳酸氫鉀確實可用於防治作物白粉病，值得推廣給農民使用。

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## ABSTRACT

Hsieh, T. F.<sup>1,2</sup>, Huang, J. H.<sup>1</sup>, and Hsieh, L. J.<sup>1</sup> 2005. Control of powdery mildew with potassium bicarbonate and polyelectrolyte. *Plant Pathol. Bull.* 14:125-132. (<sup>1</sup> Plant Pathology Division, Agricultural Research Institute, Council of Agriculture, Wufeng, Taichung, Taiwan; <sup>2</sup> Corresponding author, E-mail: tfhsieh@wufeng.tari.gov.tw; Fax: +886-4-23302803)

Sodium bicarbonate, potassium bicarbonate and ammonium bicarbonate were evaluated for their inhibitory effect on spore germination of three powdery mildew pathogens, *Oidium neolycopersici*, *Erysiphe pisi*, and *Sphaerotheca pannosa*. Data showed that the spore germinations of these pathogens were significantly ( $p < 0.05$ ) suppressed by all three bicarbonates, especially sodium and potassium bicarbonate at 0.5% (w/v). Detached leaf method also was used to evaluate 0.5% (w/v) bicarbonates and 0.03% (w/v) polyelectrolyte (FO4490SH) for control of powdery mildew. The result showed that all treatments except ammonium bicarbonate reduced the infection area of powdery mildew on tomato leaf surfaces, especially sodium and potassium bicarbonate. Three field trials were conducted in central Taiwan to evaluate the applicability of potassium bicarbonate, polyelectrolyte and fungicides for control of tomato, pea and rose powdery mildew. Each trial was arranged in a completely randomized design with four replications. Potassium bicarbonate at 0.5%, and 0.5% potassium bicarbonate plus 0.03% polyelectrolyte were effective in decreasing the disease severity of powdery mildews on all three crops tested. The treatments were as effective as fungicides. The percentages of disease control in all three treatments were more than 80%. The severity of powdery mildew was only slightly reduced by the treatment of polyelectrolyte alone on tomato and pea. Polyelectrolyte did not increase the efficacy of disease control by potassium bicarbonate in this study. Spray with water also slightly reduced the disease severity of powdery mildew on pea in comparison with no water spray. This study showed that 0.5% potassium bicarbonate could be used as an alternative method for control of powdery mildew in the field.

Key words: Tomato, pea, rose, powdery mildew, bicarbonates, polyelectrolyte, control