

草莓炭疽病之生態與防治

作物環境課

姚瑞禎



草莓炭疽病

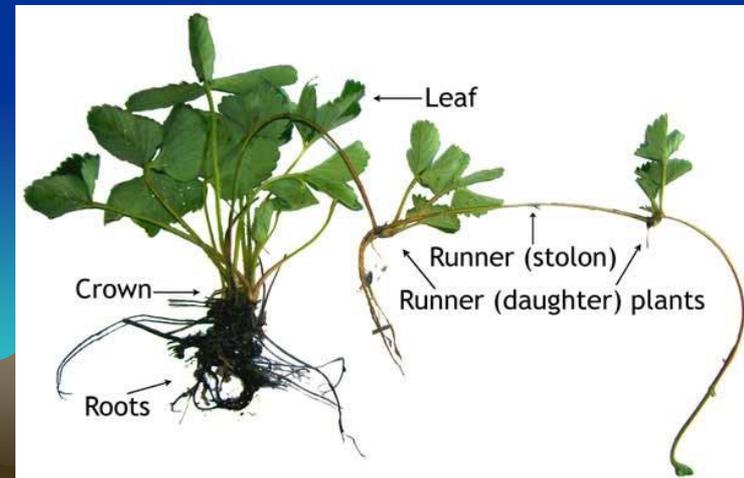
- 病原菌：

Colletotrichum gloeosporioides; *C. fragariae*; *C. acutatum*

- 1994年李昱輝與呂理燊發表在苗栗及南投草莓被*C. gloeosporioides*感染。
- 感染草莓果實、走莖、葉柄、葉片及莖冠基部。

病徵

- 初期在葉部形成類似墨水印的淺色斑點，後期顏色漸深而成黑斑。
- 葉柄及走莖感染炭疽病，初產生紅褐色小斑，之後擴大變黑色，乾燥、並略凹陷，常可見淺黃色至粉紅色之分生孢子堆。



葉片



走莖



病徵

- 炭疽病亦會造成冠腐，由新芽侵入感染後，內向全部呈現紅褐色。切開冠部則萎凋枯死，莖基向外延伸。
- 受感染之成熟果實上形成小斑，凹陷、常變黑癒合，潮濕實節後變成木乃伊化。

冠腐



果實



台灣草莓炭疽病危害

- 本病菌一年四季均可存活於草莓植株上，育苗期可於葉片、葉柄，走莖發現病徵，育苗後期若疏於管理，造成植株死亡，於苗床中時形成一小區一小區空區，以七月份後高溫時為甚，感染之病株若定植於本田，亦可能造成大量死亡。
- 本田期則於草莓苗移植本田後一個月至一個半月(覆蓋塑膠布初期)植株大量死亡。於翌年四月氣溫升高時，帶病菌植株又會死亡，為害果實則均於四月高溫之草莓果實生產後期，對產量之損失輕微。



育苗期炭疽病調查

- 101年草莓跨區輔導苗栗大湖三處高架育苗示範點，育苗期炭疽病田間罹病率(%)

| 大湖 | A | B | C |
|-----------|----|-----|----|
| May | 10 | 25 | 30 |
| June | 3 | 3.3 | 5 |
| July | 1 | 2.4 | 3 |
| August | 3 | 2 | 4 |
| September | 1 | 1 | 1 |

轄區內育苗期炭疽病調查

- 育苗農戶間罹病率差異大，較輕微的約0.1%至0.3%，而病害較嚴重的達60%，多數炭疽病罹病率約在10%至20%間。
- 草莓品種間炭疽病感病程度不同，差異明顯。
- 內湖9戶中1戶罹病株率達六成，其他農戶罹病株率皆在0.1-0.3%之間。關西炭疽病田間罹病株率約1-15%，與農友田間管理有關。

病原菌來源(感染途徑)

- 親株、種苗
- 介質、土壤
 - 土壤存活 溫溼度影響 Feil et al. 2003
 - 病原菌土壤存活 Freeman et al. 2002
- 雜草 Rahman et al. 2015



炭疽病感染源

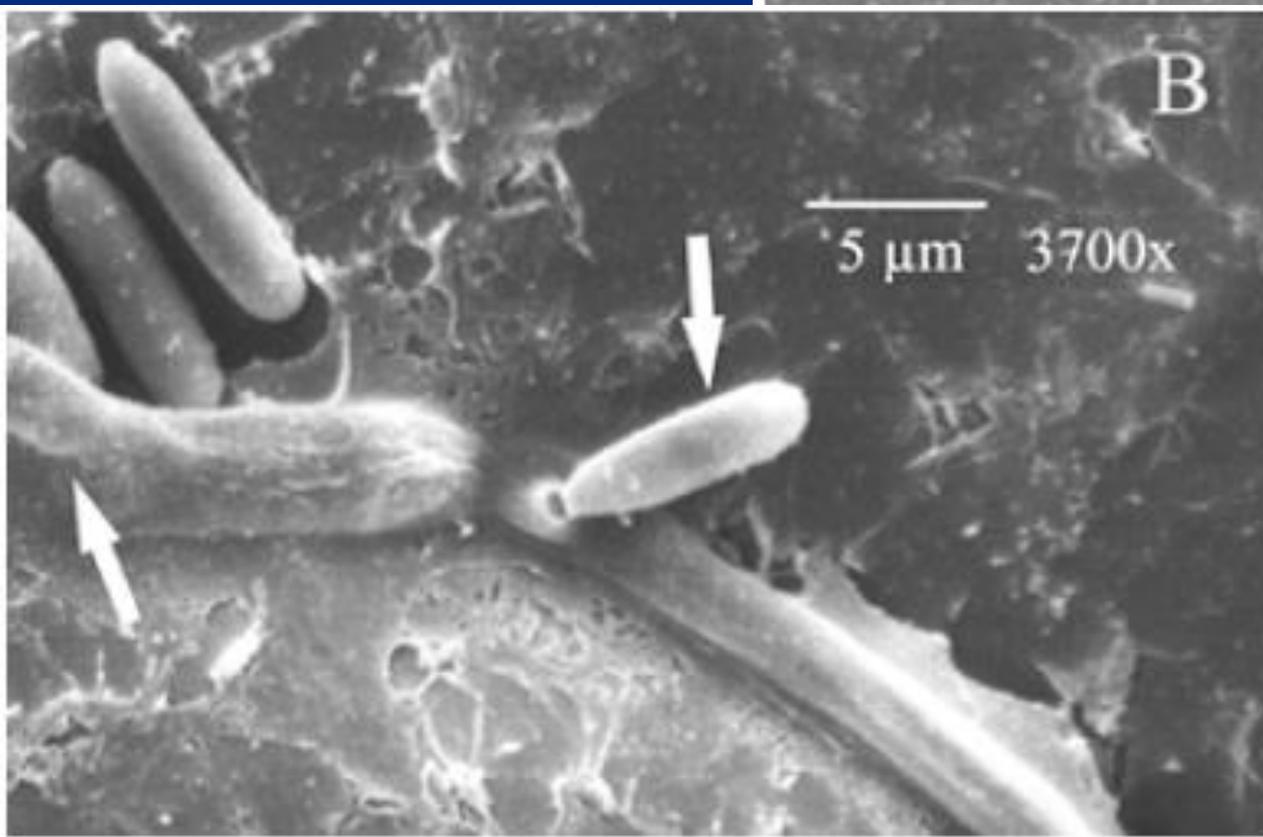
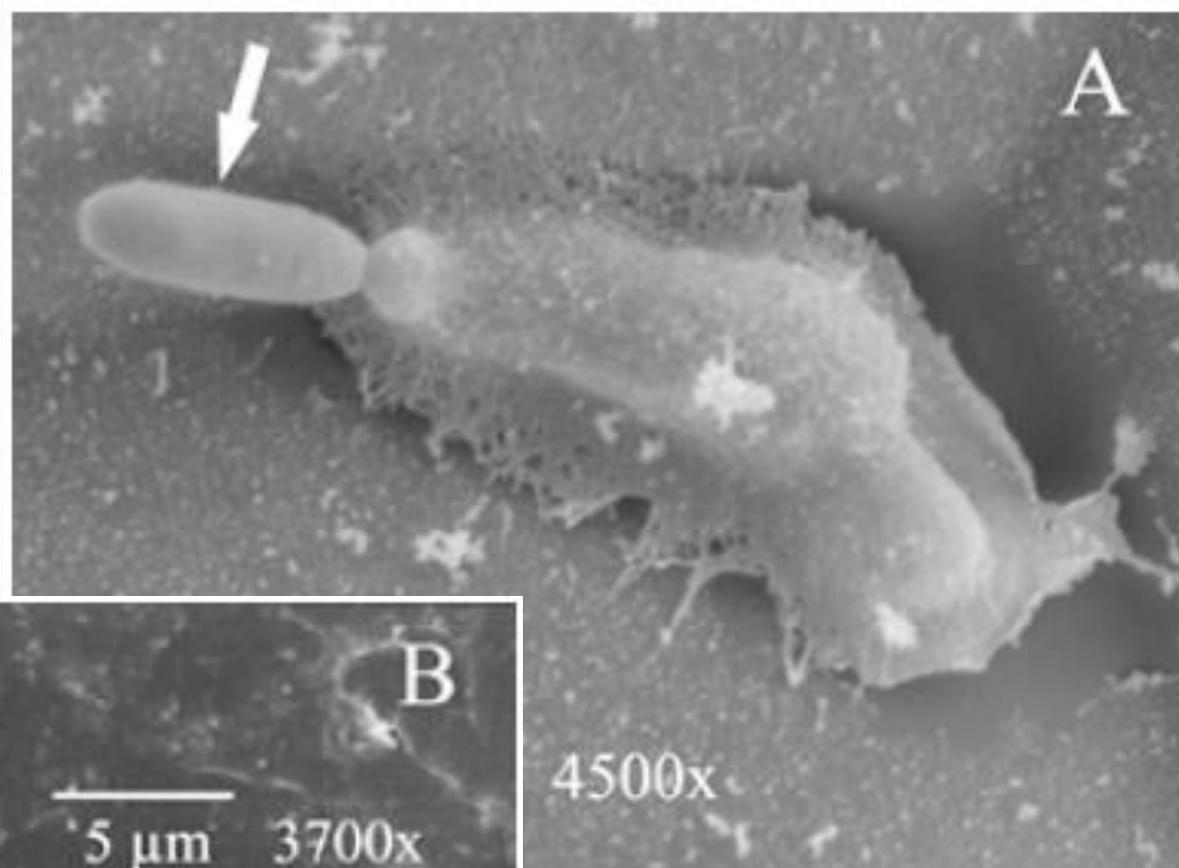




走莖上產孢



感染過程



溫度影響病原菌表現

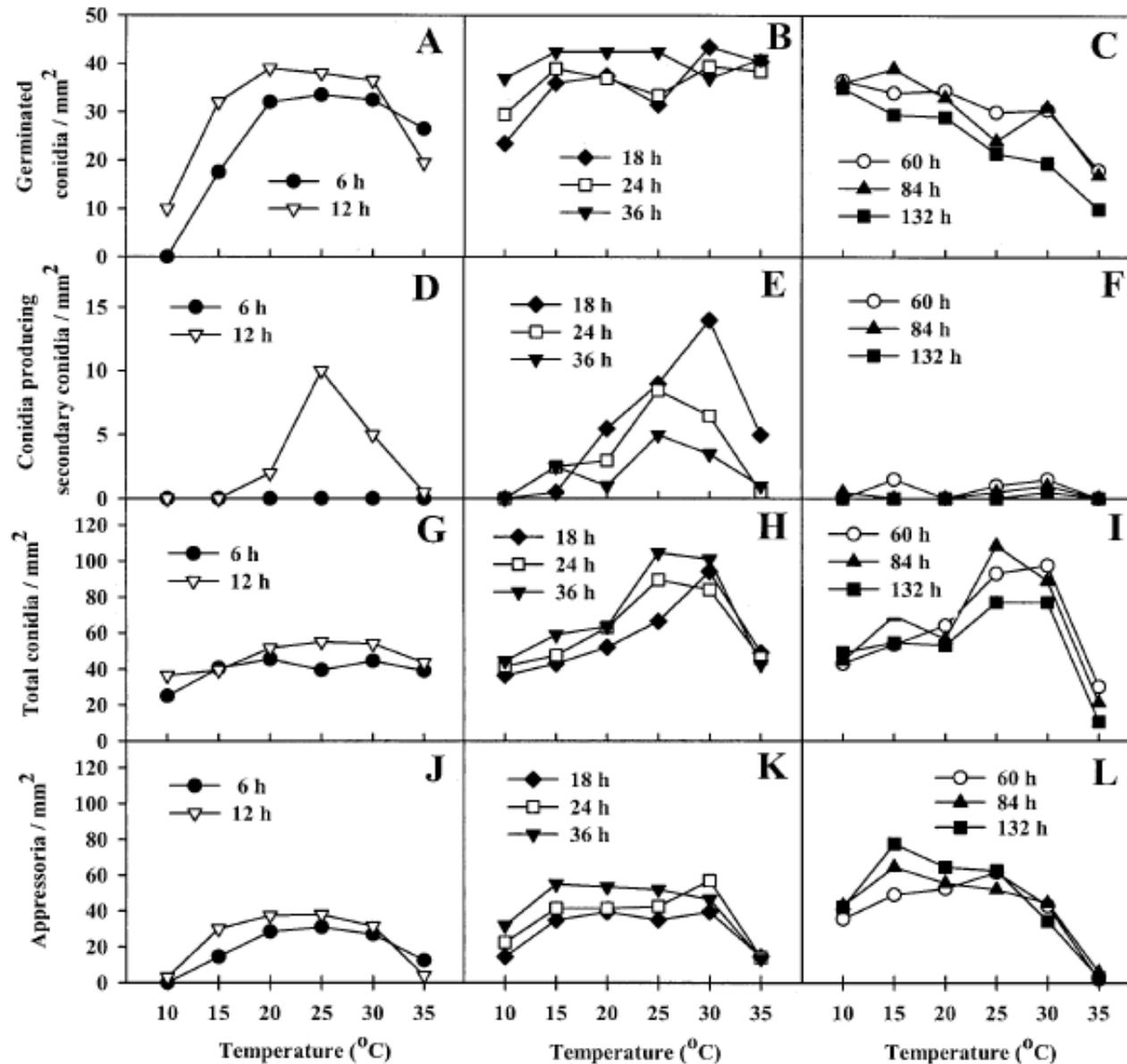


Fig. 1. Conidial and appressorial populations of *Colletotrichum acutatum* on strawberry leaves incubated at 10 to 35°C under continuous wetness: A to C, Germinated conidia; D to F, conidia producing secondary conidia; G to I, total conidia; and J to L, total appressoria. Data shown are averaged over both runs of the experiment.

濕度對病原菌感染初期影響

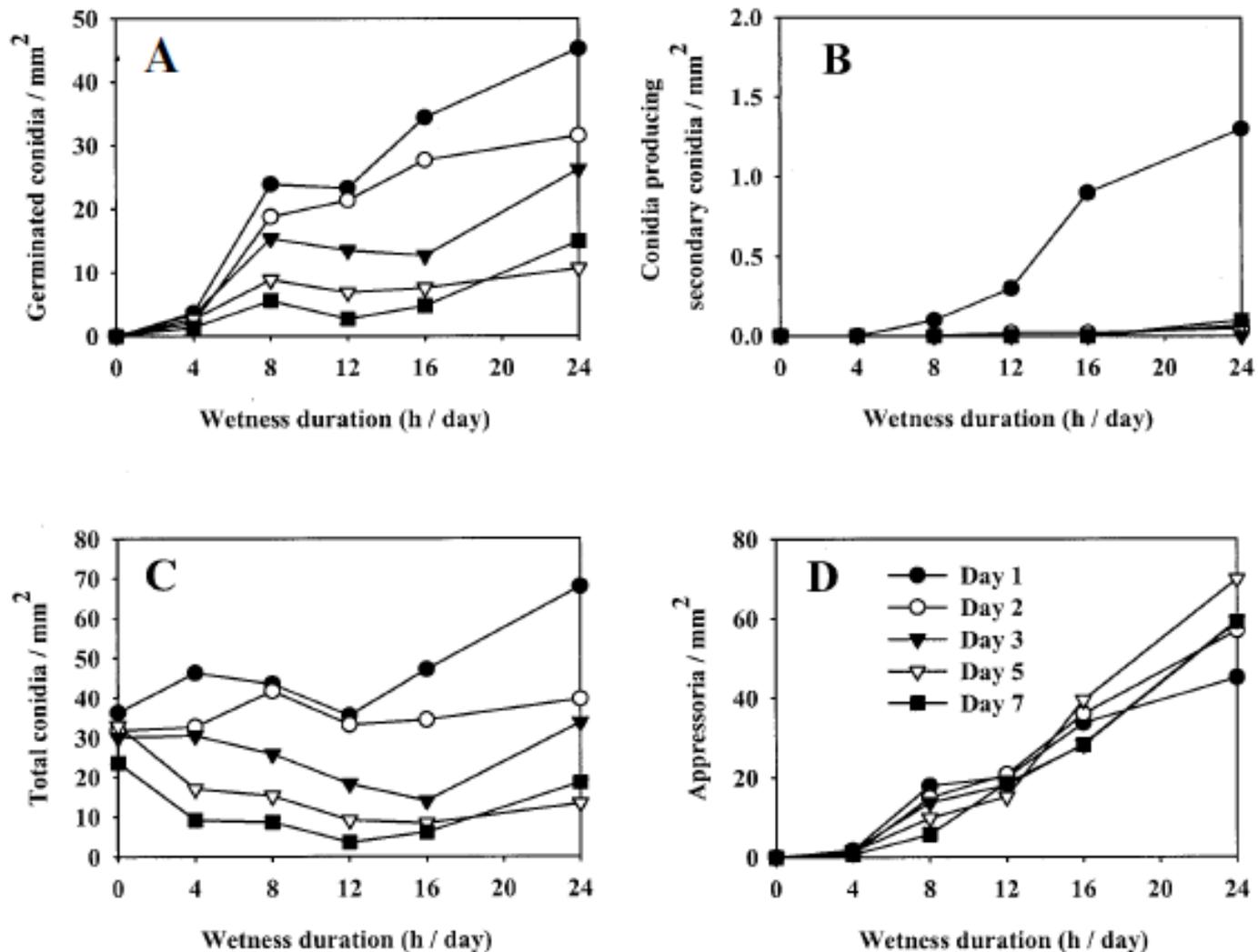


Fig. 2. Conidial and appressorial populations of *Colletotrichum acutatum* on strawberry leaves incubated at 25°C and different wet/dry treatment regimes: A, Germinated conidia; B, conidia producing secondary conidia; C, total conidia, and D, total appressoria. Data shown are averaged over both runs of the experiment.

濕度對病原菌產孢及存活影響

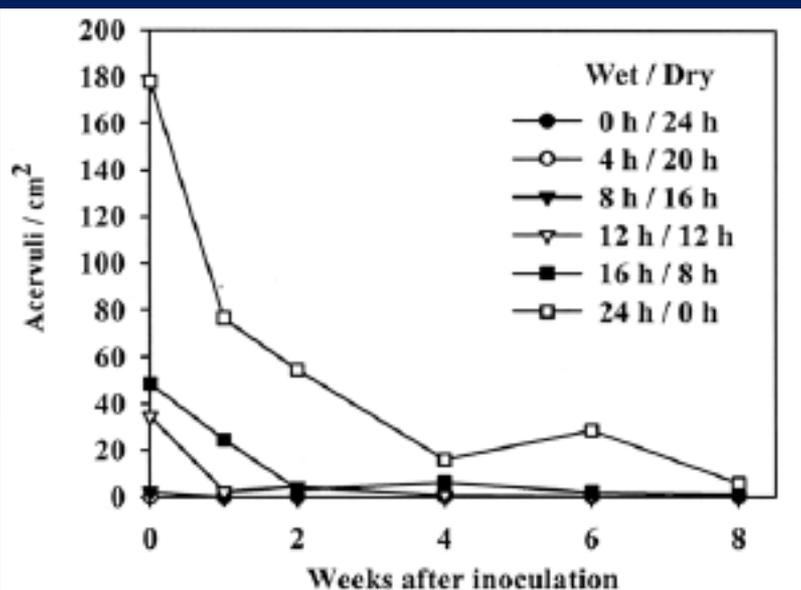


Fig. 3. Number of acervuli formed by *Colletotrichum acutatum* on strawberry leaves after the following treatment regime: plants were spray-inoculated with *C. acutatum* conidia, incubated at 25°C under six different wet/dry treatment regimes for 7 days, and maintained in the greenhouse under dry conditions for up to 8 weeks. At each sampling time during the latter period, leaf samples were excised, frozen overnight, and incubated at 25°C and 100% relative humidity for 1 week to induce acervular development. Data shown are for the second run of the experiment.

TABLE 3. Survival of *Colletotrichum acutatum* on strawberry leaves incubated at 25°C under different wet/dry treatment regimes for 7 days and maintained under dry conditions on a greenhouse bench for up to 8 weeks; survival was then assessed by freezing the leaves overnight and incubating at 25°C and 100% relative humidity for 7 days to stimulate formation of acervuli^a

| Treatment | Number of acervuli (cm ⁻² leaf area) | |
|-------------------|---|---------|
| | Run 1 | Run 2 |
| 0 h wet/24 h dry | 0.0 c | 0.0 b |
| 4 h wet/20 h dry | 0.0 c | 0.0 b |
| 8 h wet/16 h dry | 0.8 c | 0.9 b |
| 12 h wet/12 h dry | 4.4 c | 23.7 b |
| 16 h wet/8 h dry | 14.8 b | 62.2 b |
| 24 h wet/0 h dry | 44.8 a | 336.6 a |

^a Values followed by the same letter within columns are not significantly ($P \geq 0.05$) different according to Duncan's multiple range test. Values are area under the curve for acervuli formed on leaves over the survival period.

土壤病原菌偵測

Table 1. Prevalence of *Colletotrichum acutatum* in strawberry nursery and production field soils in California

| Field status | Number of sites | |
|--|-----------------|-------------------------|
| | Sampled | With <i>C. acutatum</i> |
| Currently in strawberry production, anthracnose symptoms present | 17 | 14 |
| Currently in strawberry production, anthracnose symptoms absent | 15 | 1 |
| Fallow, ^a fumigated ^b | 9 | 0 |
| Fallow, ^a not fumigated | 3 | 2 |

病組織埋於土壤病原菌存活情形

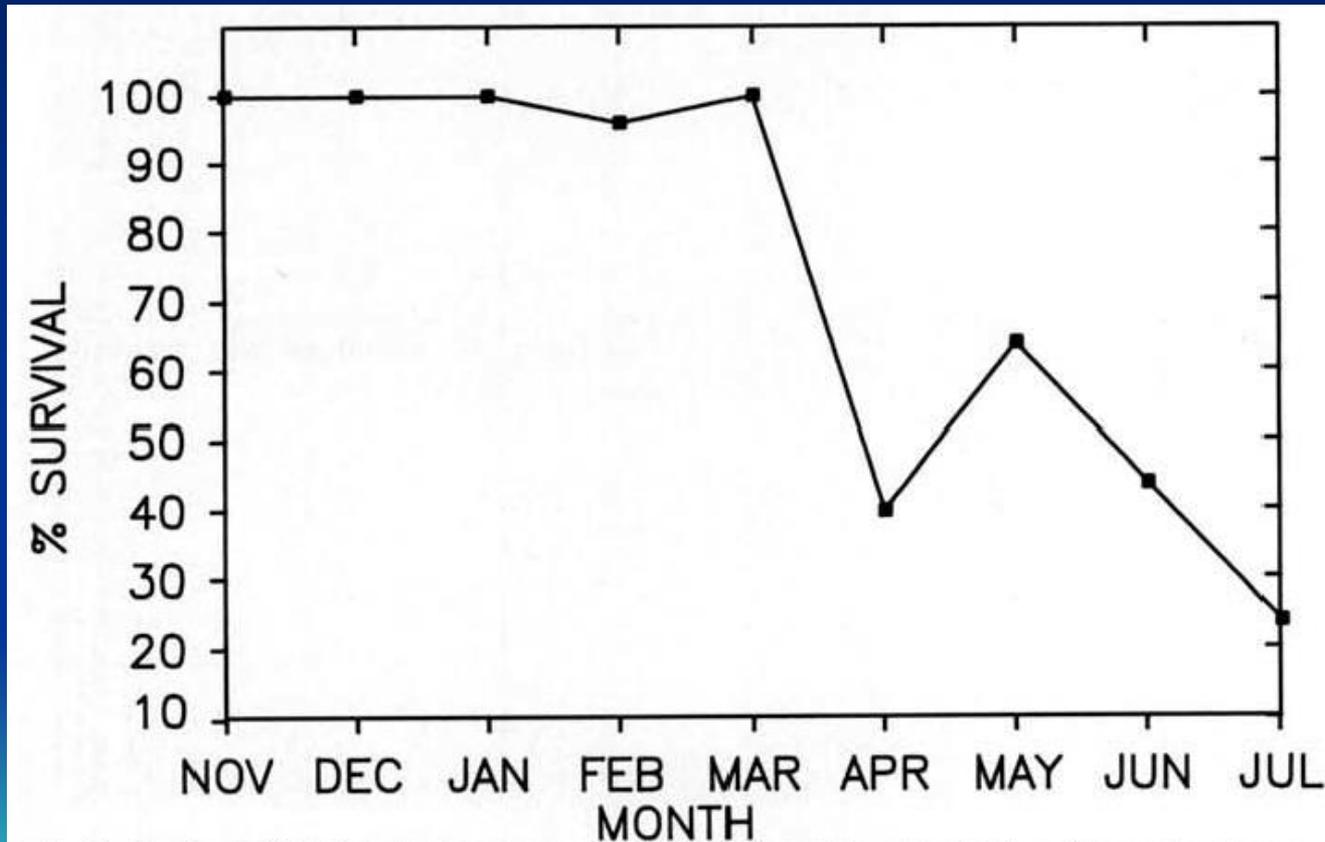


Fig. 2. Survival of *Colletotrichum acutatum* in strawberry tissue buried in a fallow strawberry nursery plot. Survival was measured as the percentage of recovered pieces that yielded *C. acutatum*.

雜草上存活 Rahman et al. 2015

Table 1. Isolates of *Colletotrichum gloeosporioides* recovered from noncultivated hosts at two different sites in North Carolina and pathogenicity on strawberry plants^x

| Host (botanical name) | Number of isolates ^y | | Pathogenicity to strawberry ^z | |
|--|---------------------------------|--------|--|-----|
| | CH | SH | CH | SH |
| Virginia creeper (<i>Parthenocissus quinquefolia</i>) | 10 (3) | 15 (4) | +++ | +++ |
| Noncultivated/Muscadine grape (<i>Vitis/Muscadinia rotundifolia</i>) | 5 (1) | 8 (2) | ++ | ++ |
| Smilax (<i>Smilax rotundifolia</i>) | 0 | 10 (1) | - | + |
| Chickweed (<i>Stellaria media</i>) | 0 | 5 | - | - |
| Brazil pusley (<i>Richardia brasiliensis</i>) | 0 | 3 | - | - |

^x CH = Castle Hayne, NC and SH = Sandhills, NC.

^y The number of isolates collected and verified using morphological and molecular methods; those pathogenic to strawberry are given in parentheses.

^z Symbols: +++ = highly pathogenic, ++ = moderately pathogenic and needed exposure to high temperature (32°C) for anthracnose crown rot and whole-plant wilting, and + = caused only stunting of the plants but no wilting. - = not pathogenic on strawberry.

親株接種比例與走莖苗產量

Table 2. Effect of mother plants inoculation on the number of runner plant production in the strawberry nursery in 2007 and 2008^z

| Inoculation level | Mean number of plants per square meter | | | |
|-------------------|--|------|--------|------|
| | 2007 | ±SE | 2008 | ±SE |
| Noninoculated | 60.4 a | 1.77 | 80.5 a | 2.36 |
| 5% mother plants | 54.1 b | 0.88 | 76.0 a | 1.52 |
| 10% mother plants | 46.6 c | 0.88 | 60.5 b | 1.04 |
| 25% mother plants | 37.7 d | 2.6 | 50.2 b | 3.47 |

^z SE = standard error of means. Values with the same letter within each column are not significantly different from other values within the same year according to Fisher's protected least significant difference test ($\alpha = 0.05$).

病原菌傳播

- 黏性孢子：藉水飛濺



模擬雨滴直徑處理

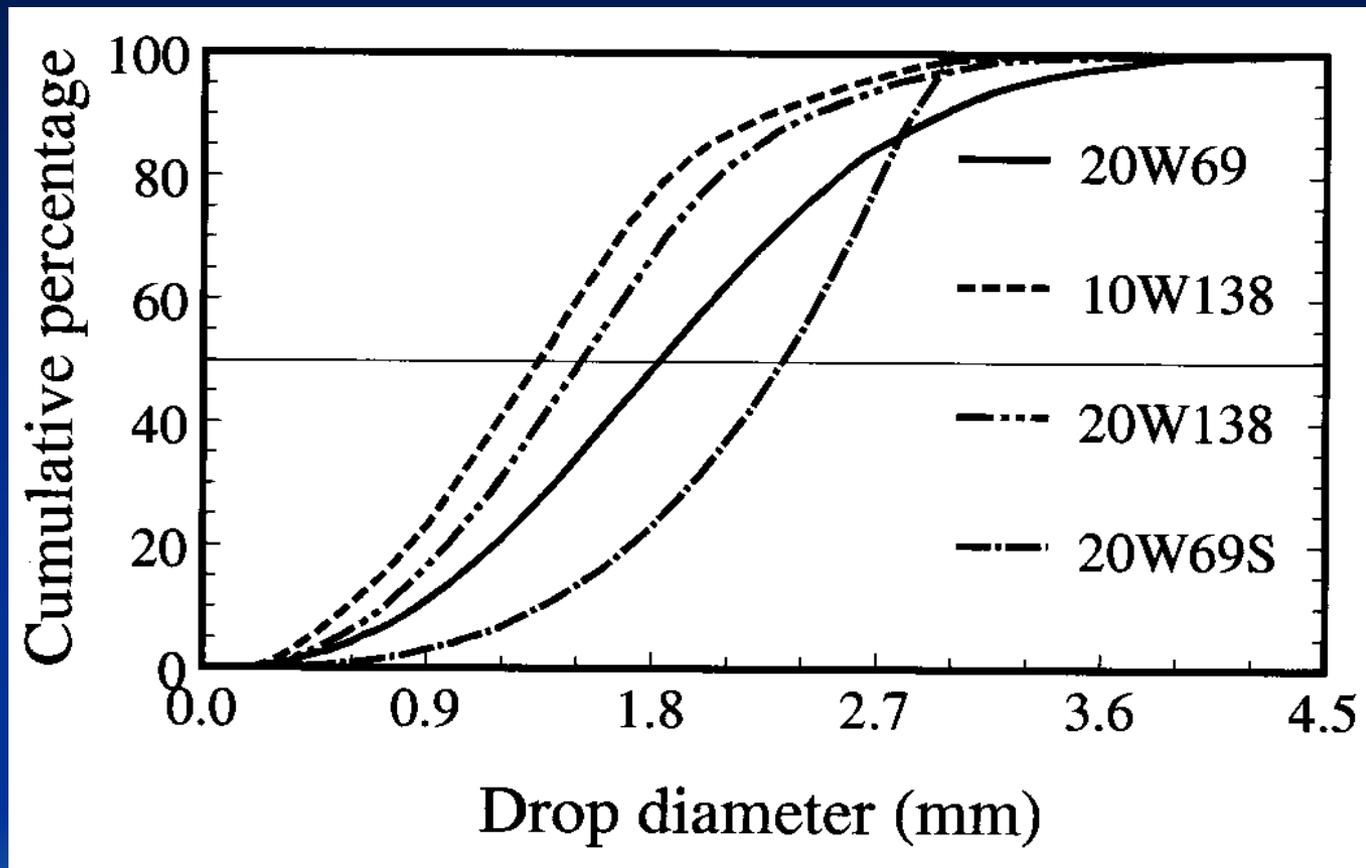
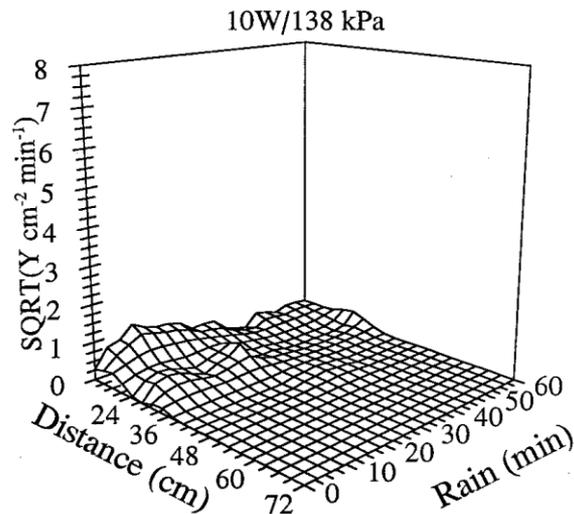
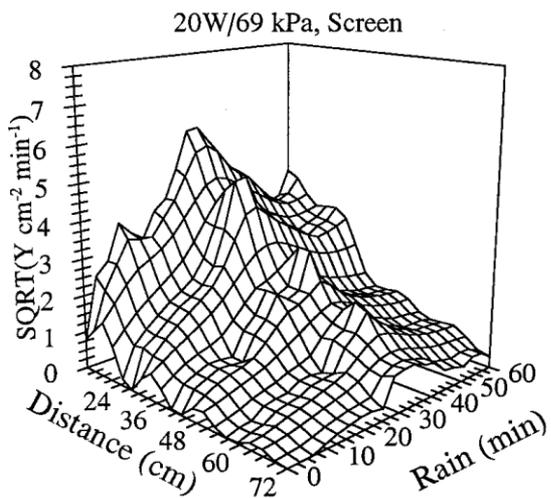
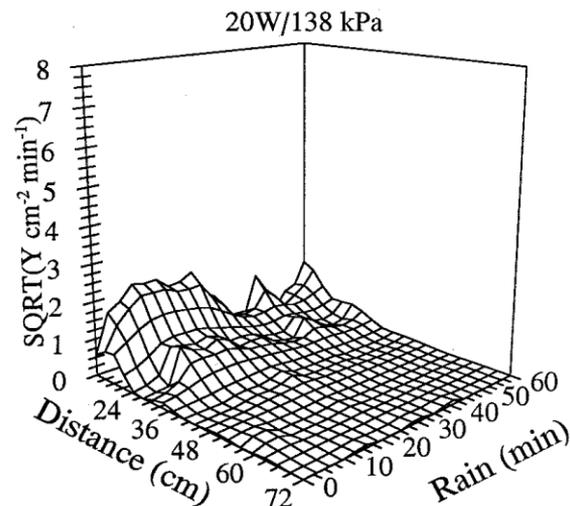
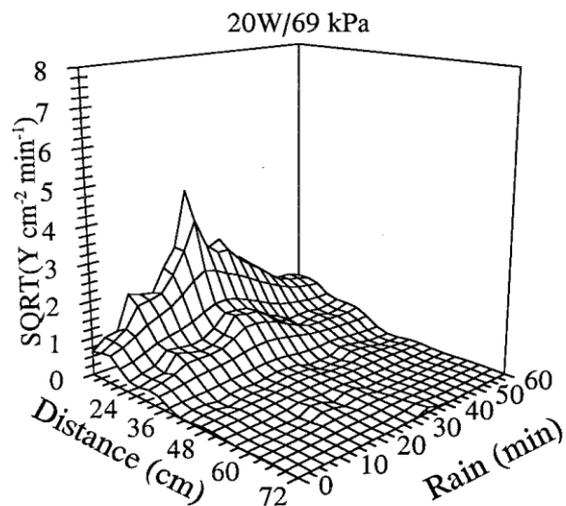


Fig. 1. Cumulative drop volume distributions of rain generated by four treatments using a rain simulator (24). Line labels indicate the nozzle (10W or 20W) and water pressure at the nozzle orifice (69 or 138 kPa). The 20W69S label corresponds to the treatment in which a horizontal screen was placed immediately below the nozzle.

水滴大小與病原菌飛散關係



果實病斑與感染源距離及下雨時間 關係

TABLE 3. Mean proportion of strawberry fruit infected by *Colletotrichum acutatum* (y) for rain durations of 4 and 16 min and distances from inoculum source of 30 and 60 cm for four treatments

| Treatment ^a | 30 cm | | 60 cm | | Mean |
|------------------------|-------------------------------|------------------|------------------|------------------|------------------|
| | 4 min | 16 min | 4 min | 16 min | |
| 20W/69 | 0.250 (0.058) ^b | 0.433 (0.033) | 0.067 (0.017) | 0.133 (0.044) | 0.221 (0.045) |
| 20W/138 | 0.233 (0.017) | 0.583 (0.130) | 0.067 (0.017) | 0.150 (0.058) | 0.258 (0.067) |
| 20W/69S ^c | 0.217 (0.093) | 0.707 (0.203) | 0.083 (0.017) | 0.183 (0.094) | 0.298 (0.089) |
| 10W/138 | 0.083 (0.044) | 0.150 (0.058) | 0.033 (0.033) | 0.050 (0.029) | 0.079 (0.020) |
| Mean | 0.196 (0.032) | 0.468 (0.081) | 0.063 (0.011) | 0.129 (0.030) | |

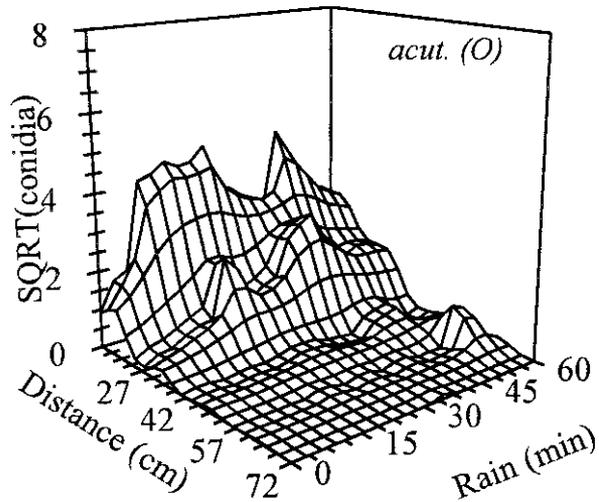
^a Nozzle/pressure (kPa).

^b Standard error in parentheses.

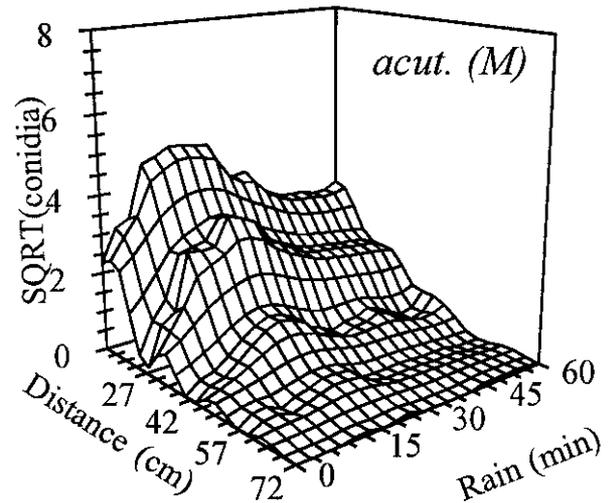
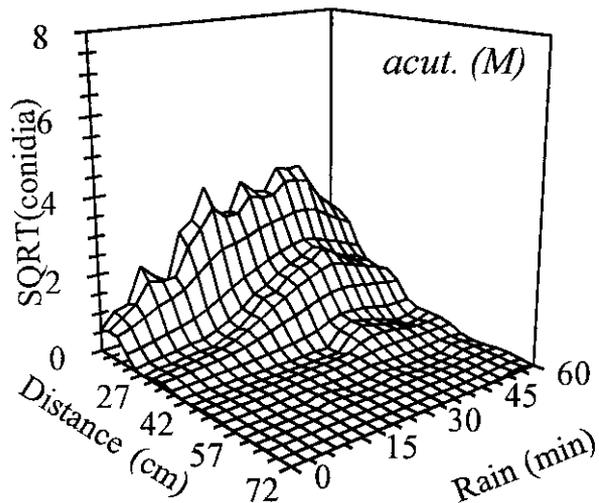
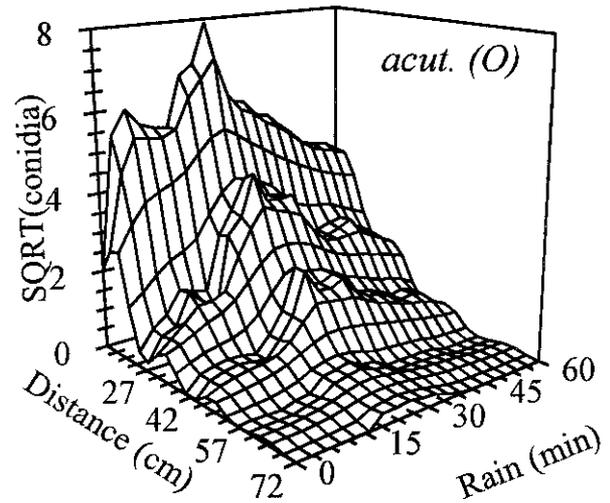
^c S = Horizontal screen placed immediately below the spray nozzle.

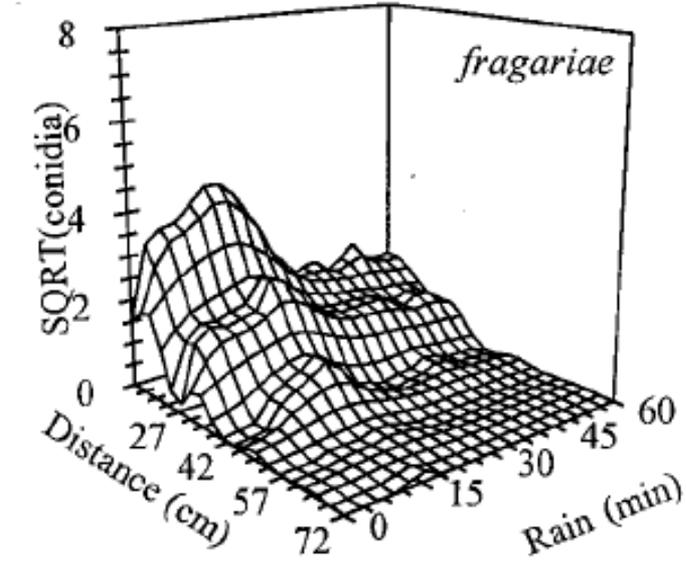
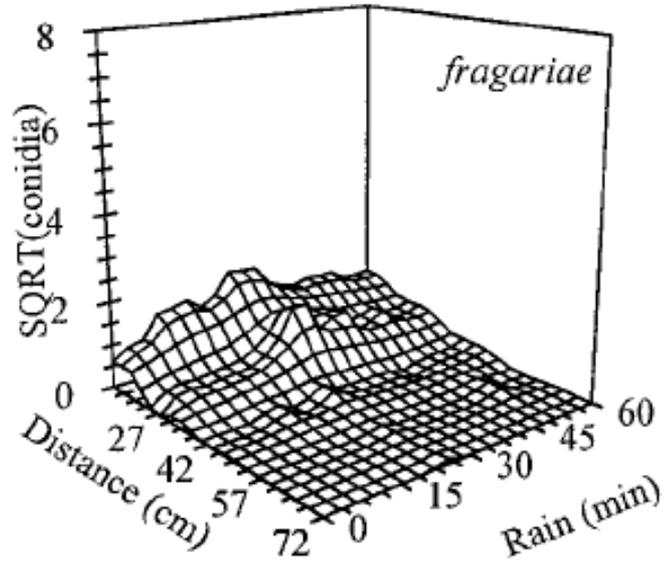
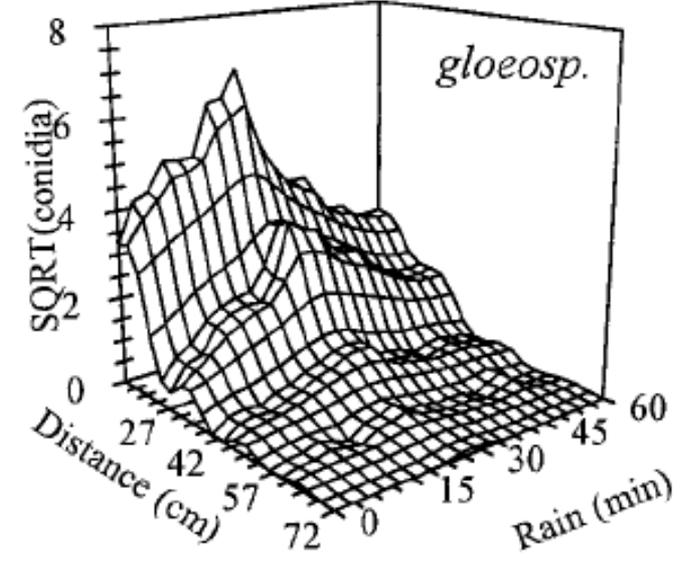
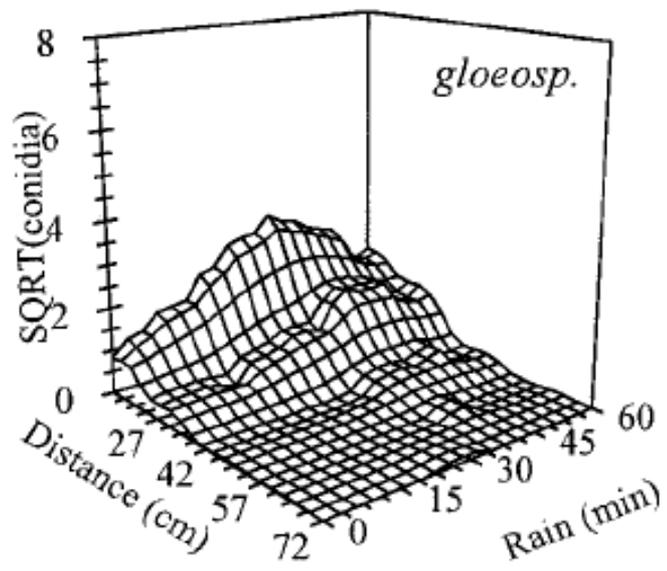
雨量與病原菌飛散關係

11 mm/h



30 mm/h





防治方法從消滅感染源著手

- 耕作防治：
 - 健康無病苗McInnes et al. 1992a
 - 抗病育種 日本方法Hirashima et al. 2015
 - 土壤消毒Freeman et al. 2002
 - 田間衛生
 - 肥料影響 Nam et al.2006 Smith, 2009a
 - 水份管理 Coelhoa et al. 2008
 - 畦面覆蓋物Coelhoa et al. 2008
- 化學防治

Louisiana州草莓園炭疽病調查結果

Table 1. Incidence of plants wilted by anthracnose crown rot in spring 1986 strawberry production fields of southeastern Louisiana established with transplants from local nurseries

| Grower | Cultivar-plant source | Wilted plants (%)^a |
|---------------|------------------------------|--------------------------------------|
| Lavigne | Tangi-local | 27.0 ± 2 ^b |
| Hoover, V. | Tangi-local | 2.0 ± 0.6 |
| Meyers | Tangi-local | 30.0 ± 2 |
| Drude | Tangi-local | 22.0 ± 1.9 |
| Hoover, L. | Tangi-local | 23.0 ± 1.9 |
| Newman | Tangi-local | 30.0 ± 2 |
| Wilson | Tangi-local | 8.0 ± 1.2 |
| Cummings | Tangi-local | 1.0 ± 0.4 |
| Jenkins | Tangi-local | 0.3 ± 0.2 |
| Gregiore | Tangi-local | 0.8 ± 0.4 |

^aBased on five independent 100-plant counts in different areas of each field. Survey on 29 April 1986.

^bStandard error.

1986-1989健康苗試驗

- 以組織培養當地品種(Tangi)進行增殖後，於隔離(無草莓生產)環境育苗，定期偵測病害。
- 種植無病原苗在田間偵測結果：1987-1989健康苗草莓園區未見炭疽病病徵。
- 無病原苗需求增加，本地苗炭疽病造成嚴重缺苗。



Table 2. Influence of plant source on occurrence of anthracnose crown rot in summer 1986 strawberry nursery beds and in spring 1987 commercial production fields in southeastern Louisiana

| Grower | Nursery beds (summer 1986) | | Production fields (spring 1987) | |
|------------|----------------------------|----------------------------|---------------------------------|--------------------------------|
| | Cultivar-source | Disease index ^a | Cultivar-source | Wilted plants (%) ^b |
| Lavigne | Tangi-local | 4 | Tangi-local Chandler-NC | 14 ± 1.6 ^c 0 |
| Meyers | Tangi-local | 2 | Tangi-local | 60 ± 2.2 |
| Hoover, L. | Tangi-local | 1 | Tangi-local Chandler-NC | 31 ± 2.1 0 |
| Jenkins | Tangi-local | 5 | Tangi-local Chandler-Canada | 10 ± 1.3 0 |
| Drude | Tangi-local | 5 | | |
| Newman | Tangi-local | 4 | Tangi-local | 2 ± 0.6 |
| Cummings | Tangi-local | 5 | Tangi-local | 3 ± 0.8 |
| Battles | Tangi-local | 5 | Tangi-local | 20 ± 1.8 |
| Ardillo | Tangi-local | 2 | | |
| Lard | Tangi-local | 1 | | |

^aDisease index 0-5: a visual estimate of disease loss in which 0 = no reduction in runner plants and 5 = 80% or greater reduction in runner plants. Values based on estimates from 10 areas per bed chosen at random. Surveyed on 21 October at the time they were being dug to establish production fields.

^bBased on five independent 100-plant counts in different areas of each field. Surveyed on 5 May 1987.

Table 3. Influence of plant source on occurrence of anthracnose crown rot in summer 1987 strawberry nursery beds and in spring 1988 commercial production fields in southeastern Louisiana

| Grower | Nursery beds (summer 1987) | | Production fields (spring 1988) | |
|------------|----------------------------|----------------------------|---------------------------------|--------------------------------|
| | Cultivar-source | Disease index ^a | Cultivar-source | Wilted plants (%) ^b |
| Lavigne | Tangi-local | 4 | | |
| | Chandler-local | 5 | Chandler-MI | 0 |
| Hoover, L. | Tangi-local | 1 | Tangi-local | 17 ± 1.7 ^c |
| | Chandler-local | 1 | Chandler-local | 35 ± 2.1 |
| | | | Chandler-MI | 0 |
| Drude | Tangi-Chase | 0 | Tangi-Chase | 0 |
| | | | Chandler-MI | 0 |
| Corona | Tangi-local | 2 | Tangi-local | 4 ± 0.9 |
| | Tangi-Chase | 0 | Tangi-Chase | 0 |
| | | | Chandler-MI | 0 |
| Jenkins | Tangi-local | 5 | Chandler-MI | 0 |
| | | | Chandler-Canada | 0 |
| | | | Tangi-local | 2 ± 0.6 |
| Vicaro | Tangi-local | 1 | Tangi-local | 3 ± 0.8 |
| Poche | Tangi-local | 2 | Tangi-Chase | 0 |
| | Tangi-Chase | 0 | Tangi-local | 20 ± 1.8 |
| Wells | Tangi-local | 2 | Chandler-MI | 0 |
| | | | | |
| Wilson | Tangi-local | 1 | | |
| Ardillo | Tangi-local | 4 | | |
| Beauchamp | Tangi-local | 0 | | |
| Liuzza | | | Chandler-MI | 0 |
| Meyers | | | Tangi-local | 16 ± 1.6 |
| | | | Chandler-local | 32 ± 2.1 |
| | | | Chandler-Canada | 0 |
| | | | Chandler-IN | 3 ^d ± 0.8 |

^aDisease index 0-5: a visual estimate of disease loss in which 0 = no reduction in runner plants and 5 = 80% or greater reduction in runner plants. Values based on estimates from 10 areas per bed chosen at random. Surveyed on 28 Sept. 1987 just before being dug to establish production fields.

^bBased on five independent 100-plant counts in different areas of each field. Survey on 3 May 1988.

Table 4. Influence of plant source on occurrence of anthracnose crown rot in summer 1988 strawberry nursery beds and in spring 1989 commercial production fields in southeastern Louisiana

| Grower | Nursery beds (summer 1988) | | Production fields (spring 1989) | |
|------------|----------------------------|---------------------------|---------------------------------|--------------------------------|
| | Cultivar-source | ACR severity ^a | Cultivar-source | Wilted plants (%) ^b |
| Vicaro | Tangi-local | 80 ± 1.8 ^c | Chandler-MI | 0 |
| Poche | Tangi-Chase | 0 | Tangi-Chase | 0 |
| | Chandler-local | 30 ± 2 | Chandler-local | 49 ± 2.2 ^c |
| Lavigne | Tangi-BR | 0 | Chandler-local | 80 ± 1.8 |
| | Chandler-local | 10 ± 1.3 | Chandler-MI | 0 |
| Hoover, L. | Tangi-Chase | 10 ^d ± 1.3 | Chandler-local | 74 ± 2 |
| | Chandler-local | 15 ± 1.6 | Chandler-CA | 0 |
| | | | Chandler-NC | 0 |
| Drude | Tangi-local | 35 ± 2.1 | Chandler-Canada | 0 |
| | Tangi-Chase | 0 | Tangi-local | 0 |
| | Chandler-local | 23 ± 1.9 | Tangi-Chase | 0 |
| Beauchamp | Tangi-local | 0 | Chandler-local | 0 |
| | Tangi-Chase | 0 | Chandler-Canada | 0 |
| | Chandler-local | 0 | Chandler-Canada | 0 |
| Wells | Chandler-local | 95 ± 1 | Chandler-local | 14 ± 1.6 |
| Meyers | | | Chandler-NC | 0 |
| | | | Chandler-CA | 0 |
| Blahut | | | Chandler-MI | 0 |
| Liuzza | | | Chandler-Canada | 0 |

^a ACR severity was determined by randomly selecting a total of 500 plants from each grower

抗病育種

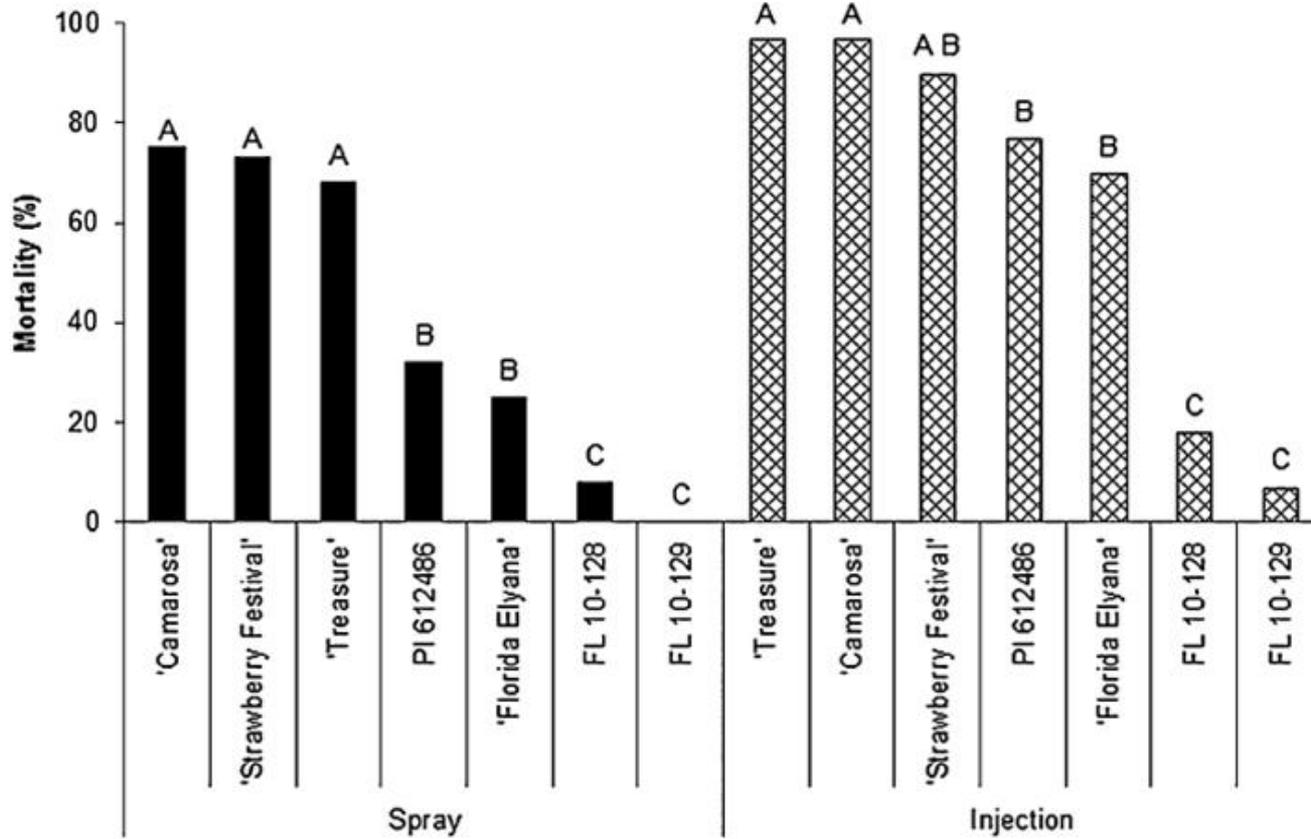
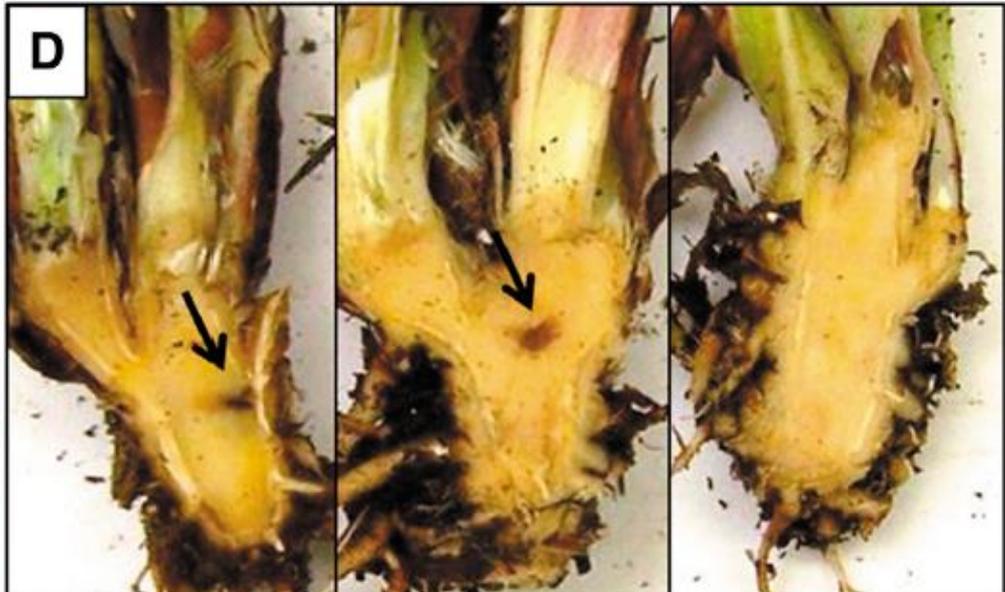
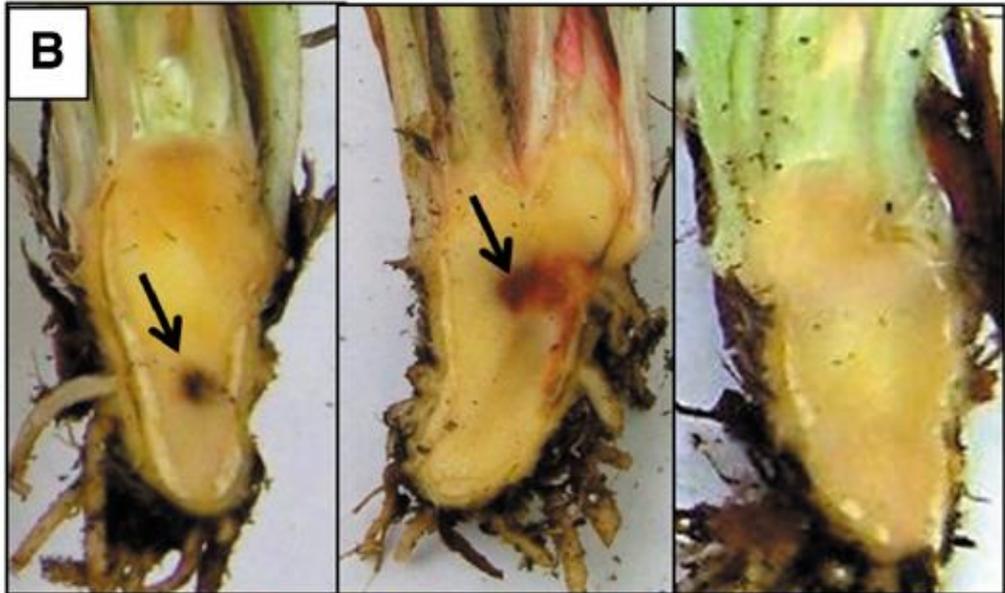


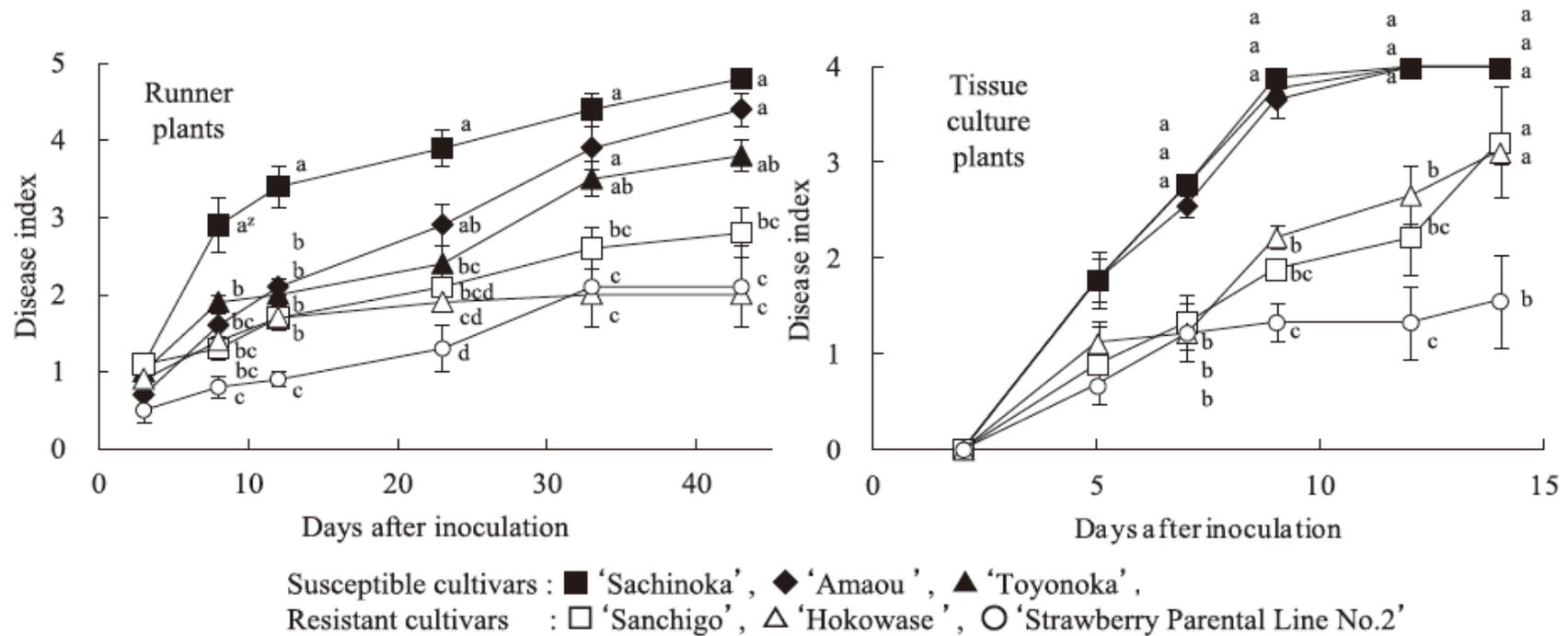
Fig. 1. Mean percent mortality of seven genotypes inoculated with a conidial suspension of *Colletotrichum gloeosporioides* by spray or injection methods. Mean values with the same letters were not statistically different ($P \geq 0.05$).



草莓抗炭疽病檢定日本新方法

Hirashima et al. 2015

- 以組織培養苗經由接種病原菌後於小空間內即可短時間快速篩選。



抗病檢定情形

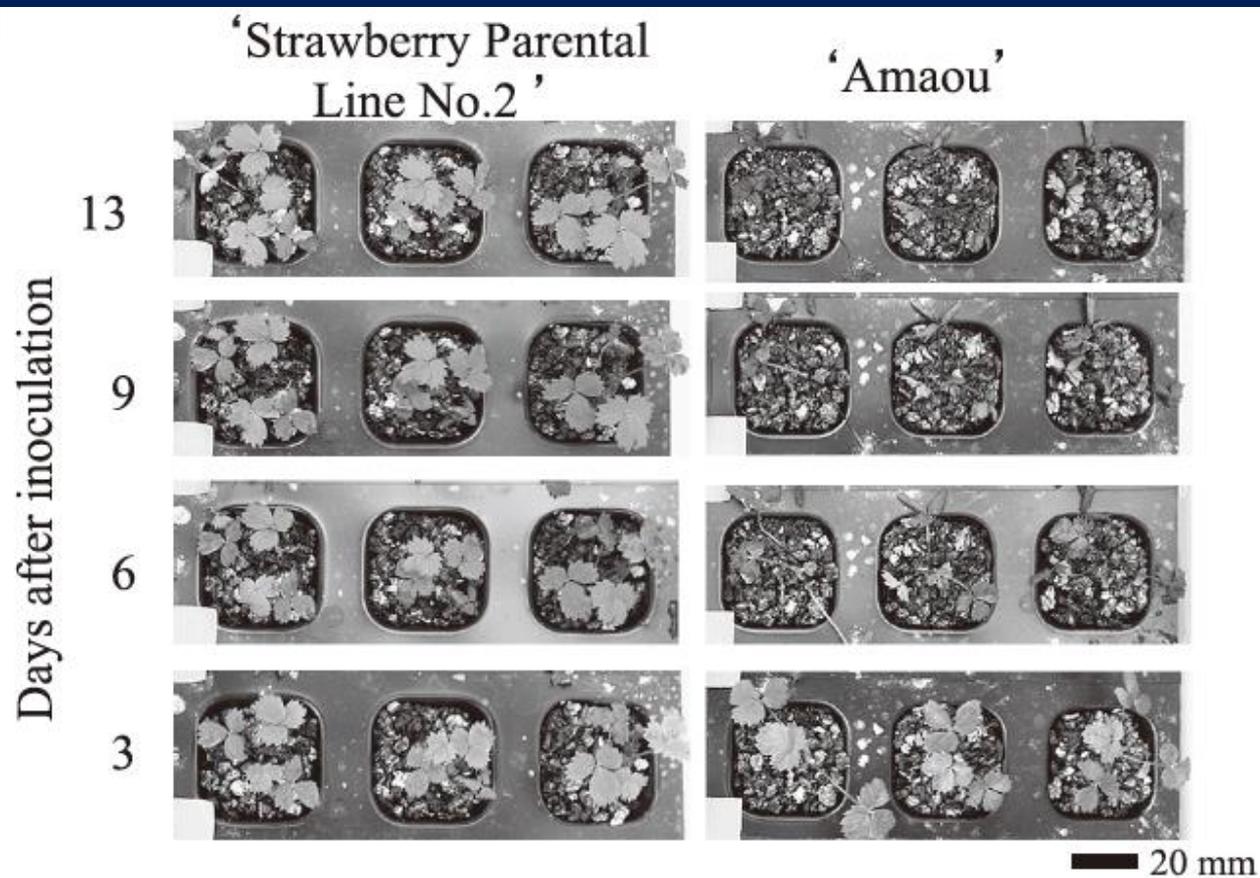


Fig. 2. The difference in progression of anthracnose symptoms on tissue culture of plants between 'Strawberry Parental Line No.2' and 'Amaou'.

Inoculum concentration of conidiospores was 1×10^4 spores \cdot mL⁻¹.

病原菌孢子在滅菌土壤族群變化

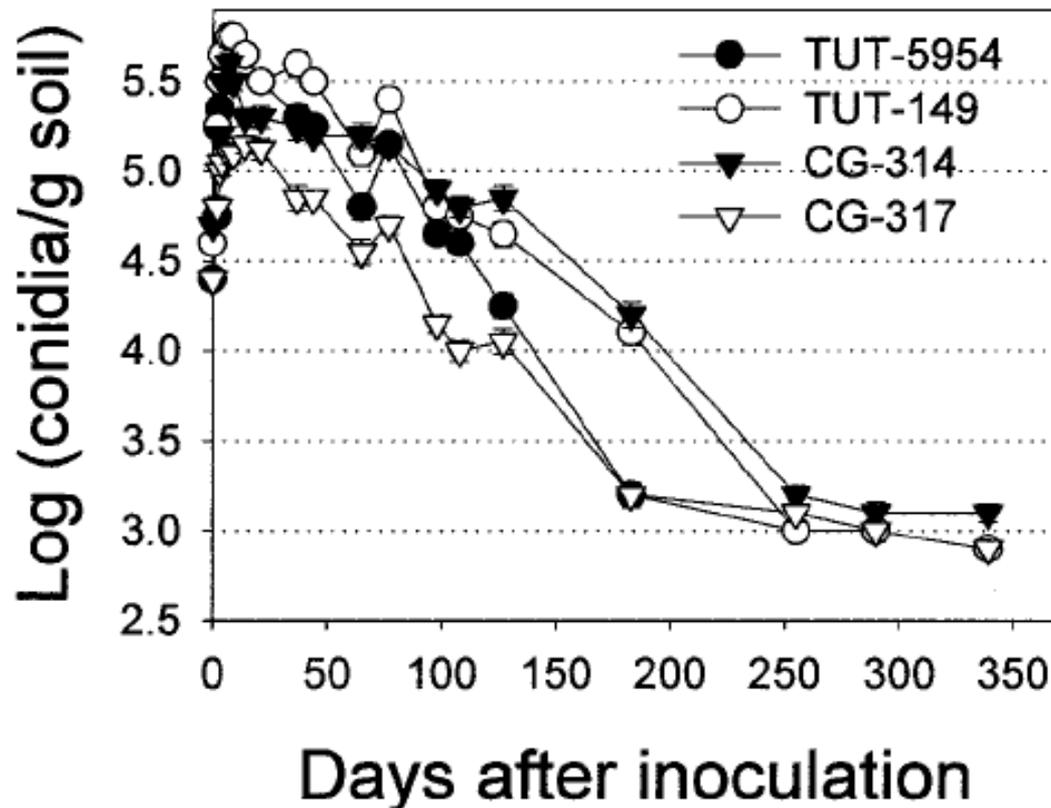


Fig. 2. Survival of *Colletotrichum acutatum* (isolates TUT-5954 and TUT-149) and *C. gloeosporioides* (isolates CG-314 and CG-317) in sterilized soil expressed as CFU over time. Bars represent standard errors of the mean. Where bars are lacking, the error is less than 5% of the value of the point. Values are means of survival of isolates from three replicate flasks.

未處理土壤病原菌孢子存活時間

Table 1. Survival, expressed as number of days needed to recover 50% (S_{50}) and 5% (S_5) of the original population, of culture-produced conidia and natural inoculum of *Colletotrichum gloeosporioides* and *C. acutatum* in untreated field soil, under controlled conditions in two experiments

| Species and isolates | Survival (days) ^z | | | |
|---------------------------------|------------------------------|-------|----------|--------|
| | Exp. 1 | | Exp. 2 | |
| | S_{50} | S_5 | S_{50} | S_5 |
| <i>C. gloeosporioides</i> (314) | 3.8 b | 4.4 a | 5.5 a | 9.8 a |
| <i>C. gloeosporioides</i> (317) | 5.7 a | 5.9 a | 3.7 b | 4.4 bc |
| <i>C. acutatum</i> (TUT-149) | 3.7 b | 4.0 a | 5.5 a | 5.8 b |
| <i>C. acutatum</i> (TUT-5954) | 3.3 b | 5.4 a | 6.1 a | 6.6 b |
| <i>C. acutatum</i> (natural 1) | 2.3 b | 3.4 b | 3.1 b | 4.2 c |
| <i>C. acutatum</i> (natural 2) | 2.3 b | 3.4 b | 3.0 b | 4.2 c |

^z Survival percentages were calculated from linear regressions of survival on time for each isolate or source. All regressions were significant ($P < 0.05$) and R^2 values ranged from 0.89 to 0.98. Values within each column followed by a common letter are not significantly different ($P > 0.05$) according to Fisher's protected least significant difference test.

不同含水量土壤病原菌孢子存活時間

Table 2. Survival, expressed as number of days needed to recover 50% (S_{50}) and 5% (S_5) of the original population, of culture-produced conidia of *Colletotrichum gloeosporioides* and *C. acutatum* in methyl bromide-treated field soil at two soil moisture levels at 25°C

| Species and isolates | Survival (days) ^z | | | |
|---------------------------------|------------------------------|---------|--------------|--------|
| | 11% Moisture | | 22% Moisture | |
| | S_{50} | S_5 | S_{50} | S_5 |
| <i>C. gloeosporioides</i> (314) | 31.7 a | 124.5 a | 6.5 a | 12.9 a |
| <i>C. gloeosporioides</i> (317) | 15.0 b | 114.4 a | 6.9 a | 10.3 a |
| <i>C. acutatum</i> (TUT-149) | 15.6 b | 72.8 b | 6.8 a | 11.7 a |
| <i>C. acutatum</i> (TUT-5954) | 15.9 b | 74.2 b | 6.3 a | 8.9 a |

^z Survival percentages were calculated from linear regressions of survival on time curves for each isolate or source. All regressions were significant ($P < 0.05$) and R^2 values ranged from 0.88 to 0.99. Values within each column followed by a common letter are not significantly different ($P > 0.05$) according to Fisher's protected least significant difference test.

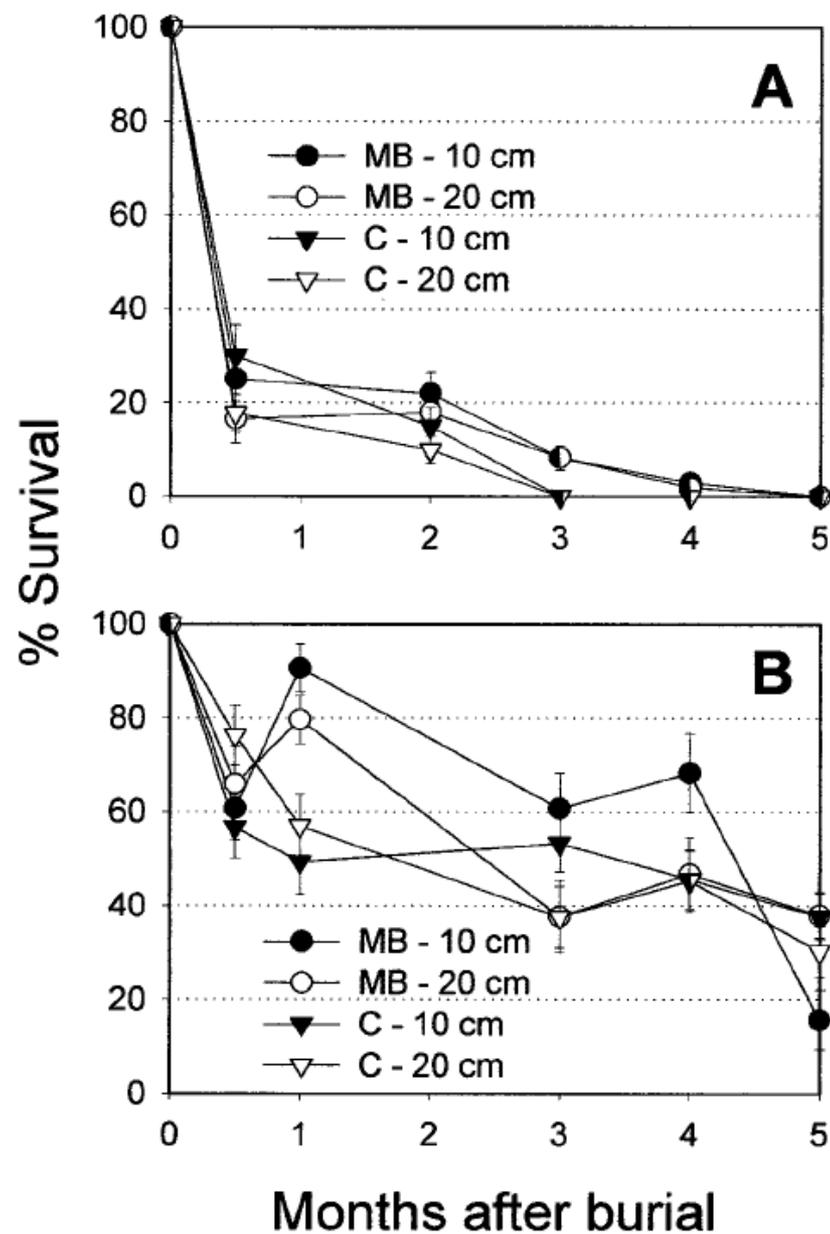


Fig. 3. Percent survival of *Colletotrichum acutatum* in A, naturally infected strawberry crowns and B, artificially inoculated mummified strawberry fruit under field conditions over time. The inocula were buried in methyl bromide (MB)-fumigated and C, untreated soil at 10- and 20-cm depths. Bars represent standard errors of the mean. Where bars are lacking, the error is less than 5% of the value of the point. Values are means of three replicates containing 10 crowns or fruit per sampling period.

土壤處理對病果上病原菌影響

Table 3. Survival of *Colletotrichum acutatum* in mummified fruit after 4 weeks in solarized or untreated soil under field conditions

| Treatments ^y | Soil depth (cm) | Survival (%) ^z |
|-------------------------|-----------------|---------------------------|
| Untreated | 10 | 40.0 a |
| Untreated | 20 | 46.0 a |
| Solarization | 10 | 6.0 b |
| Solarization | 20 | 0.0 b |

^y Control inoculum was buried in untreated field plots.

^z Values within each column followed by a common letter are not significantly different ($P > 0.05$) according to Fisher's protected least significant difference test.

Table 4. Survival of *Colletotrichum acutatum* in mummified fruits after 2 days in methyl bromide (MB)-treated or untreated soil under field conditions

| Treatments ^y | Soil depth (cm) | Survival (%) ^z |
|-------------------------|-----------------|---------------------------|
| Untreated | 0, 10, 20 | 100.0 a |
| MB | 0, 10, 20 | 0.0 b |

^y Control inoculum was buried in untreated field plots.

^z Values within each column followed by a common letter are not significantly different ($P > 0.05$) according to Fisher's protected least significant difference test.

介質處理對草莓炭疽病菌影響

- 新介質(泥炭土、椰纖)自農友收集的新介質檢測8份樣本，未檢測出炭疽病菌。
- 栽培過之介質收集12份樣本，炭疽病檢測結果：

| | | | | | | |
|---------------|-----|-----|------|-----|------|------|
| 內湖 | 1 | 2 | 3 | 4 | 5 | 6 |
| 10^3 prog/g | 1.2 | 0.9 | 0.4 | 0.8 | 1.65 | 1.4 |
| 內湖 | 7 | 8 | 9 | 10 | 11 | 12 |
| 10^3 prog/g | 0.5 | 0.6 | 0.75 | 0.6 | 1.32 | 0.35 |
| 本場 | 1.4 | 1.2 | 1.1 | 0.8 | 0.75 | 1.6 |

介質曝曬及淹水處理

- 使用過之介質，曝曬一周後病原菌檢測結果

| 本場 | 1 | 2 | 3 | 4 | 5 | CK |
|---------------------------|-----|------|-----|------|------|-----|
| 處理前 10^3cfu/g | 1.4 | 1.2 | 0.8 | 0.75 | 1.6 | 1.1 |
| 曝曬 10^2cfu/g | 0.6 | 0.45 | 0.3 | 0.5 | 0.55 | 8 |
| 淹水 10^2cfu/g | 0.4 | 0.3 | 0.4 | 0.27 | 0.4 | 8 |

水份管理及覆蓋物對病害影響

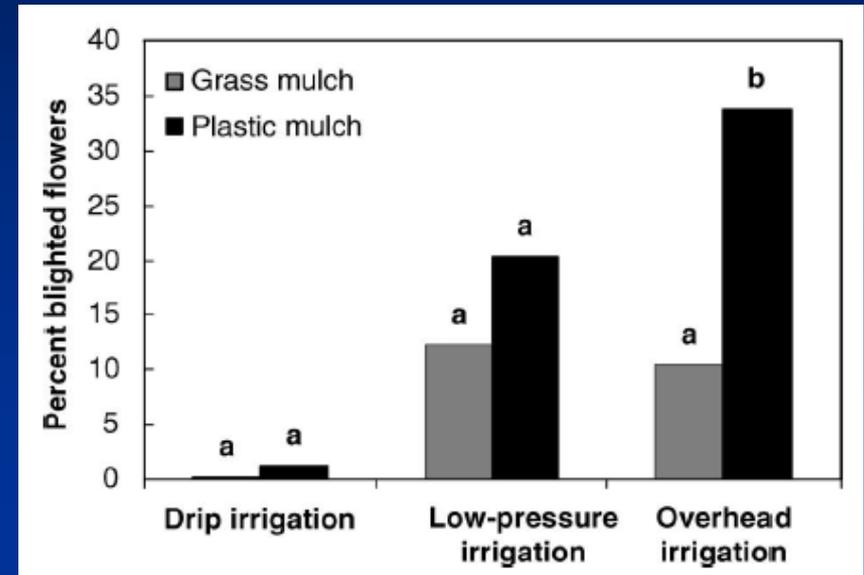
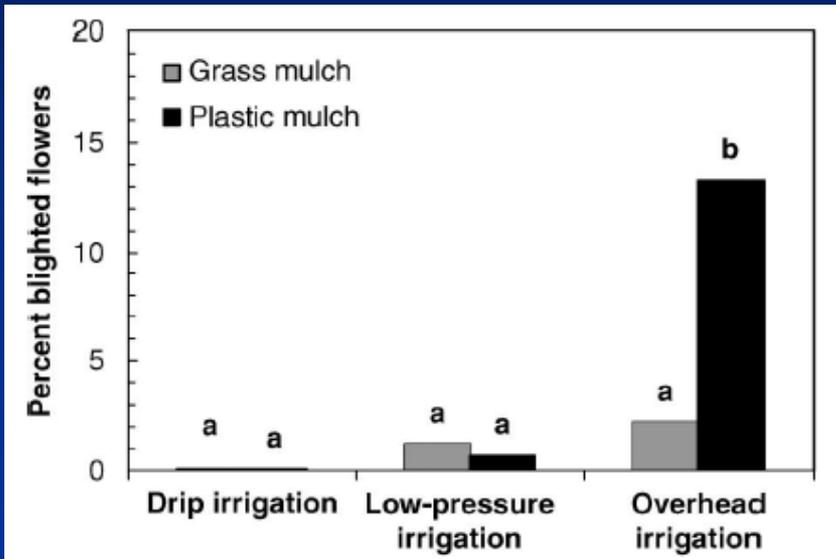


Figure 1. Effects of irrigation systems and mulching materials on the incidence of flower blight at 20 (left) and 55 days after inoculation (right). Bars with different letters are significantly different, according to Tukey's multiple range test ($P < 0.05$).

水份管理及覆蓋物病勢曲線

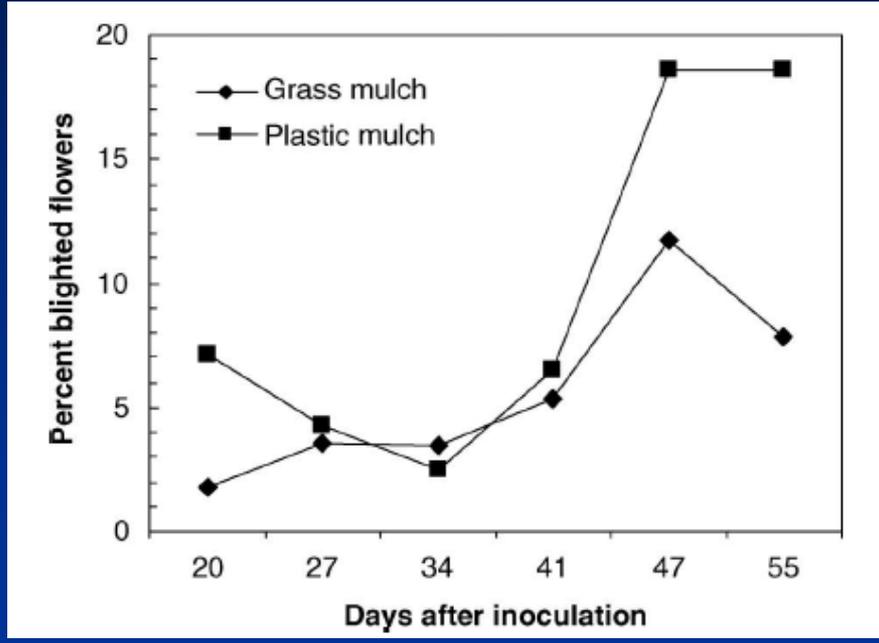
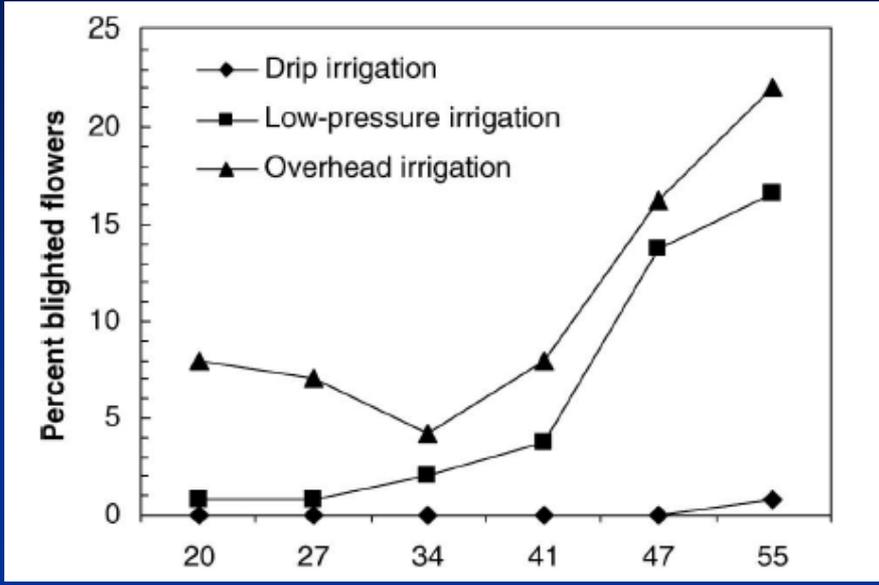


Figure 2. Disease progress curves for the single main effects of irrigation system and mulch material on the incidence of flower blight: main effects of irrigation system irrigation (left); and main effects of mulching material (right). No significant interactions were observed for the areas under disease progress curves (AUDPCs) between irrigation system and mulch material.

覆蓋物對病害影響

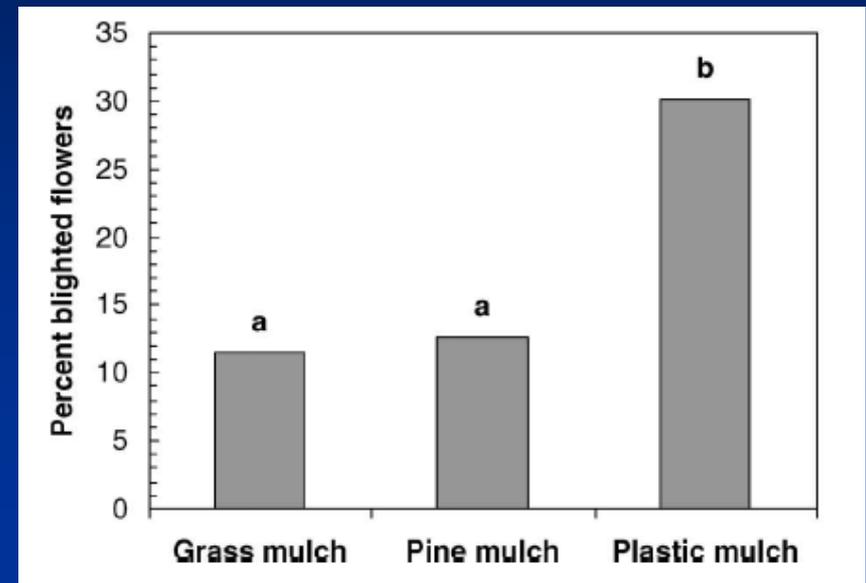
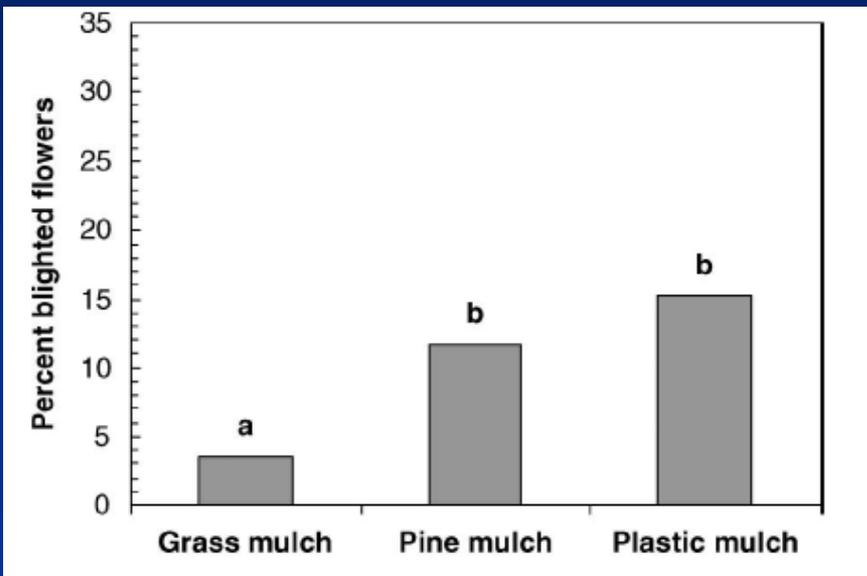
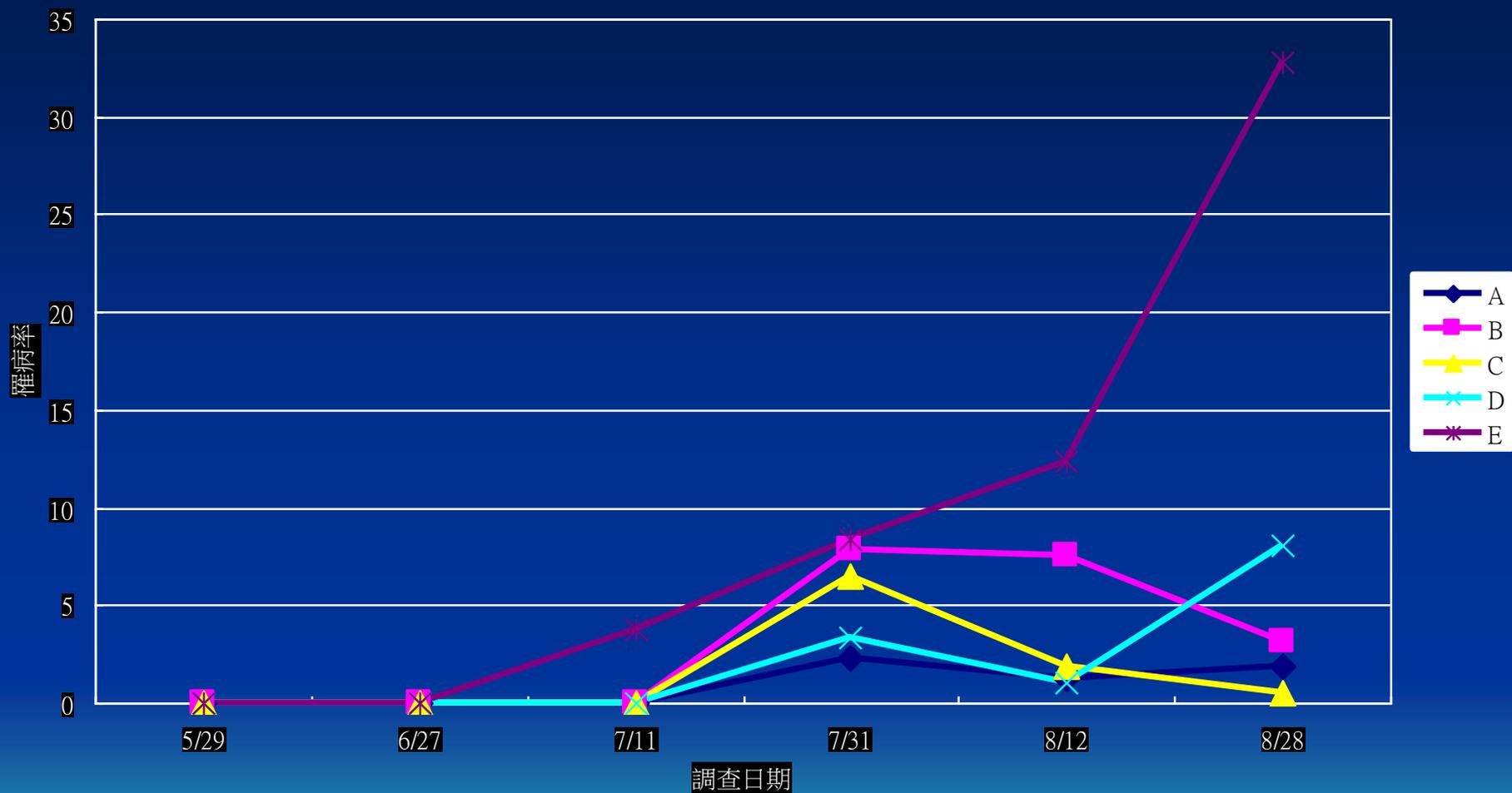


Figure 3. Single main effects of mulch type on the incidence of flower blight at 23 days after inoculation (DAI, left) and 29 DAI (right). No significant interactions between mulching material 6 cultivar genotype were detected at these points in time during the epidemics.

育苗期水份管理底部淹灌(A-D)與噴灌(E)田間走莖苗罹病率(新埔103)

| | A | B | C | D | E |
|------|------|-------|------|-------|-------|
| 5/29 | 0 | 0 | 0 | 0 | 0.012 |
| 6/27 | 0 | 0.046 | 0 | 0.048 | 0.049 |
| 7/11 | 0 | 0 | 0 | 0 | 3.766 |
| 7/31 | 2.3 | 7.895 | 6.45 | 3.333 | 8.333 |
| 8/12 | 1.27 | 7.563 | 1.92 | 1.075 | 12.33 |
| 8/28 | 1.93 | 3.125 | 0.54 | 8.088 | 32.84 |

不同灌溉方式對草莓炭疽病影響



養份對炭疽病影響

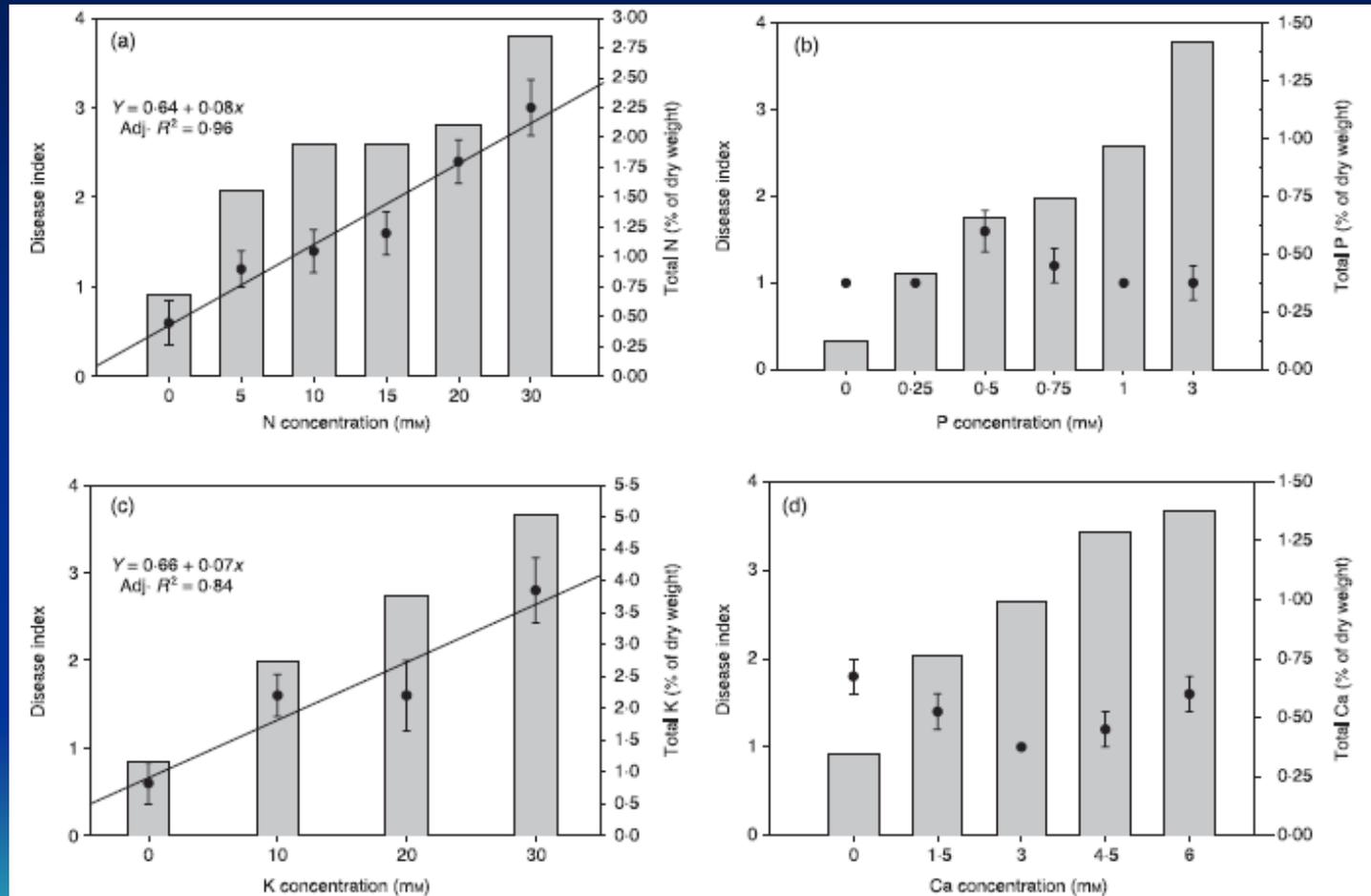


Figure 1 Development of anthracnose (scatter plot with error bars) and nutrient concentration (vertical bars) in strawberry plants treated with different concentrations of nitrogen (a), phosphorus (b), potassium (c) and calcium (d). Disease index: 0, healthy; 1, < 50% petioles affected; 2, ≥ 50% petioles affected; 3, wilted; 4, necrosis formed on entire plants. Adjusted regression coefficients and line derivations in (a) and (c) were significant ($P \leq 0.05$). Differences in (b) and (d) were nonsignificant ($P \geq 0.62$). Error bars represent \pm standard error of mean.

病害管理

- 自種苗來源控管，選取未發病區之種苗。
- 以滴灌並於田區覆蓋稻草以減少病原菌飛散，或搭設簡易設施減低雨水飛濺。
- 病原菌發芽及感染皆需高濕(相對溼度100%)，保持田間通風排水良好可減少感染及傳播。
- 減少氮肥施用，可減低病害發生。
- 田區雜草清除，減少病原菌來源。

簡報結束
敬請指正

