Occurrence and Control of Strawberry Powdery Mildew in Al-Shoubak/ Jordan

Muwaffaq Ramadan Karajeh¹, Ziad Barakat Al-Rawashdeh², and Ezz Al-Dein Muhammed Al-Ramamneh³

ABSTRACT

Powdery mildew of strawberry caused by the fungus Sphaerotheca macularis f. sp. fragariae was found in Al-Shoubak area under glasshouse conditions. White superficial fungal growth was more abundant on the lower than the upper leaf surface and no cleistothecia were noticed on any plant parts. Top leaves were more susceptible than middle or bottom leaves. Strawberry cultivars Albion and Camarosa were artificially inoculated with the fungus under growth room conditions. Disease incidence and severity were 46.7% and 50.8% in cv. Albion and significantly different from that (1.6% and 5.2%, respectively) in cv. Camarosa. In vitro leaflet bioassays and a runner-tip plantlet experiment were done to assess the influence of some fungicides and resistance-inducing chemicals in controlling the disease. Canvil was significantly effective in controlling the disease while sulfur, Triadimefon, Mycozim and Punch were only effective at the high application rates. Both calcium chloride at 1 g/l and hydrogen peroxide at 10 mM were effective in controlling powdery mildew on strawberry.

Keywords: Cultivars, fungicides, management, Sphaerotheca.

INTRODUCTION

The total area of greenhouses was estimated about 40,700 hectares worldwide (Witter and Castilla, 1995). The greenhouse industry as a whole represents a minuscule part of the total agricultural production, but the gross return to the economy could be significant (Takeda, 2000). Strawberry (Fragaria X ananassa Duchesne) production has increasingly been transferred from the fields into covered systems. In Jordan, strawberry is mainly planted under greenhouse (plastic or glass-house) conditions in irrigated agricultural areas including Jordan Valley, uplands (e.g. Al-Shoubak) and desert plains with a total annual production of about 175 tons in 2008 according to Jordan exports and producers association for fruit and vegetables (JEPA).

Powdery mildew of strawberry caused by the fungus Sphaerotheca macularis (Wallr. Ex Fr.) Jacz. f. sp. fragariae Peries, is a major disease of this crop worldwide (Spencer, 1978; Maas, 1998). The fungus attack above-ground plant parts causing serious damage to the foliage and resulting in reduction of photosynthesis due to dense mycelial coverage of leaf surface, which can lead to necrosis and eventual defoliation (Maas, 1998). Powdery mildew causes economic losses in the marketable fruit yield (Horn et al., 1972; Spencer, 1978).

Development of powdery mildew depends on optimum temperature (15–25 °C) and high relative

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-380-
humidity, higher than 75 %, but less than 98 % (Amsalem et al., 2006). Mycelia develop, survive in green tissue under all condition and sporulate under 5–30 °C (Miller et al., 2003).

Prevention is the best method of powdery mildew control of strawberry through avoiding the use of susceptible cultivars and through following up good cultural practices. However, susceptible strawberries may require protection with foliar sprays with fungicides to reduce infection and consequently fruit yield losses (Okayama, 1995; Ashour, 2009). Use of induced resistance in disease management has a promising approach against several bacterial, fungal, and viral plant diseases during the past decade as the application of certain environmentally safe chemicals (e.g. calcium chloride or hydrogen peroxide) may activate the endogenous defense mechanisms of plants, providing long-lasting resistance. Resistance-inducing chemicals were investigated as safe alternatives for controlling powdery mildews on cucurbits and strawberry (Abataleb, 2000; Hilall, 2004; Palmer, 2007; Hukkanen et al., 2007; Abada et al., 2008; Ashour, 2009).

Therefore, this research was conducted to study the occurrence and control of strawberry powdery mildew under glasshouse conditions in Al-Shoubak area of Jordan.

**MATERIALS AND METHODS**

**Greenhouse facilities and plant material**

Visual observations of strawberry powdery mildew were carried out inside a commercial glasshouse at Al-Shoubak area of Jordan, situated approximately 260 km south of Amman. The greenhouse had several passages between planting lines and 100 m² long polystyrene shelves on each side of the greenhouse. Each shelf contained 400 strawberry (cv. Albion) plants in peat bags in a single row. The height of the shelves above the floor could be adjusted whenever necessary for picking, spraying, etc. The day temperature was ranged between 15-25°C, while the night temperature during cool nights was between 8-15°C. The mean daily outside temperature was approximately 14°C and 16°C during the 2008 and 2009 strawberry growing seasons, respectively.

**Pathogen identification and inoculum preparation**

The powdery mildew population of *Sphaerotheca macularis* f. sp. *fragariae* used in the inoculations originated from strawberries cv. Albion previously grown in the same glasshouse. The fungus was identified under a slide stereoscopic microscope based on the morphology of conidia. Conidia are smooth-walled and barrel-shaped, 25 to 38 µm long and 15 to 23 µm wide (Braun et al., 2002). The fungus was maintained on young susceptible plants of the same cultivar.

Sporulating colonies of powdery mildew on leaves were put into a plastic Petri dish containing distilled water. Conidia were detached by brushing. The concentration of the fungal inoculum was adjusted to 10⁷ conidia/ ml using a haemocytometer slide (Rodriguez-Tudela et al., 2003). The pathogenicity of the fungus was confirmed by spraying the conidial suspension at 10 strawberry plants (cv. Albion) under controlled growth chamber conditions (20 ± 2°C and 12 hour-day light). Early foliar infections of *Sphaerotheca macularis* f. sp. *fragariae* were characterized by small white patches of superficial growths of the fungus on leaf blade and petiole and small fruits of the susceptible plants of cv. Albion, dense mycelial growth and numerous chains of conidia give these patches a powdery appearance.

**Artificial inoculation under growth room conditions**

Ten plants of strawberry cv. Camarosa or cv. Albion transplanted into pots containing a pasteurized mixture of clay, peat and perlite (1:1:1 v/v/v) were individually
sprayed with the conidial suspension at $10^7$ conidia/ml concentration. All plants were allowed to grow under growth room conditions with a 12 hour photoperiod under fluorescent light (4000 lux/day) for four weeks. Spreader powdery mildew-heavily diseased plants were distributed among the artificially inoculated plants to increase the possibility of infection. Disease severity was categorized using 0-4 disease scale (0: no infection, 1: small patch (up to 10%), 2: 11-25%, 3: 26-50% and 4: more than 50% leaf area covered with mildew growth) as described by Okayama et al. (1995). The overall disease severity % was the sum of numerical ratings per a treatment divided on the total number of leaves observed multiplied 100 over the maximum disease category value (4). Disease incidence was expressed as the % of diseased leaflets per a plant.

**In vitro leaf discs bioassay**

Two *in vitro* leaflet bioassays were done, in the first bioassay, leaflets (5cm-in-diameter) were individually picked from strawberry (cv. Albion) plants and dipped in 100 ml of the tested chemical solutions or distilled water as a control for 10 seconds and then sprayed with the conidial suspension. Each leaflet was placed into a test tube containing 10 ml distilled water and incubated in a full-controlled growth chamber at 20°C with a 12 hour photoperiod under fluorescent light (3000 lux/day) for one week. All treatments and control were arranged in a completely randomized design (CRD). Each treatment was replicated three times. Disease incidence was expressed as the % of mycelial coverage of infected leaves and was recorded one week after treatment.

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Trade name</th>
<th>Formulation</th>
<th>Company</th>
<th>Chemical group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flusilazole</td>
<td>Punch</td>
<td>40% EC</td>
<td>Dupont</td>
<td>Triazoles</td>
</tr>
<tr>
<td>Hexaconazole</td>
<td>Canvil</td>
<td>5% SC</td>
<td>Vapco</td>
<td>Triazoles</td>
</tr>
<tr>
<td>Triadimefon</td>
<td>Triadimefon</td>
<td>20% EC</td>
<td>Singma</td>
<td>Triazoles</td>
</tr>
<tr>
<td>Carbendazim</td>
<td>Mycozim</td>
<td>50% SC</td>
<td>Taicang city</td>
<td>Benzimidizoles</td>
</tr>
<tr>
<td>Sulfur</td>
<td>H-Sulfur</td>
<td>80% WP</td>
<td>Al-Lahab</td>
<td>Minerals</td>
</tr>
</tbody>
</table>

While in the second bioassay, powdery mildew-infected leaflets (5cm-in-diameter) were individually picked from strawberry (cv. Albion) plants, dipped in 100 ml of the tested chemical solutions or distilled water as a control for 10 seconds, placed into a test tube containing cotton plug moistened with distilled water and incubated as before. Treatments and control were replicated three times and arranged in CRD. Disease severity % was assessed and recorded as before. The percentage of disease control was also recorded as the % of relative reduction in the disease severity % of the treatment compared with that of the control. If the % of disease control more than 50% the treatment is considered effective in controlling the powdery mildew.

**Runner-tip plantlets experiment**

Runner-tip plantlets slightly infected with powdery mildew (around 30% disease severity) were individually picked from strawberry (cv. Albion) plants, transplanted into small plastic pots (250 ml in volume) filled with moistened perlite and sprayed with the tested chemical solutions or distilled water as a control and incubated in a plant growth chamber at 20°C with a 12 hour photoperiod under fluorescent light (4000 lux/day) for four weeks.
photoperiod under fluorescent light (3000 lux/day) and 80% relative humidity for one week. Disease severity % was assessed as previously described while disease incidence was expressed as the % of diseased leaflets per a plantlet.

**Statistical analysis**

Data were analyzed statistically using general linear model (GLM) procedure (SPSS software version 11.5; SPSS Inc., Chicago, USA). Least significance difference (LSD) test and t-test were used for mean separation at the 0.05 probability level (Steel *et al.*, 1997).

**RESULTS**

More patches were found on the lower surface than the upper leaf surface. Few patches of the mycelial growth were noticed on cv. Camarosa. No cleistothecia were noticed on the patches on the leaves, fruits or other plant parts under field, greenhouse or laboratory conditions.

Regarding to leaf position on strawberry plant, there were no significant differences in disease severity % between top, middle or bottom leaves during 2008 in strawberry growing season under glasshouse conditions while top leaves were more susceptible for powdery mildew infection during 2009 strawberry growing season (Figure 1). The edges of heavily infected leaves curled upward. Disease incidence and severity percentages were 46.7% and 50.8%, respectively on cv. Albion and significantly different from that (1.6% and 5.2%, respectively) on cv. Camarosa (Table 2).

**Table 2. Disease incidence and severity of powdery mildew on two strawberry cultivars under growth room conditions.**

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Disease incidence %</th>
<th>Disease severity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albion</td>
<td>46.7 (^{1}) (^{a})</td>
<td>50.8 a</td>
</tr>
<tr>
<td>Camarosa</td>
<td>1.6 b</td>
<td>5.2 b</td>
</tr>
</tbody>
</table>

\(^{1}\) Average of 10 plants/ treatment

\(^{2}\) Means within columns followed by the same letters are not significantly different at 0.05 probability level using t-test.

**A- Strawberry growing season 2008**

![Graph showing disease severity over time for top, middle, and bottom leaves of strawberry plants]
Figure 1. Powdery mildew disease development on strawberry with respect to leaf position (top, middle and bottom) during 2008 (LSD$_{0.05}$ = 10.5) and 2009 (LSD$_{0.05}$ = 22.4) growing seasons inside glass-house in Al-Shoubak area of Jordan.

Table 3 shows the results of the two *in vitro* leaflet bioassays. Among the tested fungicides, Canvil (5% hexaconazole) at both low and high application rates gave significant reductions in disease severity % compared to that of the control (water) and lead to more than 50% control (58 and 64%, respectively). Mycozim (50% Carbendazim) and sulfur gave good control at their high application rates (77 and 58%, respectively). At their low concentrations, both hydrogen peroxide (10 mM) and calcium chloride (1 g/l) as resistance inducers gave 61 and 68% control, respectively.

Table 3. Effect of fungicides and resistance-inducing chemicals on powdery mildew disease severity on strawberry (cv. Albion) leaflets in two *in vitro* leaflet bioassays:

<table>
<thead>
<tr>
<th>Fungicide/ resistance inducer</th>
<th>Conc.</th>
<th>DS1 %$^1$</th>
<th>DS2 %$^2$</th>
<th>Mean</th>
<th>Control %$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canvil</td>
<td>Low, 4ml/ 20L</td>
<td>11.7 c$^3$</td>
<td>38.8 b</td>
<td>25.4 h</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>High, 8ml/ 20L</td>
<td>18.3 c</td>
<td>25.0 bc</td>
<td>21.8 j</td>
<td>64</td>
</tr>
<tr>
<td>Triadimefon</td>
<td>Low, 4ml/ 20L</td>
<td>52.5 a</td>
<td>44.3 ab</td>
<td>48.6 c</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>High, 10ml/ 20L</td>
<td>13.8 c</td>
<td>62.3 ab</td>
<td>38.2 e</td>
<td>37</td>
</tr>
<tr>
<td>Punch</td>
<td>Low, 1ml/ 20L</td>
<td>44.4 ab</td>
<td>44.1 ab</td>
<td>44.4 d</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>High, 1.5ml/ 20L</td>
<td>56.8 a</td>
<td>44.5 ab</td>
<td>50.8 b</td>
<td>17</td>
</tr>
<tr>
<td>Mycozim</td>
<td>Low, 10 ml/20L</td>
<td>8.3 c</td>
<td>56.5 ab</td>
<td>32.6 f</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>High, 20 ml/20L</td>
<td>20.0 bc</td>
<td>7.7 c</td>
<td>14.0 l</td>
<td>77</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Low, 40g/ 20L</td>
<td>10.1 c</td>
<td>67.0 a</td>
<td>38.7 e</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>High, 50g/ 20L</td>
<td>10.0 c</td>
<td>40.6 b</td>
<td>25.5 h</td>
<td>58</td>
</tr>
</tbody>
</table>
Results of the runner-tip plantlet experiment indicated that the % of disease leaflets and disease severity % were significantly reduced for the treatments than that for the control (Table 4). All of the tested fungicides and resistance inducers gave more than 50% control except for Triadimefon, Punch, Mycozim and sulfur at their low application rates. Hydrogen peroxide at both concentrations (10 and 100 mM) gave 56 and 66% control, respectively while calcium chloride gave the highest % of control (79%) at 1 g/l concentration (Table 4).

Table 4. Effect of fungicides and resistance-inducing chemicals on powdery mildew disease development on strawberry (cv. Albion) runner-tip plantlets:

<table>
<thead>
<tr>
<th>Fungicide/ resistance inducer</th>
<th>Conc.</th>
<th>LD %1</th>
<th>DS %2</th>
<th>Control %3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canvil 5%SC</td>
<td>Low, 4ml/20L</td>
<td>33.3 c</td>
<td>25.6 c-f</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>High, 8ml/20L</td>
<td>33.3 c</td>
<td>28.8 b-f</td>
<td>59</td>
</tr>
<tr>
<td>Triadimefon</td>
<td>Low, 4ml/20L</td>
<td>33.3 c</td>
<td>36.6 bcd</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>High, 10ml/20L</td>
<td>33.3 c</td>
<td>18.6 ef</td>
<td>73</td>
</tr>
<tr>
<td>Punch 40EC</td>
<td>Low, 1ml/20L</td>
<td>33.3 c</td>
<td>37.0 bcd</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>High, 1.5ml/20L</td>
<td>33.3 c</td>
<td>18.0 ef</td>
<td>74</td>
</tr>
<tr>
<td>Mycozim</td>
<td>Low, 10 ml/20L</td>
<td>33.3 c</td>
<td>36.2 b-e</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>High, 20 ml/20L</td>
<td>33.3 c</td>
<td>19.0 ef</td>
<td>83</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Low, 40g/20L</td>
<td>50 b</td>
<td>46.0 b</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>High, 50g/20L</td>
<td>50 b</td>
<td>14.5 f</td>
<td>79</td>
</tr>
<tr>
<td>Calcium Chloride</td>
<td>Low, 1 g/L</td>
<td>33.3 c</td>
<td>15.0 f</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>High, 10 g/L</td>
<td>33.3 c</td>
<td>36.5 b-e</td>
<td>48</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>Low, 10mM</td>
<td>50 b</td>
<td>20.5 ef</td>
<td>71</td>
</tr>
</tbody>
</table>

1 DS1%: disease severity % in the first assay recorded 1 week after treatment.  
2 DS2%: disease severity % in the second assay recorded 1 week after treatment.  
3 Control % = Powdery mildew disease severity% in control- that in treatment divided on disease severity in the control (water) multiplied by 100%.  
4 Average of 3 replicates.  
5 Means within columns followed by the same letters are not significantly different at 0.05 probability level using LSD test.
### DISCUSSION

Powdery mildew of strawberry was found in Al-Shoubak area of Jordan under glasshouse conditions. The fungus *Sphaerotheca macularis* f. sp. *fragariae* was the causal agent of the disease and its pathogenicity was confirmed by inoculation on the susceptible strawberry cv. Albion under laboratory conditions. To our knowledge, this is the first study done on strawberry powdery mildew caused by *Sphaerotheca macularis* f. sp. *fragariae* in Jordan.

Regarding to plant leaf position, top leaves were found more susceptible than middle or bottom leaves for powdery mildew infection. Lower leaf surface was more susceptible for powdery mildew infection than the upper leaf surface. At least in part, the more-common appearance of the pathogen on the lower leaf surface reflects escape of the upper epidermis from infection due to leaf folding during a critical susceptible phase (Gadoury *et al*., 2007). Leaf and plant phenology can also be an important factor affecting tolerance. Higher disease incidence on younger (top) leaves was noticed. This agrees with Okayama *et al*. (1995), who observed that the youngest leaflets were more susceptible than the intermediate or the oldest leaflets and stolon-derived daughter plants were more susceptible to infection than mature plants.

The main source of infection is cleistothecia, and time of ripening and liberation of ascospores is important to development of integrated control of powdery mildew (Jarmolica and Bankina, 2009). In our study, no cleistothecia were found. It seems that the fungus does not form cleistothecia under glasshouse and laboratory conditions. Cleistothecia of strawberry powdery mildew were detected in Latvia (Jarmolica and Bankina, 2009) and Norway (Gadoury *et al*., 2007) while no cleistothecia were detected in England (Peries, 1962) and Spain (Santos *et al*., 2002). Presence or absence of cleistothecia as a source of genetic variability, may affect the efficiency of applied fungicides through developing resistance. Benomyl failed to control powdery mildew on strawberry plants in Maine and Michigan where cleistothecia of *Sphaerotheca macularis* f. sp. *fragariae* were discovered while in other US states (North Carolina, Tennessee and Arkansas) where no cleistothecia were found, benomyl successfully controlled the disease (Howard and Albregts, 1982).

Strawberry cv. Camarosa was more resistant to powdery mildew infection than cv. Albion. In a previous study (Mertely *et al*., 2004) to evaluate the effect of powdery mildew on cv. Camarosa inside tunnels, powdery mildew symptoms on plant foliage were light and apparently unrelated to marketable yield. Therefore, the more resistant cv. Camarosa could be effectively

<table>
<thead>
<tr>
<th>Fungicide/ resistance inducer</th>
<th>Conc.</th>
<th>LD %(^1)</th>
<th>DS %(^2)</th>
<th>Control %(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>High, 100mM</td>
<td>33.3 c</td>
<td>30.5 b-f</td>
<td>56</td>
</tr>
</tbody>
</table>

\(^1\) LD%: % of diseased leaflets per a plantlet.
\(^2\) DS%: disease severity %.
\(^3\) Control % = Powdery mildew disease severity% in control- that in treatment divided on disease severity in the control (water) multiplied by 100%.
\(^4\) Average of 3 replicates.
\(^5\) Means within columns followed by the same letters are not significantly different at 0.05 probability level using LSD test.
used to control powdery mildew.

Among the tested chemical fungicides, Canvil gave a considerable control for powdery mildew. Other fungicides (Sulfur, Triadimefon, Mycozim and Punch (40% flusilazole) were more effective at the high application rates. Fungicides should be applied at the first sign of disease to control powdery mildew on susceptible cultivars. This is especially important when using protectant contact fungicides such as sulfur. The control of powdery mildew with fungicides is problematic since only a limited number of appropriate systemic fungicides, is available and powdery mildew fungi have a high tendency of developing fungicide-tolerant strains as observed with other crops (Chin et al., 2001; McGrath, 2001).

Foliar application of nutrients can reduce severity of fungal diseases by supplementing the nutrition of the plant, increasing natural foliar defence mechanisms and in some cases adversely affecting the fungal development (Palmer, 2007). Calcium appears to have primary role in plant defence through maintenance of membranes and cell walls (Marschner, 1995) by enhancing the cell wall rigidity (Graham, 1983; Datnoff et al., 2001).

Calcium chloride was effective at 1 g/l. This agrees with Palmer (2007) who found that calcium chloride foliar sprays were beneficial in controlling powdery mildew on strawberry. Spraying of calcium chloride caused significant decrement in the disease severity with significant increment in the fruit yield when compared with check treatments under glasshouse and field conditions (Ashour, 2009).

Hydrogen peroxide at 10 mM was effective in controlling powdery mildew on strawberry. After a foliar spray with a solution of hydrogen peroxide, leaves exhibited resistant against Podosphaera fusca (Fr.) U. Braun & Shishkoff fungus, the causal agent of cucumber powdery mildew. Hydrogen peroxide (at 15 mM concentration) was able to greatly decrease the disease severity in two subsequent cucumber growing seasons (Hafez et al., 2008).

Resistance to downy mildew caused by Sclerospora graminicola on pearl millet was chemically induced by treating seeds of highly susceptible cultivars with the resistance activator benzothiadiazole (BTH), calcium chloride and hydrogen peroxide giving 78%, 66% and 59% protection, respectively (Geetha and Shetty, 2002). Spraying barley leaves with 25 mM of hydrogen peroxide inhibited powdery mildew pathogen (Blumeria graminis f. sp. hordei) and symptom development (Hafez and Kiraly, 2003).

In a conclusion, the powdery mildew of strawberry can be managed effectively by the use of resistant cultivar e.g. Camarosa and protective or curative foliar sprays with effective fungicides or resistance-inducing chemicals. Further studies are needed to compare the influence of resistance-inducing chemicals with that of fungicides on strawberry under greenhouse and field conditions of Jordan.

ACKNOWLEDGEMENTS

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REFERENCES


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Sphaerotheca macularis f. sp. fragariae


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