Evaluation of Poinsettia Cultivars for Susceptibility to Powdery Mildew

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Abstract. Powdery mildew (*Oidium* spp. Link) on poinsettias (*Euphorbia pulcherrima* Willd. ex Klotzsch) growing in commercial greenhouses was first observed in the United States in 1990. Susceptibility of poinsettia cultivars ('Freedom Red', 'Hot Pink', 'Jingle Bells 3', 'Pink Peppermint', 'Red Sails', 'Supjibi Red', 'Topwhite', 'V-14 Glory', 'V-14 Pink', 'V-14 White', 'V-17 Angelika White') to powdery mildew was investigated using 8- to 10-week-old poinsettias with mature bracts. Area under the incidence of disease progress curve was used to express the incidence of bracts infected over 31 d after inoculation. Three cultivars with red bracts ('Freedom Red', 'Supjibi Red', 'Red Sails') had significantly more infection than the other cultivars in both experiments, while one cultivar with white bracts ('V-17 Angelika White') had significantly less infection.

The poinsettia is a significant crop for Michigan growers, who produce 5% of all poinsettias (1993 wholesale value of \$9.9 million) in the United States (Agricultural Statistics Board, 1994). The primary foliar disease of poinsettia historically has been leaf, stem, and bract blight caused by *Botrytis cinerea* Pers.:Fr. (Jones and Strider, 1985). However, in 1992 powdery mildew (PM) was a significant problem for poinsettia growers in Michigan (M.K. Hausbeck, unpublished data). Powdery mildew occurred on poinsettias in Mexico in 1988 and 1989 and was first reported in the United States in 1990 in Pennsylvania (Kim and Olson, 1994) and the Pacific Northwest (Daughtrey and Hall, 1992). Growers in Puerto Rico also have reported PM (Daughtrey and Hall, 1992). From 1993 to 1995, PM occurred sporadically in the midwestern and northeastern United States (M.K. Hausbeck, unpublished data; M.L. Daughtrey, personal communication).

Powdery mildew appears on abaxial and adaxial leaf and bract surfaces as discrete, white, talcumlike colonies that may coalesce and are up to 1.0 cm in diameter. When colonies initiate on the abaxial side of leaves, PM may not be detected until late in the production cycle, when bracts are infected and the plants are unsalable. Poinsettias may not exhibit PM signs until after leaving the production green-

house, resulting in customer dissatisfaction (Daughtrey and Mackel, 1994).

No cleistothecia have been found for this fungus (Kim and Olson, 1994). The conidia are oval to cylindrical, 15 to 20 × 25 to 50 µm, with a chain of up to nine conidia on a single conidiophore. Under greenhouse conditions, peak conidial concentrations in the atmosphere were associated with a rapid change in temperature, relative humidity (RH), or both, with routine grower activity having little or no effect (Shaw and Hausbeck, 1995). Spore germination of conidia on poinsettia maximized at 25 °C and 85% RH (Hausbeck and Kalishek, 1994). Daughtrey and Mackel (1994) observed that PM incidence and severity did not increase during the summer, but increased dramatically during the fall. Similarly, Kim et al. (1995b) showed that infected poinsettias in greenhouses became asymptomatic during the summer, with signs of infection reappearing in mid-September at 21 to 26 °C, suggesting that the fungus may overwinter.

Growers who detect PM early in production report successful elimination of the disease by removing infected leaves and applying fungicides (Hausbeck et al., 1994). Although protective and systemic fungicides are effective against PM (Daughtrey and Mackel, 1994, 1995; Gould and Bergen, 1995a, 1995b; Hausbeck and Kusnier, 1995a, 1995b, 1995c), their cost can reduce growers' profits. Chemical residue and phytotoxicity may also leave treated plants unsalable.

Initial studies (Celio and Hausbeck, 1994; Kim et al., 1995a) showed significant differences in susceptibility among poinsettia cultivars. The objective of this study was to investigate host resistance as a component of disease management.

Materials and Methods

Plant material. Eight- to 10-week-old poinsettias obtained from various growers (Bordine's, Rochester, Mich.; DeWinters, Jennison, Mich.; Andy Mast Greenhouses,

Grand Rapids, Mich.; Henry Mast Greenhouses, Byron Center, Mich.; Michigan State University, East Lansing, Mich.) were grown in 0.9- to 1.1-L (14.0- to 15.2-cm-diameter) plastic pots containing commercial soilless potting mix composed of 40% perlite and 60% sphagnum peat. Poinsettia cultivars with red, white, pink, and variegated bracts were arranged in a completely randomized design with four and six replicate plants for Expts. 1 and 2, respectively, in a research glasshouse at Michigan State Univ. Glasshouses were maintained at 23 °C (day) and 18 °C (night). No supplemental lighting was used. Plants were watered as required with N at 200 mg·L⁻¹ solution (5 g·L⁻¹) of 15N-5P-25K fertilizer at 2- to 3-d intervals. The pH of the irrigation water was maintained at 5.7. Pesticides were not applied to plants during the experiments.

Inoculum preparation and procedure. Infected poinsettias ('Freedom Red'), maintained in a 20 °C growth chamber at high humidity (RH>70%) and a 12-h photoperiod, were used to inoculate experimental plants. To ensure uniform age and viability, conidia were dislodged 3 to 5 d before inoculation to promote growth of new conidia. Mildew-free plants were inoculated by tapping mildew-infected plants 46 cm above the healthy poinsettias and allowing conidia to settle on the leaves.

Disease assessment and statistical analysis. The proportion of bracts infected by *Oidium* sp. was assessed after inoculation (Expt. 1—12, 14, 17, 19, 21, 24, 26, 28, and 31 d; Expt. 2—10, 12, 14, 17, 19, 20, 23, 26, 28, and 31 d). A flashlight held almost parallel to the bract surface was used to increase visibility of colonies on light-colored bracts.

The area under the incidence of disease progress curve (AUDPC), representing the cumulative proportion of bracts (number of bracts with PM divided by total number of bracts) infected by 31 d after inoculation, was calculated using the method of Shanner and Finney (1977)

$$AUDPC = \frac{i = 1}{n} \sum [(Y_{i+1} + Y_i)/2][t_{i+1} - t_i]$$

where n = total number of observations, Y_i = cumulative disease expressed as a proportion at the i th observation, and t_i = time (days) after inoculation at the i th observation. Differences in *Oidium* sp. susceptibility among poinsettia cultivars were determined by performing a one-way analysis of variance of the AUDPC data using MSTAT statistical software. Mean comparisons were made among cultivars with Fisher's LSD ($\alpha = 0.05$).

Results

Experiment 1. Twelve days after inoculation, cultivars with red bracts ('Freedom Red', 'Red Sails', 'V-14 Glory', and 'Supjibi Red') had a higher incidence of disease (32% to 87%) than cultivars with pink ('V-14 Pink' and 'Hot Pink') (0% to 2%), white ('V-14 White', 'V-17 Angelika White', and 'Topwhite') (0%), or variegated bracts ('Pink Pep-

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Fig. 1. Powdery mildew incidence on poinsettias from Expt. 1 with (A) red bracts, (B) pink bracts, (C) variegated bracts, and (D) white bracts.

permint' and 'Jingle Bells 3') (0% to 3%) (Fig. 1 A–D). By 31 d after inoculation, the incidence of bracts with PM was >50% on all cultivars screened (Fig. 1).

Analysis of the AUDPC indicated that poinsettia cultivars with red bracts were significantly more susceptible than all other cultivars included in the experiment (Table 1). Two cultivars with white bracts ('V-14 White' and 'V-17 Angelika White') had significantly fewer bracts infected with PM than cultivars with red, red-variegated, pink-variegated, or pink bracts. Disease incidence for a third cultivar with white bracts ('Topwhite') was similar to that for cultivars with pink, red-variegated, and pink-variegated bracts and one cultivar with white bracts ('V-14 White').

Experiment 2. Ten days after inoculation, cultivars with red, red-variegated, and pink bracts had a higher percentage of bracts infected (75% to 94%) than cultivars with pink-variegated (40%) or white bracts (33% to 59%). By 31 d after inoculation, the incidence

of bracts with PM was >75% on all cultivars screened.

Analysis of the AUDPC indicated that three cultivars with red bracts ('Red Sails', 'Supjibi Red', and 'Freedom Red') were significantly more susceptible to PM than all other cultivars studied, with the exception of one with pink bracts ('V-14 Pink') (Table 1). The white cultivar V-17 Angelika White was significantly less susceptible than all other cultivars screened. The other cultivars with white bracts ('Topwhite' and 'V-14 White') exhibited disease incidence similar to that of the cultivars with pink and variegated bracts.

Discussion

All cultivars screened in this study became infected with PM and were considered unsalable after 31 d. Three cultivars with red bracts ('Freedom Red', 'Supjibi Red', and 'Red Sails') were more susceptible to PM in both experiments compared to cultivars with pink,

variegated, and white bracts. Disease incidence on a fourth cultivar with red bracts ('V-14 Glory') was inconsistent between the experiments. Kim et al. (1995a) reported 86% to 99% of bracts infected 5 weeks after inoculation of the cultivars Freedom Red, Supjibi Red, and Red Sails, as well as lower disease incidence (62%) on 'V-17 Angelika White'. Rankings of these four cultivars based on the percentage of leaves infected were similar to those based on the percentage of bracts infected in another study (Kim et al., 1995a). Disease incidence on leaves was not calculated in our experiments because of relatively low leaf infection on all plants during the first experiment, most likely a result of inoculating the plants from above.

To produce cost-effective, high-quality poinsettias, an integrated disease management strategy including sanitation, fungicide application, and environmental manipulation will be necessary. Cultivar selection may also play an important role in disease management strategies. It was the initial perception of growers that red cultivars were more susceptible to PM. This study suggests that PM colonies may be established sooner on cultivars with red bracts, indicating a need for increased vigilance during scouting of those cultivars so that timely fungicide treatments can be applied. 'Freedom Red' recently has been rated the bestselling cultivar in the United States (Heacox, 1996). Since this popular cultivar and other cultivars with red bracts are particularly susceptible to PM, additional attention paid to red-bracted poinsettias when scouting for PM may stave off disease outbreaks. While cultivars with white bracts are less susceptible to PM, it is worth noting that detection of PM in a commercial setting may be delayed due to low visibility of colonies on white bracts. Therefore, growers should take similar precautions for cultivars with white bracts, as all the white-bracted cultivars included here were susceptible to PM.

Information presented here will help further epidemiological research concerning PM on poinsettias. Researchers studying this obligate fungal parasite may want to use cultivars with red bracts in their experiments for earlier PM colony development, as well as the ease of observing PM colonies on bracts.

Table 1. Disease incidence of powdery mildew (*Oidium* sp.) on poinsettias.

Cultivar	Bract color	AUDPC ^a (% bracts infected × day)	
		Expt. 1	Expt. 2
Eckespoint Freedom Red	Red	1812 a ^b	1984 a
Eckespoint Red Sails	Red	1717 a	1997 a
Gutbier V-14 Glory	Red	1632 a	1781 c
Gross Supjibi Red	Red	1582 a	1995 a
Gutbier V-14 Pink	Pink	1175 b	1940 ab
Eckespoint Jingle Bells 3	Red/var ^c	1146 b	1754 c
Annette Hegg Hot Pink	Pink	1000 bc	1781 c
Annette Hegg Topwhite	White	951 b–d	1741 c
Eckespoint Pink Peppermint	Pink/var	761 c–e	1777 c
Gutbier V-14 White	White	665 de	1845 bc
Gutbier V-17 Angelika White	White	639 e	1593 d

^aArea under the incidence of disease progress curve.

^bMean separation within columns by Fisher's LSD at $P \leq 0.05$.

^cVariegated bracts with the primary color indicated.

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