Evaluating Sugarbeet Seedlings for Resistance to Powdery Mildew *

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INTRODUCTION

Since its initial epiphytotic occurrence in 1974 (1, 3), powdery mildew (*Erysiphe polygoni* DC) has consistently ranked as one of the most serious diseases of sugarbeet (*Beta vulgaris* L.). The disease is controlled primarily by applying sulfur (2, 4). In some situations, three or more applications are required. Sulfur has been very effective in reducing losses; however, the development of resistant cultivars is an economically and environmentally desirable long-range objective.

With that objective in mind, we have identified sources of resistance, and determined that seedlings can be used to evaluate resistance. This paper reports comparisons of three methods for evaluating sugarbeet seedlings for reaction to powdery mildew and correlates seedling evaluations with evaluations made in the field under natural infection.

MATERIALS AND METHODS

Twenty sugarbeet cultivars or breeding lines were selected as representing a wide range of reactions to powdery mildew based on evaluations in the field and greenhouse. The reaction to powdery mildew for each of these lines was determined by evaluating it in the field under natural infection for 3 years, and by subjecting it to three different seedling methods using artificial inoculation.

Field Evaluation

Four 20-foot rows of each line were planted in a randomized complete block design. Planting was done during early May near Farmington, Utah, in 1978, 1979, and 1980. Natural infection occurred each year beginning in August, and evaluations were made in mid-September.

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Powdery mildew development on the foliage was evaluated by visually assigning a rating of 1 to 5 to each row based on the extent of mycelial growth and sporulation. A rating of 1 indicated very sparse mycelial growth and no evidence of sporulation, whereas a rating of 5 indicated dense mycelial growth and abundant sporulation.

Cotyledon Method

Plants were grown in the greenhouse for 3 weeks until the cotyledons were fully expanded and the first true leaf was beginning to emerge. A section 1 cm long was cut from a cotyledon of each of 12 plants per line tested. Cotyledon sections were placed underside up in a randomized complete block pattern on a sheet of moist filter paper. The sheet of filter paper was positioned at the bottom of an inoculaton chamber consisting of a plywood column 1.2 m high and 0.5 m square.

Inoculation was accomplished by shaking infected leaves at the top of the chamber so conidia settled uniformly on the surface of the cotyledon sections. Conidia were blown off of infected leaves 2 days before they were used for inoculation. Therefore, most conidia used as inoculum were less than 48 hr old. Inoculum dosage was measured by placing agar strips with the cotyledon sections and counting conidia on the agar surface. Dosage was routinely adjusted to 8 to 10 conidia per mm^2 of surface.

Each inoculated section was floated on 1 ml of water containing 40 μg/ml benzimidalole (Baker Chemical Co., Phillipsburg, N.J. 08865) in plastic 96-cup disposable trays. The trays were enclosed in zip-close polyethylene bags to prevent evaporation and incubated for 6 days in a growth chamber. The growth chamber was operated with 10-hr days at 22 C, and 14-hr nights at 18 C. The trays of cotyledon sections were placed 20 cm below 15-w fluorescent lights (3,063 lux).

Fungus development on cotyledon surfaces was evaluated by examining each section with X 30 magnification. A rating of 1 to 5 based on extent of mycelial growth and abundance of sporulation as in field evaluations was assigned each section.

Leaf-Disk Method

Seedlings were grown in the greenhouse for 5 weeks or

until their first true leaves were fully expanded. A disk 1cm in diameter was cut from near the base of the blade of the first or second true leaf of each plant to be tested. The disks were cut with a No. 5 cork borer. Disks from 12 plants were used to evaluate each sugarbeet line. The disks were placed underside up on moist filter paper in a randomized complete block pattern and inoculated using the same procedure described above for cotyledon sections. Incubation of inoculated disks and evaluations were also as for cotyledon sections.

Whole-seedling Method

Seedlings were grown in the greenhouse for 5 weeks before inoculation. The seedlings were randomly arranged in a walk-in growth chamber with doors that could be closed to reduce air currents. Each entire seedling was inoculated by holding infected plans with abundant sporulation about 60 cm above the seedlings and then shaking them to dislodge the conidia. This procedure was repeated two or three times to insure a uniform distribution of conidia.

The inoculated seedlings remained in the growth chamber for 7 to 8 days until disease symptoms developed. The growth chamber was operated on a 16-hr day (fluorescent light at 4,500 lux) at 25 C, and 8-hr night at 20 C. Reaction to powdery mildew was evaluated by assigning a disease rating of 1 to 5 as described for the other methods.

RESULTS AND DISCUSSION

Significant differences occurred in powdery mildew disease ratings assigned to 20 sugarbeet cultivars and breeding lines when exposed to natural infection in the field (Table 1). Field ratings were similar for entries over 3 years. Commerical cultivars D2, AH12, HH22, and UI8 were susceptible. Resistant breeding lines such as L37, FC504, EL40, and L53 have diverse genetic back-grounds and may be excellent sources for developing cultivars resistant to powdery mildew.

The powdery mildew ratings for the three seedling assay methods are listed in Table 1. Ratings differed significantly with the cotyledon and leaf-disk methods However, these methods do not warrant further consideration because the range of

disease reactions was narrow and the correlations with field ratings were low. It was observed during this study that injury influenced powdery mildew development, and this may explain

Table 1. Sugarbeet powdery mildew ratings and correlations of field plots with seedling assay methods.

Cultivar or breeding line	Assay Method			
	Field[a]	Cotyledon[b]	Leaf disk[b]	Seedling whole plant[b]
L37	1.0[c]	3.1	3.4	1.9
FC504	1.1	2.0	2.5	2.6
EL40	1.2	1.8	1,8	1.7
L53	1.4	2.1	2.4	3.0
8513	1.5	2.0	2.6	2.3
S72-316	2.1	1.8	2.0	1.8
53100-04	2.2	2.3	2.2	4.0
S72-315	2.7	1.8	2.1	2.0
L56	2.8	1.4	2.3	1.4
1345	2.8	2.8	2.5	3.3
L8	3.0	1.5	1.6	2.6
L19	3.2	2.7	2.6	4.4
D2	3.5	3.1	2.9	3.9
NB1	3.6	3.0	2.5	3.0
L10	3.7	2.8	3.0	3.9
AH12	3.8	2.8	2.3	4.0
A5	3.8	2.2	2.7	3.0
HH22	4.0	2.5	2.6	3.8
U18	4.3	2.0	2.0	3.8
L54	4.9	2.6	3.3	3.9
LSD 0.05	0.6	0.9	0.7	0.7
Correlations w/ field plots		0.30	0.16	0.65**

[a] Field ratings are averages of four replications in each of 3 years. Variances by year were homogeneous; therefore, analysis was combined over years.

[b] Ratings are averages of three tests of four replications each.

[c] Ratings based on scale of 1 to 5 with 1 = very sparse mycelium development and no evidence of sporulation, and 5 = dense mycelium development and abundant sporulation.

** Significant correlation at P = 0.01.

the lack of correlation between cotyledon and leaf-disk ratings and field ratings. The greatest injury effect would occur with leaf-disks, and this method gave the poorest correlation with field evaluations.

The whole-seedling method gave the highest correlation with field results (r = .65). If we exclude lines L53 and 53100-04, which had higher seedling than field ratings, and line 56 which had a lower seedling than field rating, the correlation of whole-seedling and field ratings is r = .78. All nine of the lines that received field ratings over 3.0 were classified 3.0 or higher in the whole-seedling test. All but three of the 11 lines that received 3.0 or lower field ratings were classified below 3.0 in the whole-seedling test (Table 1). These results indicate that the whole-seedling method of evaluating for powdery mildew resistance could effectively identify susceptible lines but would occasionally fail to identify a resistant line.

It should be noted that a growth chamber was used for inoculation and disease development because this investigation was not compatible with non-disease work being done in the greenhouse. Other testing has shown, however, that seedling evaluation can be done in the greenhouse, particularly if shading is provided during periods of intense sunlight.

This seedling method requires only 6 weeks to complete and can be done anytime during the year. Resistant selections are not destroyed in the evaluation process but can be recovered for reproduction. This method should facilitate the development of resistant cultivars and the study of how resistance is inherited.

LITERATURE CITED

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