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Special Research Report #309: Powdery Mildew Resistance in Transgenic Gerbera Plants

Category of Report: Plant Breeding and Genetic Engineering

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BACKGROUND

Figure 1. Gerbera flowers.

Powdery mildew is the most common and destructive disease in gerbera production and landscape use. Chemical control has been the primary tool for managing powdery mildew in commercial production. Growers often have to apply fungicides on a weekly basis, which leads to significant increases of production costs and difficulties in crop management. Few management options are available for controlling powdery mildew on gerberas in the landscape. Disease-resistant varieties have been widely used to reduce disease incidences and severity in fruit, vegetable and agronomic crops. The lack of sources of disease resistance has been the major limiting factor for developing and using disease-resistant varieties in floricultural crops. One promising approach to overcoming this shortage is to transfer plant defense-related genes from non-crop plants to crop plants.

The objective of this study was to transfer the Arabidopsis *NPR1* gene (non-expresser of pathogenesis-related 1 gene) into gerbera and to evaluate the resistance of regenerated gerbera plants to powdery mildew.

MATERIALS AND METHODS

Two gerbera varieties were used in genetic transformation with a DNA construct containing the *NPR1* gene and the neomycin phosphotransferase II (*nptII*) gene. The *nptII* gene was used as a selectable marker for it can confer gerbera plants resistance to kanamycin, an antibiotic used in the tissue culture medium. Common gerbera plants are very sensitive to kanamycin. Gerbera plantlets that were able to grow normally in kanamycin-containing media were considered as putative transgenics and they were

then confirmed in molecular assays using oligonucleotide primers designed from the *nptII* and *NPR1* genes.

Gerbera plants regenerated from transformation experiments were grown in containers in a growth room and the plants were naturally inoculated with spores of the powdery mildew pathogen *Podosphaera xanthii*. The temperature and humidity in the growth room were maintained at approximately 24°C and 75% to promote powdery mildew development. Powdery mildew severity on the gerbera plants was evaluated on a scale of 1 to 10, 1 = no disease and 10 = 81% to 100% of the leaf area showing powdery mildew (Hausbeck, M.K., W.R. Quackenbush, and S.D. Linderman. 2002. Evaluation of cultivars of African daisy for resistance to powdery mildew. B&C Tests 18:O0004).

RESULTS

More than 70 plantlets were regenerated from transformation experiments. The plantlets were established in containers and grown in the growth room for several months before the established plants were exposed to powdery mildew.

Figure 2. Severe powdery mildew on a non-transformed gerbera plant G8.

There was a broad range of resistance response among regenerated gerbera plants, from highly susceptible to quite resistant with few powdery mildew symptoms (Figure 2 and 3). Overall, the disease progress showed that a number of transformed plants had few mildew symptoms and better mildew resistance than the non-transformed plants during the entire disease-rating period (Figure 4).

Figure 3. Transformed gerbera plants G38-1 showing green leaves and few powdery mildew symptoms.

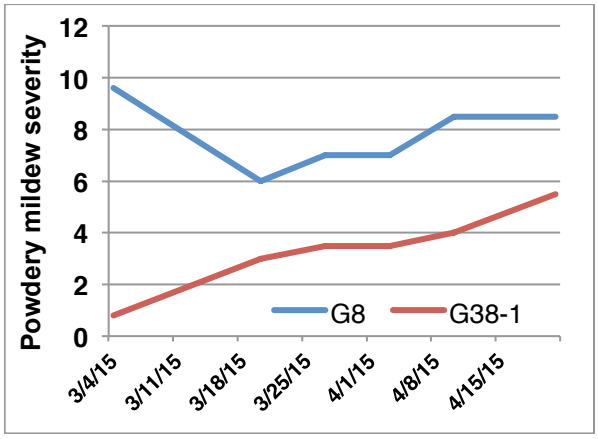

Figure 4. Powdery mildew severity on non-transformed plant G8 and transformed gerbera G38-1 in March and April 2015.

It also seemed that some transformed plants maintained more healthy leaves than other transformed plants or the non-transformed plants (Figure 5).

CONCLUSIONS

Transgenic gerbera plants with the *NPR1* gene and the neomycin phosphotransferase II (*nptII*) gene seem to express increased resistance to powdery mildew. Genetic transformation with plant defense-related genes from other plants such as Arabidopsis may open a new and promising avenue for improving powdery mildew resistance in gerbera. This avenue may also offer potential to develop disease-resistant varieties in other floriculture crops or for other diseases.

Figure 5. Transformed gerbera plant G3 maintained many healthy leaves.

Plant defense genes are common in every plant. It may be worthwhile to isolate these types of genes from floricultural crops and over-expressing them as a new approach to overcoming the shortage of sources of disease resistance in these crops.
The introduction and over-expression of plant defense-related genes in gerbera may result in changes in plant and leaf morphology. Further studies are needed to assess the full effects of NPR1 gene over-expression on flower characteristics including vase life.

INDUSTRY IMPACT

Use of disease-resistant varieties can help growers manage major diseases more effectively and control production costs. Results from this study have shown that genes from other plants can be transferred into gerbera to increase their resistance to powdery mildew. A similar strategy can be applied to other floricultural crops and/or for other diseases. Use of this strategy can open a new and promising avenue for overcoming the shortage of disease-resistant materials and potentially developing much needed disease-resistant varieties.

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