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Adapting microbial biocontrol of plant disease for a changing climate: effect of increased temperature

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Background and Objectives: Biological control can be regarded as an alternative to chemical control of pests and diseases of crops and as an important tool for sustainable agriculture. It is based on the use of one or more living organisms to maintain population levels of another organism at a level that does not cause economic damage to the crop. Biocontrol agents (BCAs) are usually specific for particular pests and diseases, have minimal or no impact on the environment and biodiversity and are not toxic to humans. As they are living organisms, BCAs are strongly influenced by environmental conditions and climate change could hamper the use of biocontrol in areas where it is already a common practice. Commercial BCAs that are negatively influenced by relatively high temperatures may become useless if temperatures rise above a limiting threshold. At the same time, the use of BCAs that work well at higher temperatures may be increase and spread as warmer conditions become more common. The aims of our case study are: i) to quantify and compare the effects of temperature and relative humidity (RH) on the survival of two BCAs, which were isolated from a warm climate and a cold climate, active against grapevine powdery mildew; ii) to evaluate their survival in the grapevine phyllosphere during the growing season under field conditions in two climates; and iii) to estimate their biocontrol efficacy against grapevine powdery mildew under field conditions.
Methodology: Two BCAs were used. B52 is a bacterium that was originally isolated in northern Italy and Y13 is a yeast that was originally isolated in Israel. When plants were artificially infected with the disease under controlled conditions, both microorganisms were effective against grapevine powdery mildew. For these experiments, the BCAs were grown in liquid media for 48 h at 20°C, centrifuged and suspended in water. To evaluate the effects of different temperatures (15, 22 and 30°C) and RH levels (45 ± 5 and 75 ± 5%) on the survival of the two BCAs, rooted grapevines (five cuttings/treatment, cv. Chardonnay) were sprayed with aqueous suspensions of the BCAs. BCA populations on the vines were examined immediately before and 2 h, 1 day, 3 days and 7 days after treatment. The survival of the two BCAs under field conditions was evaluated three times during the growing season in a cold temperate climate (northern Italy) and twice during the growing season in a Mediterranean climate (southern Italy). Biocontrol efficacy was evaluated as the reductions in powdery mildew severity (percentage of symptomatic leaf surface) and incidence (percentage of symptomatic leaves) in two different seasons in the vineyards mentioned above.
Results: Y13 survived well; its population numbers were stable through 7 days after inoculation in all of the temperature and humidity treatments. In contrast, the size of the B52 population decreased significantly at the highest temperature (30°C). These results were confirmed in the vineyard, where B52 did not survive well during warmer periods in the temperate climate and did not survive at all, even 2 h after inoculation, in the Mediterranean environment. Both Y13 and B52 gave satisfactory disease control in the vineyard in the cold-temperate climate in 2007 and 2008.
Conclusions: Biocontrol is one of the most important tools for sustainable agriculture. Predictions of climate change involving increasing temperatures should be considered during the development of commercial BCAs. A few degrees of difference in temperature may negatively influence the survival of microbial BCAs, which could make certain biocontrol activities ineffective. A BCA that is native to a warm environment can better adapt to increasing temperatures; therefore, it may have a longer commercial life if temperatures increase in future decades. BCAs that are adapted to higher temperatures may become increasingly useful as global and local temperatures increase.

