Dormancy Release of ‘Gala’ Mutations Apple Trees with Garlic Extract and Mineral Oil

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Abstract
This study aimed to examine the effects of garlic extract and mineral oil on the budbreak of ‘Gala’ mutations apple trees. In the first trial, ‘Mondial Gala’ apple trees were sprayed to “drip point” at dormant bud stage using an air blast, with the following treatments: 1) control (untreated); 2) H₂CN₂ 0.25% + 4% MO (mineral oil); 3) 0.5% GE (garlic extract) + 3% MO; 4) 1.0% GE + 3% MO; 5) 1.5% GE + 3% MO. In the second trial in a ‘Royal Gala’ commercial orchard, the following treatments were sprayed, using a hand driven sprayer: 1) control (untreated); 2) 3% MO (mineral oil); 3) 0.5% GE (garlic extract) + 3% MO; 4) 1.0% GE + 3% MO; 5) 1.5% GE + 3% MO. The same experiment was carried out using natural extract garlic obtained from cold-pressing of garlic cloves and filtering. The use of garlic extract 0.5% and mineral oil 3% was effective in bud dormancy release of ‘Mondial Gala’ and it was analogous to the standard treatment with hydrogen cyanamide. In ‘Royal Gala’ apple trees all treatments showed a very poor sprouting, basically due to an atypical warm winter in this region. But, anyway, the treatment 0.5% GE + 3% MO advanced bud sprouting when using the commercial product Bioalho®, although no differences were verified at 56 DAT. When natural garlic extract was used, no differences were observed between treatments.

INTRODUCTION
Irregular budburst of deciduous fruit trees, mainly in regions with mild winters, often creates significant economic problems. Indeed, it is generally accepted that chilling is essential to terminate this state of dormancy and to allow normal budburst (Lavee and May, 1997). Nir et al. (1986) suggested that chilling is an environmental factor that inhibits catalase activity in buds, analogous to the effects of H₂CN₂ treatment. In regions where this chilling requirement is not fulfilled, chemical treatments for budbreak should be necessary.

Because the principal apple cultivars grown in Brazil, namely ‘Gala’ and ‘Fuji’, do not meet their full chilling requirement (Petri, 1997), even at the higher elevations of the southern region (Iuchi et al., 2002), the use of chemicals for breaking bud dormancy is essential. Currently, however, only mineral oil and hydrogen cyanamide (H₂CN₂) are recommended for sprouting induction of deciduous fruit trees in Brazil (Petri et al., 2002). Nevertheless, the search for new bud break agents is essential due to the high toxicity of hydrogen cyanamide (Settimi et al., 2005).

Searching for new alternatives for budbreak, Kubota and Myamuki (1992) verified that garlic paste applied to cane cut surfaces of ‘Muscat of Alexandria’ grapevines, immediately after pruning, was more efficient than calcium cyanamide (CaCN₂), a substance normally used for vines in Japan. In ‘Santa Rosa’ plum trees, mixtures of 4% mineral oil and 2, 4 or 8% garlic extract were effective on bud dormancy release (Sanchez, 1992). In ‘Royal Gala’ apple trees Botelho et al. (2007) observed that mixtures of 2% mineral oil and 1, 5 or 10% garlic extract were also successful. According to Kubota et al. (1999b) the active substances in garlic responsible for breaking bud dormancy are volatile compounds containing sulfur and with an allyl group.

The purpose of this study was to verify the effects of garlic extract and mineral oil on bud dormancy release of apple trees in the southern region of Brazil.
MATERIAL AND METHODS

Three experiments were carried out in commercial orchards in Paraná State, southern region of Brazil. Treatments were composed of the following commercial products: Bioalho® (garlic extract, Natural Rural Co), Attach® (75% mineral oil, Bayer Cropscience Co.) and Dormex™ (490 g.L⁻¹ H₂CN₂, Basf Co.). Bioalho® is a water-soluble natural product obtained from cold-pressing of garlic cloves.

Experiment 1: Bud Dormancy Release of ‘Mondial Gala’

The experiment was carried out in a 4-year-old commercial orchard of ‘Mondial Gala’ apple trees on EM-9 rootstock located in Palmas, Paraná, Brazil (26°29’S and 51°59’26”W, 1,035 m a.s.l.), spaced 0.5 × 3.5 m and trained to a slender spindle. This region has an average of 1,023.3 chilling units in winter (Botelho et al., 2006) according to the North Carolina Method (Shaltout and Unrath, 1983).

After winter pruning, on 9.01.2006, the following treatments were sprayed to “drip point” at dormant bud stage using an air blast: 1) control (untreated); 2) H₂CN₂ 0.25% + 4% MO (mineral oil); 3) 0.5% GE (garlic extract) + 3% MO; 4) 1.0% GE + 3% MO; 5) 1.5% GE + 3% MO. Five trees in a row were sprayed as an experimental plot and a unique central plant was chosen for evaluations.

Experiments 2 and 3: Bud Dormancy Release of ‘Royal Gala’

The experiment was carried out in a 4-year-old commercial orchard of ‘Royal Gala’ apple trees on EM.9 rootstock located in Guarapuava, Paraná, Brazil (25°33’S and 51°29’W, 1,095 m a.s.l.), spaced 0.9 × 3.6 m and trained to a slender spindle. This region has an average of 773.3 chilling units in winter (Botelho et al., 2006).

After winter pruning, on 9.06.2006, the following treatments were sprayed to “drip point” at dormant bud stage using a hand driven sprayer: 1) control (untreated); 2) 3% MO (mineral oil); 3) 0.5% GE (garlic extract) + 3% MO; 4) 1.0% GE + 3% MO; 5) 1.5% GE + 3% MO. The third experiment was carried out using natural garlic extract obtained from cold-pressing of garlic cloves and filtering in our laboratory.

The trials were laid out using a randomized block design with five whole-tree replications. In each apple tree, five branches were examined for bud sprouting percentage at 14, 28, 42 and 56 days after treatments (DAT). Budbreak was considered positive when a green tinge was seen beneath the bud scales.

All data were analyzed statistically using the ANOVA and factorial analysis methods in the ASSIST statistical package (UFCG, Campina Grande-PB, Brazil).

RESULTS AND DISCUSSION

Significant interaction (p≤0.01) between budbreak treatments and budbreak date was found in all trials, except when natural garlic extract was used. All budbreak treatments improved bud sprouting of ‘Mondial Gala’ apple trees but there were no significant differences between them. Budbreak treatments attained between 66.4 and 76.1% bud sprouting while control reached only 40.5% at 56 DAT (Fig. 1). Garlic extract (GE) at 0.5% + 3% MO showed similar effects compared to hydrogen cyanamide alone (72.8% and 76.1%, respectively). Similar results were observed in ‘Royal Gala’ apple trees by Botelho and Müller (2007) using 1.0% GE + 2% MO.

In ‘Royal Gala’ apple trees, all treatments showed a very poor sprouting, basically due to an atypical warm winter in Guarapuava. The ‘Mondial Gala’ experiment did not have such problem because it was located in Palmas, a colder region. Any way, the treatment 0.5% GE + 3% MO advanced bud sprouting when using the commercial product Bioalho®, although no differences were verified at 56 DAT. Higher doses of garlic extract decreased bud sprouting, showing a phytotoxicity effect (Fig. 2). When natural garlic extract was used, no differences were observed between treatments; however plants sprayed with 0.5% GE + 3% MO had higher absolute values in every evaluation date, following the same tendency of other trials (Fig. 3).

In this experiment, garlic extract and mineral oil mixtures were equal to the
standard treatment for dormancy break of ‘Mondial Gala’ apple trees. Similar results were verified with garlic-based compounds in grapevines (Kubota and Myamuki, 1992; Kubota et al., 2000), plum trees (Sanchez, 1992) and apple trees (Botelho and Müller, 2007). According to Kubota et al. (1999) the active substances in garlic responsible for breaking bud dormancy are volatile compounds containing sulfur and with an allyl group (CH2CHCH2), especially the diallyl disulfide, which is the most abundant sulfide in garlic. Exposure of grapevine cuttings to volatiles from grated garlic and commercial garlic promoted budbreak. However, the effect of diallyl disulfide on the breaking bud dormancy in grapevines that were not chilled was not established (Kubota et al., 2000).

CONCLUSION

The use of garlic extract 0.5% and mineral oil 3% was effective in bud dormancy release of ‘Mondial Gala’ and it was analogous to the standard treatment with hydrogen cyanamide, a product considered highly toxic. On the other hand, Bioalho® is a natural product recommended for organic production systems according to actual Brazilian legislation. From an economic point of view, both treatments are equivalents and, therefore, the garlic extract could be a suitable product for budbreak of apple trees in commercial orchards. More investigations in different regions must be carried out to define doses and time of application.

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Literature Cited


Fig. 1. Sprouting percentage of ‘Mondial Gala’ treated with different treatments for budbreak. Vertical bars are the SD (n=5).
Fig. 2. Sprouting percentage of ‘Royal’ treated with different treatments for budbreak (GE = Bioalho®). Vertical bars are the SD (n=5).

Fig. 3. Sprouting percentage of ‘Royal’ treated with different treatments for budbreak (GE = natural garlic extract). Vertical bars are the SD (n=5).