The Influence of New Methods of Corm Coating on Freesia Growth, Development and Health

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Abstract

Recently in agriculture, there has been a growing interest in new proecological technologies whose main aim is the protection of biological material against negative effects of direct contact with the environment. We examined the effect of coating freesia corms with natural polysaccharides such as chitosan and its derivatives on growth and plant health. Two experiments were conducted under covers, to test how particular coating methods affect the length of the vegetative and generative stages, the quality and number of flowers, plant health and corm quality. Vegetative and generative parts of the plants were measured, leaf green index was determined and the leaves and corms were analyzed to detect viruses and fungal diseases e.g. Fusarium sp. It was found that, irrespective of the coating method, encapsulated plants emerge earlier and their vegetative stage was 10-14 days shorter in comparison with control plants. Although the effects on the flower quality and plant health varied and depended on the kind of coating chemistry, the results for either of the coating variants were inferior to the results in control plants. The studies show that coating of corms clearly improves their health, reduces selected fungal infection, inhibits the development of fungal pathogens, reduces and eliminates, depending on the coating chemistry, some virus and fungal occurrence. The results of DAS-ELISA test for freesia corms for some coating chemistries were the same or slightly differed from the control, untreated plants, whereas corms produced from corms without coating showed virus infection. Coating turned out to have no influence on virus presence in freesia leaves.

INTRODUCTION

Corms used for freesia reproduction must be regenerated every few years due to their ageing process, decreasing vigour and increasing problems associated with diseases and pests (Bach, 1992). The rate of senescence and quality deterioration depends both on cultivar characteristics and growing conditions as well as corm reproduction methods. The production of healthy corms, their preparation in order to obtain even, abundantly flowering, good quality plants as soon as possible are of utmost importance in freesia cultivation (Imanishi, 2002; Startek et al., 2002).

In recent years there has been a growing interest in using various types of coatings as an effective method of protecting seeds, bulbs and corms against negative effects of direct contact with exterior environment. Despite widely-described improvements in immobilisation technologies, the problem of finding appropriate substrates and reaction conditions compatible with natural materials remains unsolved. The majority of recommended agrotechnical coating methods concern the application of coat polymers for
covering granulated mineral fertilizers. However, both the synthetic polymers and coating conditions are not suitable for coating plant corms and seeds.

In horticulture, growth stimulants and substances enhancing the natural plant resistance to pathogens, including ionic polysaccharides such as chitosan (Pospieszny et al., 1991), have aroused great interest. The literature on the application of chitosan in the cultivation of some ornamental plants indicate that it can strongly inhibit disease development, stimulate plant growth, shorten developmental cycles and affect plant quality (Ohta et al., 1999; Saniewska, 2001). Chitosan’s molecular weight is one of the most important parameters affecting its biological properties. At the moment there is no available information concerning the relationship between its molecular weight and its effects on plant properties.

The aim of the studies commenced in 2002 was to examine the effects of freesia corm coating on their health, the course of developmental stages, basic morphological traits, flowering quality and corm yield. Natural anion polysaccharides together with chitosan varying in molecular weight were used for corm coating.

MATERIALS AND METHODS

Two experiments were conducted on “Easy Pot” freesia - ‘Gompey’ in Experiment 1 and ‘Popey’ in Experiment 2. The plants were grown in a foil tunnel from June to mid December without any summer cooling. For both the experiments, the corms (>5 cm) had been stored for 12 weeks at 18-28°C. Prior to planting they were coated according to the technology described in Polish Patent Application P 359797 (Bartkowiak et al., 2003).

Four coating variants were made using polysaccharides: 1% gellan and 1% iota-carrageenan in the solution of which corms were dipped for 30 seconds and 2 kinds of chitosan solution containing 0.2% of molecular weight 2,000 and 100,000 g mol⁻¹ in which the corms were soaked for 10 minutes. Sodium salts were used for coating in Experiment 1 and iron salts (III) in Experiment 2. Control corms were soaked in distilled water.

Freesia corms were planted into peat substrate supplemented with minerals with a spacing of 12.5 cm x 10 cm, in a randomised block design. Every experimental object consisted of 40 corms, 10 per each replication. Multicomponent fertiliser was used to maintain the nutrient content at the level recommended for freesia. During each experiment, observations were made concerning the course of developmental stages, i.e. emergence, heading, flowering and the end of vegetation. Morphological characteristics of the plants were measured, e.g. in generative stage – the length and number of inflorescences, diameter and number of flowers per inflorescence. At the beginning of flowering the leaf greening index, which is closely correlated to chlorophyll content, was measured using a chlorophylmeter Minolta SPAD-502.

After vegetation had died and corms were lifted, their weight and number were determined and the coefficient of increase in weight and number were calculated. Twice during the experiments, at full blooming and after death of the vegetation, the health of the corms were assessed. DAS-ELISA tests were conducted to identify the presence of freesia mosaic virus (FMV), using method described before (Kaminska, 1991). Samples of corms and leaves were homogenised with extracting buffer in 1:10 ratio. The results were based on spectroscopic measurements (405 nm) using Multiscan apparatus. Disinfected corm surface sterile fragments of parenchyma were also taken and inoculated on potato dextrose agar (PDA) on Petri dishes on PDA with streptomycine. Petri dishes were incubated for 5-10 days at 24-25°C and 90-95% humidity. Fungal colonies appearing successively around parenchyma were transferred on PDA and after 20-days incubation, identified according to Domsch et al. (1980).

The results of morphological characteristics and coefficient of corm weight and number increase were subjected to analysis of variance and Tukey test at 5% level of confidence (Table 1-2). The course of developmental stages depending on experimental object is presented in Fig. 1-2 and the evaluation of corm health in Table 3.
RESULTS AND DISCUSSION

The Course of Developmental Stages
Corm coating affected the length of developmental stages in freesia in both experiments (Fig. 1). In comparison with control plants, freesia from coated corms emerged 14 days earlier on the average (‘Gompey’) in experiment 1 and 10 days earlier (‘Popey’) in experiment 2. The beginning of coated corm emergence depended also on anion polysaccharides – for example corms covered with iota-carrageenan started emergence earlier than those coated with gellan (Fig. 1). In experiment 2 the effect of iota-carrageenan was less evident whereas the differences in the date of heading depended on the molecular weight of chitosan (Fig. 1). When chitosan of higher molecular weight was used, heading started 2-4 days earlier. In experiment 1 the earliest heading was observed in freesia coated with iota-carrageenan. In all coated freesia, flowering started earlier than in control plants. The effect of coating chemical composition on flowering was similar to the effects on heading.

Morphological Traits
Coatings had no effect on freesia height, stem number, the number of leaves and their greening index. Coating increased the number of inflorescence stems by 20-150% in all variants and in some variants especially with iota-carrageenan, elongated these stems (Table 1). Neither the number of flowers per inflorescence nor flower diameters was affected by coating.

Corm Yield
In both experiments, coating of mother corms significantly increased the weight of progeny corms (Table 2). Three-fold higher weight increase was recorded in experiment 1 as a result of coating mother corms in gellan and chitosan 2,000 g mol\(^{-1}\) and in experiment 2 after gellan and chitosan (2,000 g mol\(^{-1}\)) treatment and iota-carrageenan and chitosan 2,000 g mol\(^{-1}\). Compared to controls, the coefficient of corm number increase was lower than the coefficient of weight increase 8-137% (Table 2). Generally, the increase in corm number was higher in experimental variants when 2,000 g mol\(^{-1}\) chitosan was used than 100,000 g mol\(^{-1}\).

Healthiness
\(A_{405}\) values of freesia mosaic virus were lower for ‘Gompey’ in experiment 1 after gellan and chitosan 100,000 g mol\(^{-1}\) coating in comparison with the corms without coating (Table 3). In some combinations they were very low, similar to the result on control buffer (negative value). No differences in infection of freesia leaves between coated and control plants were found. \(A_{405}\) values for leaves were considerably higher than for corms, which indicated a higher leaf infection. *Fusarium* and *Penicillium* dominated among the fungi on the freesia corms. Control corms, were most infected. In both experiments the corms coated in gellan and chitosan 100,000 g mol\(^{-1}\) were completely healthy, since no pathogenic fungi were found. After gellan and chitosan 2,000 g mol\(^{-1}\) coating in ‘Gompey’, *Trichoderma* was detected. Species of this fungus are antagonistic to the genus *Fusarium* and do not cause disease on plants. The results were similar in both experiments. It seems that the third element i.e. the metal salt used for coating and its reaction with polysaccharides, also gives a significant effect. In our recent studies (unpublished) in which the effects of several salts were evaluated we found that iron salts are less favourable to plants than sodium salts. In experiment 1 in which together with polysaccharides some sodium salts were used, there was a shorter emergence period than in experiment 2 with iron salt.

On the basis of the results obtained in two parallel experiments evaluating the use of hydrogel freesia corm coatings, the use of natural and chemically modified polysaccharides corm coating technologies may enhance control or some physiological processes and improve plant healthiness.
Literature Cited

Tables

Table 1. Effects of corm coating on some generative morphological traits of two freesia cultivars from Easy Pot group.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Trait</th>
<th>Coating corms variants¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Number of inflorescences</td>
<td>1.25 a²</td>
</tr>
<tr>
<td></td>
<td>Length of the inflorescences shoot (cm)</td>
<td>12.1 a</td>
</tr>
<tr>
<td>2</td>
<td>Number of inflorescences</td>
<td>1.18 a</td>
</tr>
<tr>
<td></td>
<td>Length of the inflorescences shoot (cm)</td>
<td>12.5 a</td>
</tr>
</tbody>
</table>

¹0 – control; 1 – gellan and chitosan 2,000 g mol⁻¹; 2 – gellan and chitosan 100,000 g mol⁻¹; 3 – iota-carrageenan and chitosan 2,000 g mol⁻¹; 4 – iota-carrageenan and chitosan 100,000 g mol⁻¹
²Means followed by the same letter do not differ at 5% level of significance (Tukey’s multiple range test).

Table 2. Effect of corm coating on corm yield of two freesia cultivars from Easy Pot group.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Trait</th>
<th>Coating corms variants¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Coefficient of corm weight increase</td>
<td>1.13 a²</td>
</tr>
<tr>
<td></td>
<td>Coefficient of corm number increase</td>
<td>1.20 a</td>
</tr>
<tr>
<td>2</td>
<td>Coefficient of corm weight increase</td>
<td>1.03 a</td>
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<tr>
<td></td>
<td>Coefficient of corm number increase</td>
<td>0.97 a</td>
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</tbody>
</table>

¹As in Table 1,
²As in Table 1
Table 3. Absorbence values ($A_{405}$) obtained in DAS-ELISA test for two freesia corm cultivars and four coating variants.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Stage</th>
<th>Control (buffer)</th>
<th>Coating corms variants¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Full blooming</td>
<td>0.06</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>After vegetation</td>
<td>0.06</td>
<td>0.18</td>
</tr>
<tr>
<td>2</td>
<td>Full blooming</td>
<td>0.06</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>After vegetation</td>
<td>0.06</td>
<td>0.09</td>
</tr>
</tbody>
</table>

¹As in Table 1

Figures

Fig. 1. The length of developmental stages in cultivar ‘Gompey’ from Easy Pot depending on methods of corm coating.
Fig. 2. The length of developmental stages in cultivar ‘Popey’ from Easy Pot depending on methods of corm coating.