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Response of gladiolus (*Gladiolus* spp) plants after exposure corms to chitosan and hot water treatments

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ABSTRACT

The state of Morelos, Mexico has gradually become an important producer of gladiolus. Some preconditioning treatments of corms are empirically done causing uneven emergence and low quality of flowers. In this investigation, before planting, gladiolus corms var. 'Blanca Borrego' were dipped in chitosan (chitosan reagent and commercial chitosan Biorend®), in hot water at various temperatures and in treatments combined with Biorend® at 1.5% and hot water. Results indicated that the most influenced variables were corm germination, number of flowers per spike, number of cormlets and vase life. Overall, the commercial product Biorend® at 1.5% accelerated corm emergence in approximately 4 days, the number of flowers increased by 2–7 and the vase life extended for 3 days. The number of cormlets was also duplicated. Corms dipped in the commercial chitosan Biorend® at 1.5% at different intervals of time were not greatly affected except for the emergence and number of cormlets. However, for this experiment there were significant effects on the number of leaves and flowers because of the interactions between chitosan and the immersion time. The temperature of 55 °C affected plant development because emergence was delayed by 6 days; and there were less number of leaves, flowers and cormlets. On the other hand, the incidence of *Fusarium oxysporum* in naturally infected corms was 0% at temperatures of 55 °C and 50 °C. Immersion times (0, 10, 15 and 20 min) in hot water at 50 °C did not show significant effects on plant development and vase life. Corms dipped in Biorend® at 1.5% and hot water at 50 °C accelerated their emergence for about 1–7 days, the number of flowers increased by two, extended the storage life for 1–3 days and increased the number of cormlets. The integration of these two treatments -Biorend® and hot water- might be a good option for increasing the gladiolus plant quality and vase life.

1. Introduction

Gladiolus is an easy-to-grow flower, especially valued for use in floral arrangements. Gladioli produce tall spikes of large blossoms, in a rainbow of colors. As recently as 2005, gladiolus flowers accounted for more than 80% of total cut flowers production in Mexico. Gladiolus flowers have become one of the most important of Morelos growers' cut flower industry (Cabrera and Orozco, 2003). After flower spikes are harvested corms are usually left in the field for 2 months. Once corms are collected, they are dried at ambient temperature for 3 days, peeled, graded by size and washed with a fungicide. The treated corms are usually left at ambient temperature for up to 3 months (personal communication). Because of the high costs, cold storage of corms is not yet a common practice among gladiolus growers.

Chitosan obtained by deacetylation of chitin is a natural, biodegradable, nontoxic polymer with various applications in agriculture (Sandford, 1989; Larez, 2008). Several lines of experimental investigation have demonstrated the chitosan efficacy to protect seedlings against pest and diseases, improve seed germination, promote plant growth, and consequently increase crop yield. For ornamental plants, chitosan application to the corms of freesias (*Freesia*), showed an earlier emergence and shortening in the vegetative growth (Startek et al., 2005). In tissue culture studies, concentration and molecular weight of the chitosan applied influenced the meristematic bud growth in the shoots of orchid plants (*Dendobrium phalaenopsis*), also an ornamental one (Nge et al., 2006). Application of foliar applications with chitosan resulted in higher vegetative growth of the leaves and weight of the inflorescences and improvement in the

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postharvest quality of curcuma (*Curcuma alismatifolia* × *Curcuma cordata*) cv. 'Laddawan' (Tamala et al., 2007). For other cultivated plants, chitosan seed coating promoted the emergence as well as increased the vigor of wheat (*Triticum aestivum*) (Bhaskara Reddy et al., 1999) and the vegetative growth in pearl millet (*Pennisetum glaucum*) (Sharathchandra et al., 2004).

Hot water applications are reported to be preconditioning treatments for gladiolus corms for eradication of *Fusarium oxysporum* and other pathogens (Vigodsky, 1970). It has been reported that the physiological response of the gladiolus corms to hot-water treatments depends on the temperature applied, variety, harvest period, and size of corms (Vigodsky, 1970; Cohen et al., 1990). Plant sprouting of gladiolus corms of three different varieties ('White Friendship', 'Peregrina' and 'Sans Souci') was deficient when held at temperatures of 66 °C and 80 °C at different times (Villanueva and García, 1987). In that study, plant emergence of hot-treated corms was similar to other treatments such as Ethrel and giberelic acid application, and immersion in nonheated water. In the state of Morelos, corms may be hot-water treated; however, this practice is mainly done empirically, bringing about uneven emergence and a general poor quality of plants.

The objective of this investigation was therefore to evaluate the effect of treated corms var. 'Blanca Borrego' with chitosan reagent and commercial chitosan, hot water, and the integration of both treatments on gladiolus plant development and vase life of flowers.

2. Material and methods

2.1. Plant material

The experiments were conducted at Emiliano Zapata Experimental Unit, Yautepec, Morelos, Mexico (latitude 18°49′42.97″ North, longitude 99°05′38.72″ West). Experiments were carried out in corms of *Gladiolus glandiflorum* var. 'Blanca Borrego'. Corms were donated by local growers. The diameter of the corm was approximately 4–6 cm and they were obtained the previous year following the normal cultivation practices of the area. Corms were selected by discarding those damaged; they were carefully peeled, treated, and dried and with the points upwards they were planted in plastic containers (35 cm). The soil mixture comprised of perlite, coconut fiber, vermiculite and lombricompost (33.3%, 33.3%, 25.0%, and 8.4%, respectively). The containers were almost filled full with the sterilized mixture, and two corms per pot were planted in the center, 7–10 cm apart and 5 cm deep and they were placed in a greenhouse. The usual agronomic practices (fertilization, watering, etc.) for gladiolus plants were followed until harvest time.

2.2. Chitosan preparation

For the first experiment two types of chitosan were evaluated; chitosan reagent and commercial chitosan Biorend®. Chitosan reagent (Sygma) was prepared according to the methodology of El Ghaouth et al. (1992). The tested chitosan concentration of 1.5% was prepared by dissolving 30 g of chitosan in 1000 ml of distilled water adding gradually 10 ml of acetic acid. The solutions were heated and constantly agitated for 24 h and the pH adjusted to 5.5 by adding sodium hydroxide 0.1 N and 0.1 ml of Tween 80. The final solution was adjusted to 2000 ml of distilled water. The commercial chitosan Biorend® (Biotex-Bioagro, Tierra de Fuego, Chile) was prepared at 1.0% and 1.5% concentrations according to label indications.

2.3. Experiments

2.3.1. Effects of type of chitosan and immersion time

The first experiment consisted of dipping the corms for 1 h in the following treatments: (1) chitosan reagent and (2) commercial chitosan Biorend® both at 1.5%, (3) water and (4) untreated (control). In the second experiment, the corms were dipped in Biorend® at 1.0% and 1.5% for 30, 60 and 120 min and in water (control).

2.3.2. Effects of hot water and immersion time

The first experiment consisted in dipping the gladiolus corms for 15 min at the following temperatures: 45 °C, 50 °C, 55 °C and at ambient temperature (18 ± 2 °C) (control). In the second experiment, corms were dipped in hot water at 50 °C at 0, 10, 15, and 20 min.

2.3.3. Effects of the combination of chitosan and hot water

Corms were immersed for 15 min in hot water at 45 °C, 50 °C, 55 °C and at ambient temperature (18 ± 2 °C). Once dried they were submerged for 1 h in the commercial chitosan Biorend® at 1.5%.

2.4. Evaluation of pre and postharvest variables

For all experiments the variables evaluated were: (1) corm emergence: Number of days from when the corm was planted until the cotyledon was visible, (2) initiation of floral spike; number of days from when the corm was planted until the first floral button was visible, (3) total number of leaves at harvest (4) number of flowers: Harvesting was carried out when the first sign of color was visible, (5) vase life: Plants were submerged in water until flowers showed the initial signs of wilting that is, the appearance of brown color at the edge of the flower, (6) number of cormlets per plant: Cormlets were retrieved from the soil mixture and counted, (7) disease incidence (%) and fungi identification: Identification was in accordance with Barnett and Hunter, 1972.

2.5. Statistical analysis

For all experiments 20 corms were used per treatment with three repetitions. For the experiment with chitosan (reagent and Biorend®) and immersion times, treatments were arranged in a factorial (4 × 3) design. The treatments for the remaining experiments were arranged in a completely randomized design. Percentage disease was analyzed using the Chi square procedure. Means separation was carried out by Tukey's multiple range test ($P \leq 005$).

3. Results

3.1. Effects of type of chitosan and immersion time

The experiment was conducted to evaluate different types of chitosan, and there were significant differences ($P \leq 0.05$) in corm emergence, number of flowers, vase life, and number of cormlets (Table 1). Corms dipped in the commercial chitosan Biorend® at 1.5% concentration had the earliest emergence (8.8 days) compared with the treatments of chitosan reagent and control. The emergence of Biorend®-treated corms was accelerated by 4 days approximately compared with the control ones. The number of flowers per spike was considerably large in plants where corms were previously treated with Biorend® whereas the number of flowers in corms treated with chitosan reagent, water, and control were 2, 5, and 7, respectively. The vase life of gladiolus flowers was extended by approximately 3 days in corms dipped in both types of chitosan, and the number of cormlets per corm was doubled with the commercial chitosan Biorend®. This same treatment influenced corm emergence with significant differences ($P \leq 0.05$), shortening the corm emergence time. With respect to experiments where the integration of hot water and Biorend® (at 1.0% and 1.5%) was carried out, there were significant