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Effect of seed priming on growth, flowering and cut flower quality of carnation

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ABSTRACT

Carnation is one of the most important commercially grown flowers in the world. It has wide variations in shape and colours as well as good keeping quality. The present experiment was conducted to study the effects of seed priming through various chemicals such as salicylic acid, glycine betaine, potassium nitrate, ascorbic acid and hydropriming on growth and floral quality attributes of carnation. The seeds were pre-treated with different priming agents (salicylic acid 100 mg/L, glycine betaine 1536 mg/L, potassium nitrate 10 g/L, ascorbic acid 50 mg/L, and water) for 24 hours and then sown in clay pots. Seeds without treatment were served as control. Sowing was done on 21-10-2014 during year 1 and on 20-10-15 during year 2. Seeds were sown in pots and after two months of sowing, seedlings were transplanted into clay pots till flowering. Hydropriming (water treatment) resulted in the maximum seed germination (43.04%) and took minimum days to initiate first flower bud (87 days). Salicylic acid treated seeds resulted in the plants with delayed flower bud initiation and had maximum flower stalk length (3.08 cm), root length (21.89 cm), fresh weight of foliage (54.35 g), dry weight of foliage (16.66 g), fresh weight of roots (3.97 g), dry weight of roots (1.64 g), total biomass per plant (52.84 g), and longer length of growth cycle (177.5 days). Potassium nitrate treatment showed the maximum fresh weight per flower (4.24 g), dry weight per flower (0.95 g) and flower stalk diameter (10.44 mm). The minimum fresh and dry weights per flower were recorded (2.750, 68 g respectively) in unprimed seeds.

Key words: *Dianthus caryophyllus*, flower attributes, hydropriming, salicylic acid, seed priming agents.

INTRODUCTION

Carnation (*Dianthus caryophyllus* L.) belongs to the *Caryophyllaceae* family. The carnation is indigenous to the Mediterranean region, along the coast of Italy and in Greece. It was cultivated about 2,000 years ago, mostly in temperate regions of the world (Jurgens *et al*., 3). Carmation growth behavior may be either annual or perennial. Generally, it has wide variations in shape and colors and having good keeping quality. It is used in bedding, edging, borders, pots, and rock gardens (Tarannum, 13). It has good ability to survive under long distance transportation. The flowers are commonly used in bouquets, boutonnieres, corsages and flower arrangements. Flowers are also used in cardiotonic, fever, nervous maladies, treating diaphoretic and alexiteric diseases (Al-Snafi *et al*., 12). The most important floricultural crops in Pakistan cut flower trade are roses, iris, carnation, narcissus, gladiolus, tuberoses, lilies, freesia and gerbera. The total area under flower cultivation is about 3284 ha in Punjab province. However, there is no proper official documentation of the statistics on the fresh flowers in the country (Khan and Rehman, 4).

Vase life termination for various cut flowers is measured by wilting of their petals. Carnation flowers are delicate to microbial attack at the stem base or in the vase solution, which limits their vase life. Carnation cultivars differ in the period of their vase life which is one of the characters that determine their commercial value (Qureshi *et al*., 10). Its demand is increasing day to day as a cut flower crop in the world, including Pakistan. Improvement in post-harvest and preservation techniques have greater economic importance for extension of its vase-life.

Poor plant stand establishment is a major issue for carnation production. Seed priming is one of the excellent strategies used to enhance the seed germination as well as improve the plant growth of many flowering crops i.e. marigold, amaranthus, snapdragon and calendula (Jurgens *et al*., 3). Osmotic alteration or seed priming prior to sowing is considered as an effective way to increase germination and emergence rate in many species. The beneficial effects of seed priming have been established for various field crops (Arif *et al*., 1). Primed seeds have good efficiency for water absorption from growing media. Hydropriming, halopriming, osmopriming, solid matrix priming, hormonalpriming and biopriming are the basic techniques of seed priming (Nawaz *et al*., 9).

Ascorbic acid plays an important role in seed germination, growth, development, cell division, cell expansion, root development, photosynthesis, shoot apical meristem development, regulation of leaf senescence and regulation of flowering

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(Khan *et al*., 5). Salicylic acid plays a key role in regulating the growth and development processes as well as responses to biotic and abiotic stresses. Potassium nitrate increases the efficiency of plant water and sugar use for preservation and normal growth functions. It encourages plants to develop a vigorous, healthy root system, regulates the opening and closing of stomata, water retention of plants, improves the growth of meristematic tissues, helps in nitrogen metabolism, proteins synthesis and carbohydrate metabolism and its translocation. Increased seedling emergence in potassium nitrate primed seed may be attributed to metabolic repair processes, a build-up of germination metabolites or osmotic adjustments during priming treatments. Glycine betaine stabilizes quaternary structure of proteins and membranes against adverse effects of drought, high salinity and high temperature. It is extensively believed to protect cytoplasm from Na^+ toxicity. It is an important organic osmolyte that plays active roles in osmotic adjustment, photosynthesis, antioxidant capacity and ion uptake that regulate plant growth (Wani *et al*., 14). Zahedi *et al*. (15) observed the improvements in seed germination, root length and shoot length of *Dianthus barbatus*. In fact, priming induces a wide range of biochemical changes in the seed that required initiating the germination process i.e. breaking of dormancy, hydrolysis and enzymes activation (Wani *et al*., 14). Therefore, the present study was carried out to analyze the effects of seed priming on growth and flower quality attributes of carnation. Seed priming agents used were salicylic acid, glycine betaine, potassium nitrate and ascorbic acid.

MATERIALS AND METHODS

The present research work was conducted at the Department of Horticulture., Bahauddin Zakariya University, Multan, Pakistan during 2014-2016 to study the effects of seed priming on growth, flowering and vase life of carnation. Seeds of the carnation mix were purchased from Channan Din Seeds, Lahore. Seeds were primed by soaking in different solutions of Salicylic acid 100 mg/L, Glycine betaine 1536 mg/L, Potassium nitrate 10 g/L and Ascorbic acid 50 mg/L and also in water for 24 hours in dark condition and then air dried for 2 hours. Dry seeds were used as control treatment.

Sowing was done on 21-10-2014 during year 1 and on 20-10-15 during year 2. Seeds were sown in pots filled with fine peat moss, soil and plant litter (50: 25: 25 v/v) after two months of sowing, seedlings were transplanted into clay pots (Ø = 25 cm), filled with silt and farm yard manure (75: 25 v/v) till flowering. Irrigations were applied regularly after every 2 to 3 days without any application of fertilizer. Plants were stacked with small bamboo sticks to prevent bending of stems during flowering. The experiment was laid out according to a completely randomized design (CRD) with 3 repeats. Randomly nine plants in each treatment were selected and tagged for observing data on vegetative growth and flowering parameters.

The following observations were recorded during the study according to Nawaz et al. (9). Seed germination (%) was recorded on a daily basis. Root length (cm), fresh weight of roots (g), dry weight of roots (g), length of growth cycle (days), time to first flower bud initiation (days), fresh weight of foliage (g), dry weight of foliage (g), total biomass per plant (g), flower stalk length (cm), flower stalk diameter (mm), fresh weight per flower (g) and dry weight per flower (g). The percentage was calculated by the formula,

$$\text{Germination \%} = \frac{\text{Seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

By using the statistical software, Statistix 8.1 (Tallahassee Florida, USA), the collected data were analyzed to construct analysis of variance tables. The treatment means were compared through the LSD test at 5% probability level.

RESULTS AND DISCUSSION

The best seed germination (93.04%) was observed in water treatment, which was significantly different from all other treatments, while the minimum seed germination (68.88%) was recorded in ascorbic acid treatment (Table 1). In the present study, it was observed that glycine betaine and ascorbic acid treatments reduce seed germination. In hydropriming, possible mechanism is that water increases metabolic activities, enzymatic activities, and improves availability of nutrients and production of hormones. Therefore, the present data showed that hydropriming resulted in better germination as compared to all other seed priming treatments. Present results are also in agreement with the results of Mohammadi (7) who observed that seed priming with distilled water could be used as a beneficial method to enhance seed performance in soybean. Similarly, Arif *et al*. (1) also concluded that seed germination percentage was accelerated by hydropriming in soybean.

The maximum root length (21.89 cm) was recorded in the plants developed from seeds treated with salicylic acid, followed by control (unprimed) seeds, and those treated with glycine betaine and potassium nitrate. The minimum root length (16.00 cm) was recorded in plants resulting from seeds treated with ascorbic acid, followed by

Table 1. Effect of seed priming agents on growth attributes of carnation.

Seed priming agent	Seed germination (%)	Root length (cm)	Fresh weight of roots (g)	Dry weight of roots (g)	Length of growth cycle (days)
Salicylic acid	75.53 b	21.89 a	3.97 a	1.64 a	177.50 a
Glycine betaine	69.51 b	20.17 ab	3.76 a	1.49 a	174.50 ab
Potassium nitrate	78.22 b	19.83 ab	3.07 ab	1.18 ab	171.50 b
Ascorbic acid	68.88 b	16.00 c	2.54 b	0.84 b	165.00 c
Hydropriming	93.04 a	17.78 bc	3.25 ab	1.54 a	162.00 c
Control (dry)	78.43 b	20.88 ab	2.28 b	0.91 b	157.50 d

Mean values sharing similar letters (s) in a column are statistically non-significant at p = 0.05 (LSD Test)

water (hydropriming). These two treatments were statistically at par with each other (Table 1). Present data demonstrated that root length was increased by applying salicylic acid. Similar findings were also reported by Monfared and Armaki (8), who found that seed priming with salicylic acid resulted in the maximum root length in *Melilotus officinalis*.

The maximum fresh and dry weights were recorded in the roots developed from seeds treated with salicylic acid, followed by those with glycine betaine, water (hydropriming) and potassium nitrate. The minimum fresh weight (2.28 g) was recorded in the plants developed from control (unprimed) seeds, followed by ascorbic acid, potassium nitrate and hydropriming. The minimum dry weight of roots (0.84 g) was recorded in the plants developed from ascorbic acid, followed by control (unprimed seeds) and potassium nitrate treated seeds (Table 1). Salicylic acid may possibly increase the fresh and dry weights of roots.

Days from sowing to the death of a plant is called as length of the growth cycle. The maximum length of growth cycle was noted in the plants produced from seeds treated with salicylic acid, followed by when treated with glycine betaine. These two treatments were statistically at par. The shortest growth cycle (157.50 days) was observed in the control plants, which was significantly different from all other treatments (Table 1). This was possibly due to the reason that, salicylic acid treatment delayed flower bud initiation or flowering in carnation plants. Therefore, plants treated with salicylic acid had longer life span or the maximum length of growth cycle. Various effects of salicylic acid on growth and productivity of plants have been described by several workers (Khan *et al.*, 5; Bideshki and Arvin, 2; Shakeel and Mansoor, 11; Qureshi *et al.*, 10). Salicylic acid is known to affect the various physiological and biochemical processes of plants and may play a significant role in regulating their growth and productivity. Salicylic acid significantly enhances seed germination and seedling vigor (Mahesh *et al.*, 6).

The maximum days taken to first flower bud initiation were observed in salicylic acid treatment, followed by control (unprimed seeds), ascorbic acid and glycine betaine and the minimum days taken to first flower bud initiation were estimated in water treatment (Table 2). The flower bud initiation has been delayed in the plants developed from salicylic acid treated seeds which took the maximum days to initiate first flower bud. Our results indicated that early flower bud initiation was observed in the plants resulted from the seeds treated with water (hydropriming), which took the minimum days. This might be due to early germination under water treatment (hydropriming).

Table 2. Effect of seed priming agents on growth and flowering attributes of carnation.

Seed priming agent	Time to first flower bud initiation (days)	Fresh weight of foliage (g)	Dry weight of foliage (g)	Total biomass per plant (g)
Salicylic acid	92.50 a	54.35 a	16.66 a	52.84 a
Glycine betaine	90.50 ab	49.12 ab	15.65 ab	51.74 ab
Potassium nitrate	89.67 b	40.61 bc	12.21 bc	47.04 abc
Ascorbic acid	91.00 ab	29.81 c	10.44 c	38.77 c
Hydropriming	87.00 c	34.30 c	11.29 c	44.15 abc
Control (dry)	92.00 ab	37.72 bc	12.62 abc	43.69 bc

Mean values sharing similar letters (s) in a column are statistically non-significant at p = 0.05 (LSD Test)

Seeds treated with salicylic acid developed into the plants with higher fresh weight (54.35 g) and dry weight (16.66 g) of foliage, followed by glycine betaine. Seed priming with ascorbic acid resulted in the minimum fresh (29.81 g) and dry (10.44 g) weights of foliage, followed by hydropriming, potassium nitrate treated and control (dry) seeds. These four seed priming treatments behaved statistically alike (Table 2). Shakeel and Mansoor (11) found that salicylic acid has the ability to increase fresh weights of maize and mung bean plants, respectively.

The maximum biomass (52.84 g) was calculated in the plants resulted from seeds treated with salicylic acid, followed by glycine betaine, potassium nitrate and hydropriming. All these four treatments were statistically alike to each other. The minimum (38.77 g) was recorded in the plants developed from seeds treated with ascorbic acid, followed by control (unprimed) seeds, water (hydropriming) and potassium nitrate treatment. These four treatments were statistically at pat with each other (Table 2). Salicylic acid treatment increased the fresh weights of foliage and roots in the present study. Therefore, it also increased the total biomass of plants, because of its growth promoting effect. Similar findings were also reported by several researchers previously (Bideshki and Arvin, 2).

The maximum flower stalk length (3.08 cm) was recorded in plants resulting from the seeds treated with salicylic acid, which was significantly different from all other treatments. Control (unprimed) seeds resulted in the minimum flower stalk length (2.72 cm), followed by those treated with glycine betaine, ascorbic acid, water (hydropriming) and potassium nitrate (Table 3). All these five treatments were statistically at par with each other. Salicylic acid, being a growth promoter increases the growth of plants by enhancing cell division. In the present study, flower stalk length was increased in the plants resulting from the seeds pre-treated with salicylic acid. These results are similar to the findings of Qureshi *et al*. (10) who reported that the flower stalk length increased in salicylic acid treated seeds of carnation.

The maximum flower stalk diameter (10.44 cm) was recorded in the plants developed from potassium nitrate treated seeds, while the minimum flower stalk diameter (8.51 cm) was assessed in the plants resulting from seeds treated with water (hydropriming), followed by control (unprimed) seeds, salicylic acid and glycine betaine treated seeds (Table 3). Thus, seed primed with potassium nitrate resulted in increased flower stalk diameter. This was possibly because, potassium nitrate being a source of nutrients, increased the growth of plant.

Potassium nitrate treatment resulted in the maximum fresh weight of flowers (4.24 g), followed by salicylic acid treatment. The minimum fresh weight (2.75 g) was observed in flowers produced from control (unprimed) seeds, followed by those from hydropriming, ascorbic acid and glycine betaine. All these four treatments were statistically at par with each other (Table 3). Increased fresh weight per flower in the plants resulted from potassium nitrate treated seeds might be due to the reason that, potassium plays a significant role in the transport of water and nutrients throughout the plant.

Seed treatment with potassium nitrate treatment resulted in the maximum dry weight of flowers (0.95 g), followed by salicylic acid treatment, while the minimum dry weight (0.68 g) was recorded in flowers produced from control (unprimed) seeds, followed by those treated with hydropriming, glycine betaine and ascorbic acid. All these four treatments were statistically similar to each other (Table 3). Increased dry weight per flower in the plants resulted from potassium nitrate treatment could be possibly because this treatment also resulted in the maximum fresh weight of flowers.

It is concluded that seed priming with different chemicals agents such as salicylic acid, glycine betaine, potassium nitrate and ascorbic acid. In the

Table 3. Effect of seed priming agent on quality attributes of carnation.

Seed priming agent	Flower stalk length (cm)	Flower stalk diameter (mm)	Fresh weight per flower (g)	Dry weight per flower (g)
Salicylic acid	3.08 a	8.91 bc	3.99 a	0.88 ab
Glycine betaine	2.75 b	9.01 bc	3.26 b	0.76 bc
Potassium nitrate	2.87 b	10.44 a	4.24 a	0.95 a
Ascorbic acid	2.78 b	9.43 b	3.22 b	0.85 abc
Hydropriming	2.80 b	8.51 c	2.83 b	0.75 bc
Control (dry)	2.72 b	8.83 bc	2.75 b	0.68 c

Mean values sharing similar letters (s) in a column are statistically non-significant at p = 0.05 (LSD Test) present study, salicylic acid treatment was found to be more effective among all the treatments for many traits i.e. root length, fresh weight of roots, dry weight of roots, length of growth cycle, time to first flower bud initiation, fresh weight of foliage, dry weight of foliage, total biomass per plant, flower stalk length and fresh weight per flower.

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