

# Effect of Planting Density on The Landscaping Potentials of *Pelargonium zonale* L. and *Santolina chamaecyparissus* L. Plants

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## ABSTRACT

The present work was carried out in the Flower and Ornamental Plants Research Gardens, Faculty of Agriculture Alexandria University, Egypt during the years of 2010 and 2011. Two local cultivars of *Pelargonium zonale* L. and *Santolina chamaecyparissus* L. were used in this work to study the effect of planting density on the parameters that affected their potential landscape uses.

Different planting density were used i.e. 6, 9, 12 and 15 plants/m<sup>2</sup> for *Pelargonium* and 9, 12, 15 and 18 plants/m<sup>2</sup> for *Santolina*.

Results indicated that increasing the planting density (plants/m<sup>2</sup>) significantly increased only plant height. However, it decreased the plant diameter, leaf area, number of main branches/plant and slightly decreased plant condition (appearance, health, beauty, ornamental value and function) for *Pelargonium* and *Santolina* plants as well.

From the previous results it is recommended to use *Pelargonium* plants with an average diameter of 28 cm and at a rate of 15 plants/m<sup>2</sup>, while for *Santolina* plant it is needed to start with a suitable plant (its diameter > 15 cm) at rate between 15– 18 plants/m<sup>2</sup> to obtain good landscaping potential and ornamental value.

## INTRODUCTION

Landscaping play an important role in delivering good for development. It provides shade, color and softens the appearance of built structures as well as buffering the adverse impacts of development.

Geranium plant (*Pelargonium zonale*, L., Family *Geraniaceae*) is one of the famous and favorite ornamental plants originated in South Africa, then introduced to Europe. It is now widely spread throughout the temperate and subtropical regions of the world (Clifford, 1972). It's an erect perennial, having fibrous roots, leaves are simple nearly round in shape venation is palmate, characterized by horseshoe-shaped dark mark, having scent glands.

The flower color ranges from rose-pink to all shades of red as well as pure white. The distinctly irregular flowers are found in a typically umbel-like inflorescence.

*Pelargonium* is used in the garden in different positions in beds, around trees, along pathways and walk edgings, on lawns, in pots, in window boxes and wall gardens. *Pelargonium* can be mixed with other plants in beds and borders.

*Santolina* plant (*Santolina chamaecyparissus*, L., Family *Compositae* "Asteraceae") native to southern Europe and Mediterranean region then introduced to Europe as herb gardens. It's an erect woody herb, leaves are simple minute covering the branches. It is famously known as an aromatic herb and because of its gray color its used for writing on lawns or as a border (Osborne, 1972).

A lot of people are unaware of the ideal plant spacing for landscape plants for the perfect aesthetic appearance. Also every plant requires space in which to develop normally. The result of close planting is eventually an overcrowded condition and a lack of healthy, well-developed foliage, flower and fruit. The more vigorous specimens crowd out the weaker ones and useless a "thinning-out" process is adopted, the mass effect becomes quite uneven and ragged (Taylor, 1921).

When planting perennial groups some factors must be considered; color, height, blooming period, environmental and culture requirements.

The most important consideration in selecting plant for a perennial garden is to group them according to their environmental and cultural requirements.

The aim of the present work was to reach the suitable planting density for both *Pelargonium* and *Santolina* plants.

## MATERIALS AND METHODS

The present work was carried out in the Flower and Ornamental Plants Research Gardens, Faculty of Agriculture, Alexandria university, Egypt during the years 2010 and 2011.

The experiment was carried out to study the effect of the plant density of *Pelargonium zonale* and *Santolina chamaecyparissus* L. on their landscaping potentials.

The cuttings of both plants were taken from the mother plants in uniform length with an average of 15

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cm and then planted in 50 cm diameter pots (50 cuttings per pot) in well aerated soil (2 sand: 1 clay) and placed in a shade place on November 2010.

One month after planting the rooted cuttings were transplanted to 15 cm pots filled with an equal mixture of sand and clay soil.

After another month from transplanting, the plants were cultivated into flowerbeds with one square meter area and each flower bed contained different number of the used plants (planting densities).

The plants were fertilized with balanced complete fertilizers (one gram per liter, 500 ml for each pot weekly), a complete fertilizer (20– 20– 20) was used for Pelargonium plants (Siktberg, 2006), and (20– 10– 20) was used for Santolina plants (Blessington *et al.*, 2005).

Soil samples were collected at a depth ranged between 0– 15 cm before cultivation for the chemical analysis.

The soil pH and electric conductivity were 7.89 and 14.8 ds/m, respectively.

As for the soluble cations the potassium, sodium, magnesium and calcium were 1.9, 91.1, 51.5 and 28.5 meq/l, respectively, while the soluble anions of Cl<sup>-</sup> and HCO<sub>3</sub><sup>-</sup> were 130.3 and 7.5 meq./l, respectively.

Four planting densities were used separately for each plant, namely 6, 9, 12 and 15 plants/m<sup>2</sup> for pelargonium, and 9, 12, 15 and 18 plants/m<sup>2</sup> for santolina.

The experiment design was randomized complete block design with three replicates and each replicate contained four treatments for each plant. (Snedecor and Cochran, 1974).

The experiment continued till October 2011 and the following data were recorded in both experiments:

Plant height, plant diameter, cover percentage, stem diameter, number of main branches, number of leaves per plants (for Pelargonium only), leaf area (for Pelargonium only), number of inflorescences per plant (only for Pelargonium), flowering date (days) (for Pelargonium only), growth shape (five grades), plant condition (five categories from 9 to 1), flowering intensity (for Pelargonium with grades from 9 to 1), flower quality (for Pelargonium with 9 grades from 9 to 1) and the chemical soil analysis was done too at the end of the experiments.

Note: cover percentage, growth shape, plant condition, flower intensity and flower quality were done as reported by Nooh, 1981.

## RESULTS AND DISCUSSION

The results (in tables from 1 to 18) indicated that increasing the planting density (plants/m<sup>2</sup>) significantly increased only plant height. However, it decreased plant diameter, cover percentage, leaf area, number of main branches/plant and slightly decreased plant condition (appearance, health, beauty, ornamental value and function) for the two used plants Pelargonium and Santolina. Furthermore, some of the plants characteristics (i.e. stem diameter, number of leaves/plant and number of inflorescences /plant) were significantly affected.

Besides, results showed that after 8 months from the starting of the experiments using Pelargonium at 15 plants/m<sup>2</sup> covered 91% of area, while cultivation Santolina at 18 plants/m<sup>2</sup> covered only 32% of area.

These results were due to the use of small sized Santolina plants at the beginning of the experiment, which they were not enough to reach their maturity size during 8 months and cover a suitable area.

Also, suitable planting density increases the landscape value of ornamental plants where they perform normal growth shape.

Increasing planting density lead to growth competition for achieving more spacing, which inhibits underground growth but enhances the stem growth (Degenhardt and Kondra, 1981, Rao *et al.*, 1989; Morrisson *et al.*, 1990)

The highest flower number/plant was obtained in the lowest plant density.

These results may be attributed to increase the competition between cultivated plants for nutrition and light, which led to form many branches per plant, consequently many flowers could be formed and development per plant.

The progressive increases in plant height and internodes length at decreasing plant spacing and the corresponding decreases in stem diameter (to a greater extent inside compared to outside plants) indicate diminishing carbohydrate suppliers (Kaname and Itagi 1970; Zahara and Timm 1973; Crothers and westermann 1976) apparently because of decreasing plant exposure to light and have been associated with significant reductions in photosynthetic productivity (Papadopoulos and Ormrod 1988).

Generally, the greater the population density, the more competition there will be for resources. Through this population, one or more strained resources will become limiting for plant growth. As population density increases, the growth of individual plants will be limited.

Most researchers found that planting density affects the plant growth, Nooh (1981) on some annuals,



**Table 5. Means of number of main branches per plant of *Pelargonium zonale* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 6                                     | 0.07           | 0.3  | 1.5  | 2.9    | 4.1       | 5.2     | 2.35  |
| 9                                     | 0.13           | 0.5  | 1.7  | 2.8    | 3.9       | 5.1     | 2.36  |
| 12                                    | 0.07           | 0.4  | 1.3  | 2.6    | 3.5       | 4.5     | 2.06  |
| 15                                    | 0.07           | 0.5  | 1.6  | 2.7    | 3.7       | 4.4     | 2.16  |
| L.S.D at 0.05                         | N.S.           | N.S. | N.S. | N.S.   | N.S.      | N.S.    |       |

**Table 6. Means of number of leaves per plant of *Pelargonium zonale* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |       |       |        |           |         | Means |
|---------------------------------------|----------------|-------|-------|--------|-----------|---------|-------|
|                                       | May            | June  | July  | August | September | October |       |
| 6                                     | 6.07           | 9.00  | 11.87 | 18.67  | 25.80     | 32.40   | 17.32 |
| 9                                     | 4.80           | 9.73  | 14.13 | 19.60  | 25.13     | 32.07   | 17.58 |
| 12                                    | 6.20           | 11.20 | 15.47 | 22.53  | 30.60     | 37.87   | 20.64 |
| 15                                    | 5.93           | 11.00 | 15.33 | 21.13  | 26.27     | 32.20   | 18.64 |
| L.S.D at 0.05                         | N.S.           | N.S.  | 0.20  | 0.13   | N.S.      | N.S.    |       |

**Table 7: Means of number of inflorescence per plant of *Pelargonium zonale* L. as affected by different planting density treatments. (plants/m<sup>2</sup>).**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 6                                     | 0              | 0.53 | 1.27 | 1.33   | 2.07      | 3.07    | 1.65  |
| 9                                     | 0              | 0.53 | 1.33 | 1.60   | 1.27      | 2.07    | 1.36  |
| 12                                    | 0              | 0.60 | 0.93 | 0.93   | 1.53      | 2.20    | 1.24  |
| 15                                    | 0              | 0.53 | 0.80 | 0.93   | 1.20      | 2.07    | 1.11  |
| L.S.D at 0.05                         |                | N.S. | N.S. | N.S.   | N.S.      | N.S.    |       |

**Table 8. Means of plant condition of *Pelargonium zonale* L. as affected by different planting density treatments. (plants/m<sup>2</sup>).**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 6                                     | 9.00           | 9.00 | 8.60 | 8.60   | 8.47      | 8.60    | 8.71  |
| 9                                     | 9.00           | 9.00 | 9.00 | 8.87   | 8.87      | 8.47    | 8.87  |
| 12                                    | 8.86           | 8.87 | 8.73 | 8.47   | 8.07      | 7.53    | 8.42  |
| 15                                    | 8.73           | 8.87 | 8.73 | 8.33   | 7.8       | 7.27    | 8.29  |
| L.S.D at 0.05                         | N.S.           | N.S. | N.S. | N.S.   | N.S.      | N.S.    |       |

**Table 9. Means of flower intensity of *Pelargonium zonale* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 6                                     | 0              | 6.93 | 6.83 | 6.83   | 6.98      | 7.33    | 6.98  |
| 9                                     | 0              | 6.43 | 6.73 | 6.88   | 6.83      | 6.83    | 6.74  |
| 12                                    | 0              | 5.73 | 5.60 | 5.48   | 5.36      | 5.25    | 5.48  |
| 15                                    | 0              | 5.63 | 5.60 | 5.53   | 5.78      | 5.73    | 5.65  |
| L.S.D at 0.05                         |                | 0.45 | 0.52 | 0.58   | 0.53      | 0.49    |       |

**Table 10. Means of flower quality of *Pelargonium zonale* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 6                                     | 0              | 7.70 | 7.70 | 7.68   | 7.60      | 7.60    | 7.7   |
| 9                                     | 0              | 7.10 | 7.73 | 7.55   | 7.33      | 7.17    | 7.4   |
| 12                                    | 0              | 6.40 | 6.43 | 6.26   | 6.00      | 5.97    | 6.2   |
| 15                                    | 0              | 6.10 | 6.10 | 5.80   | 5.80      | 5.87    | 5.9   |
| L.S.D at 0.05                         |                | 0.84 | 0.29 | 0.37   | 0.60      | 0.49    |       |

**Table 11. Means of growth shape of *Pelargonium zonale* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 6                                     | 0              | 0    | 0    | 0      | 5.93      | 7.10    | 6.5   |
| 9                                     | 0              | 0    | 0    | 0      | 6.87      | 7.67    | 7.3   |
| 12                                    | 0              | 0    | 0    | 0      | 6.20      | 7.00    | 6.6   |
| 15                                    | 0              | 0    | 0    | 0      | 6.33      | 7.67    | 7.0   |
| L.S.D at 0.05                         |                |      |      |        | N.S.      | N.S.    |       |

**Table 12. Means of plant height (cm.) of *Santolina chamaecyparissus* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |       |       |        |           |         | Means |
|---------------------------------------|----------------|-------|-------|--------|-----------|---------|-------|
|                                       | May            | June  | July  | August | September | October |       |
| 9                                     | 10.00          | 10.83 | 11.3  | 12.37  | 13.2      | 14.07   | 11.93 |
| 12                                    | 9.73           | 10.8  | 11.33 | 12.37  | 14.43     | 15.07   | 12.29 |
| 15                                    | 10.2           | 11.63 | 12.43 | 13.8   | 15.43     | 17.13   | 13.44 |
| 18                                    | 10.13          | 11.6  | 12.8  | 14.8   | 16.8      | 18.33   | 14.08 |
| L.S.D at 0.05                         | N.S.           | N.S.  | N.S.  | 1.64   | 1.20      | 2.00    |       |

**Table 13. Means of plant diameter (cm) of *Santolina chamaecyparissus* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |       |       |        |           |         | Means |
|---------------------------------------|----------------|-------|-------|--------|-----------|---------|-------|
|                                       | May            | June  | July  | August | September | October |       |
| 9                                     | 4.28           | 10.63 | 12.82 | 15.80  | 18.23     | 20.03   | 13.63 |
| 12                                    | 3.87           | 9.33  | 11.93 | 13.83  | 16.13     | 18.37   | 12.24 |
| 15                                    | 4.15           | 9.70  | 11.67 | 13.67  | 15.67     | 16.7    | 11.93 |
| 18                                    | 4.18           | 8.53  | 10.81 | 11.90  | 13.53     | 15.07   | 10.67 |
| L.S.D at 0.05                         | N.S.           | 0.84  | 1.00  | 1.34   | 0.98      | 1.33    |       |

**Table 14. Cover percentage (%) of *Santolina chamaecyparissus* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |       |       |        |           |         | Means |
|---------------------------------------|----------------|-------|-------|--------|-----------|---------|-------|
|                                       | May            | June  | July  | August | September | October |       |
| 9                                     | 1.29           | 8.03  | 11.67 | 17.63  | 23.43     | 28.37   | 15.1  |
| 12                                    | 1.41           | 8.20  | 13.47 | 18.00  | 24.53     | 31.77   | 16.2  |
| 15                                    | 2.03           | 11.08 | 16.04 | 22.03  | 25.80     | 32.77   | 18.3  |
| 18                                    | 2.47           | 10.28 | 16.51 | 20.06  | 28.87     | 32.06   | 18.4  |
| L.S.D at 0.05                         | 0.69           | 1.52  | 3.49  | 3.83   | 3.04      | 4.29    |       |

**Table 15. Means of stem diameter (mm.) of *Santolina chamaecyparissus* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 9                                     | 2.93           | 3.40 | 3.40 | 4.13   | 4.33      | 4.33    | 3.75  |
| 12                                    | 3.00           | 3.26 | 3.27 | 3.87   | 3.93      | 3.93    | 3.54  |
| 15                                    | 2.93           | 3.67 | 3.67 | 4.06   | 4.13      | 4.13    | 3.76  |
| 18                                    | 2.93           | 3.60 | 3.60 | 3.67   | 3.93      | 4.00    | 3.62  |
| L.S.D at 0.05                         | N.S            | N.S  | N.S  | N.S    | N.S       | N.S     |       |

**Table 16. Means of number main of branches per plant of *Santolina chamaecyparissus* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 9                                     | 1.87           | 4.00 | 7.87 | 10.93  | 15.43     | 20.83   | 10.15 |
| 12                                    | 2.00           | 3.93 | 7.60 | 10.60  | 13.67     | 14.33   | 8.69  |
| 15                                    | 1.87           | 3.80 | 7.47 | 10.47  | 13.03     | 14.13   | 8.46  |
| 18                                    | 2.00           | 4.00 | 7.03 | 10.07  | 11.47     | 12.00   | 7.08  |
| L.S.D at 0.05                         | N.S            | N.S  | N.S  | N.S    | 0.91      | 2.12    |       |

**Table 17. Means of plant condition of *Santolina chamaecyparissus* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 9                                     | 9.00           | 8.60 | 8.86 | 8.86   | 8.86      | 8.86    | 8.84  |
| 12                                    | 9.00           | 8.70 | 8.71 | 9.00   | 8.86      | 8.73    | 8.84  |
| 15                                    | 9.00           | 9.00 | 9.00 | 8.86   | 8.73      | 8.73    | 8.89  |
| 18                                    | 9.00           | 9.00 | 8.73 | 8.60   | 8.86      | 8.73    | 8.82  |
| L.S.D at 0.05                         | N.S            | N.S  | N.S  | N.S    | N.S       | N.S     |       |

**Table 18. Means of growth shape of *Santolina chamaecyparissus* L. as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Treatments<br>(plant/m <sup>2</sup> ) | Growing Period |      |      |        |           |         | Means |
|---------------------------------------|----------------|------|------|--------|-----------|---------|-------|
|                                       | May            | June | July | August | September | October |       |
| 9                                     | 0              | 0    | 0    | 0      | 7.53      | 7.80    | 7.66  |
| 12                                    | 0              | 0    | 0    | 0      | 8.60      | 8.30    | 8.45  |
| 15                                    | 0              | 0    | 0    | 0      | 8.06      | 8.70    | 8.38  |
| 18                                    | 0              | 0    | 0    | 0      | 6.60      | 6.87    | 6.73  |
| L.S.D at 0.05                         |                |      |      |        | N.S       | N.S     |       |

N.S= Not Significant at 0.05 level of probability.

L.S.D.= Least significant difference at 0.05 of probability.

**Table 19. Soil analysis of *Pelargonium zonle* L. and *Santolina chamaecyparissus* L flowerbeds as affected by different planting density treatments. (plants/m<sup>2</sup>)**

| Experiment<br>type | Soil Characteristics |      |                        |                |                  |                      |                       |                  |      |
|--------------------|----------------------|------|------------------------|----------------|------------------|----------------------|-----------------------|------------------|------|
|                    | EC<br>dS/m           | pH   | Soluble cations meq./1 |                |                  |                      | Soluble anions meq./1 |                  | SAR  |
|                    |                      |      | Na <sup>+</sup>        | K <sup>+</sup> | Mg <sup>++</sup> | Ca <sup>+</sup><br>+ | Cl <sup>-</sup>       | HCO <sub>3</sub> |      |
| Flowerbeds         | 10.8                 | 7.41 | 60.8                   | 0.9            | 30               | 52.5                 | 148                   | 15               | 14.7 |

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