# Cut Flower Production of Lily Bulbs Grown in Different Sites in Argentina - a Comparative Approach

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**Abstract**

**Bulbs imported from The Netherlands were multiplied by scaling. The scales were planted in the field and grown for two years in five sites of Argentina: Tucumán, Hilario Ascasubi, Bahía Blanca, Epuyén and Trevelin. Then, the flowering sized bulbs obtained were evaluated in a greenhouse in Bahía Blanca for flower production and compared with bulbs from The Netherlands. The hybrids tested were Asiatic 'Navona' and 'Nello', *Lilium longiflorum* 'White Heaven' and 'Avita', Oriental 'Dordogne' and 'Expression', LA 'Fangio' and 'Royal Respect', OT 'Yelloween', LO 'Triumphator' and OA 'Fancy Crown'. Argentine bulbs of different hybrids and sites produced cut flowers of good quality, especially regarding the number and size of flower buds. Bulbs of LA 'Fangio' produced floral stems of higher quality than those of the other hybrids and showed no difference in quality attributes with respect to the bulb growth site. The three main hybrid groups, *L. longiflorum*, Asiatic and Oriental, behave differently according to temperature conditions of the site of origin of bulbs, these being the principal factor controlling the growth and development of *Lilium*. Asiatic and Oriental hybrids are better adapted to cooler climates and produced better flower stems from bulbs grown in Epuyen and Trevelin. *L. longiflorum* 'White Heaven', adapted to warmer climates produced more buds and longer stems if bulbs were grown in Tucumán and Bahía Blanca. Plants from bulbs grown in the south had a shorter cycle due to extra chill hours in field previous to harvest, but had shorter stems. Floral stem quality from local bulbs of the hybrid 'White Heaven' was similar to that produced from imported ones.**

## INTRODUCTION

The greatest demand for flower bulbs is centralized in the Northern Hemisphere, but production is moving increasingly into the Southern Hemisphere, i.e., Australia, New Zealand, South Africa, Brazil and Chile (Benschop et al., 2010). At present, lily bulbs come almost entirely from The Netherlands, the largest producer, and from Chile and New Zealand in the Southern Hemisphere.

In Argentina, lily bulb production is an emerging activity and has begun in part due to the projects funded by the National Agency for Promotion of Science and Technology. Argentina offers a wide variety of soil and climactic conditions that satisfy the different requirements of several hybrids of *Lilium* (CETEFHO-JICA, 1998). However, the information existing in the country about the production of lily bulbs is scarce.

The recent expansion of the flower industry in Argentina and the need for producers to seek alternative or complementary production to their main agricultural activity has generated a growing interest in bulb production. At present, the lily is the most important cut flower from bulbs in Argentina. Due to its importance and potential, several programs were carried out in different parts of the country with the aim of testing bulb production of different groups of *Lilium* hybrids. Comparative studies of planting dates and hybrids behavior were conducted during four growing seasons. In each

experimental site, well-grown bulbs that reached commercial sizes were obtained in one or two growing seasons, depending on the hybrid, the site and the planting time (Facchinetti et al., 2005, 2006a,b, 2007, 2008a) (data not published).

Bulbs grown in different areas are not necessarily in the same physiological state even if they are harvested at the same apparent external degree of maturity. They may express different growth potentials even if they are subsequently stored and grown under the same conditions. It appears that bulbs produced under different climatic conditions will not be in the same physiological state if they are harvested on the same date.

In lily flower production, the quality of the bulb determines the quality of its flower. Considering that the ultimate goal is cut flower production and to a lesser extent, potted plants and gardening, the aim of this study was to evaluate the forcing behavior of the bulbs grown in different sites in Argentina (with different agro-climatic characteristics) and to compare them with bulbs imported from The Netherlands.

## MATERIALS AND METHODS

Bulbs imported from the Netherlands were multiplied by scaling (Marinangeli et al., 1999). The scales were planted in the field at five sites of Argentina with different agro-climatic characteristics (Fig. 1, Table 1): Tucumán, Hilario Ascasubi, Bahía Blanca, Epuyén and Trevelin and were grown for two years to produce commercial sized bulbs (14/16 cm) which were then evaluated in a greenhouse in Bahía Blanca for flower production and compared with bulbs from The Netherlands. Two experiments were carried out, one in 2007 and the second in 2008.

In 2007, the hybrids tested were Asiatic 'Navona' (*Na*) and 'Nello' (*Ne*), *L. longiflorum* 'Avita' (*Av*), Orientals 'Dordogne' (*Do*) and 'Expression' (*Ex*), LA 'Fangio' (*Fa*) and 'Royal Respect' (*Rr*), OT 'Yelloween' (*Ye*), and LO 'Triumphator' (*Tr*). The sites of origin of bulbs were Tucumán (TU), Hilario Ascasubi (HA), Bahía Blanca (BB), Epuyén (EP) and Trevelin, (TR). Also bulbs from 'Fangio' (size 16-18) from BB, EP and TR were used to compare them with bulbs of the same size imported from The Netherlands (HO). The field harvest dates were the first week February for TU bulbs, mid-March for HA and BB bulbs, and end of April for EP and TR bulbs. After harvest, bulbs were stored at 20°C until vernalization (4°C for 90 days). The planting took place on 17 August 2007. Dutch bulbs are usually harvested during October and November.

In 2008, the hybrids tested were Asiatic *Na*, *L. longiflorum* 'White Heaven' (*Wh*), Oriental *Ex*, LA *Fa*, OT *Ye*, LO *Tr* and OA 'Fancy Crown' (*Fc*). The sites of origin of bulbs were BB, EP and TR. Also bulbs from *L. longiflorum Wh* (size 16-18) from BB were used to compare with bulbs of the same size from The Netherlands (HO). Harvest dates were approximately the same as in 2007. The bulbs were kept at 4°C, beginning on 28 April for 90 days, to ensure complete vernalization. Planting took place on 28 July 2008.

Bulbs were forced in a greenhouse with controlled lateral ventilation up to 30% of the area, covered with 150 µm polyethylene film and shaded with an aluminized mesh (60% light reduction). Bulbs were planted 10 cm deep in 90 cm wide beds, in sandy-loam soil (1.5% organic matter) conditioned with 10 $dm^3/m^2$ peat moss. Irrigation and fertilization was by drip irrigation.

The planting density was 64 bulbs/$m^2$. For each hybrid a randomized complete block design with four replications in split plots was used; hybrids in the main plot and sites in the smaller ones. The experimental unit included 14 plants, and the records, taken from the 10 central plants, were: days to visible buds, days to first colored bud (harvest), maximum height at visible bud and at harvest, number of buds per stem, number of aborted buds, number of malformed buds, length of the first bud and size of the stem at its base. Minimum and maximum average temperatures in the greenhouse were 11.1 and 31.2°C, respectively, in 2007-2008, and 12.7 and 34.3°C, respectively, in 2008-2009, for the period 19 September-13 February.

Statistical analyses were performed by ANOVA using Info-Gen (Balzarini and Di

Rienzo, 2004) and comparisons between the mean values were made by Tukey test at the 0.05 probability level. Biplot graphics were used to visualize the multivariate analysis using principal components.

## RESULTS AND DISCUSSION

In general, the forcing time for the hybrids was longer than that reported by a supplier of bulbs, except for the Asiatic hybrids *Na* and *Ne*, in 2007 (Table 2) and for the hybrid *L. longiflorum Wh* in 2008 (Table 3). This occurred because at the beginning of the cycle the night temperatures were lower than those suggested by the International Flowerbulb Center (IBC, The Netherlands), i.e., 12 to 13°C (Fig. 2) and lower temperatures lengthen the growing season. Asiatic hybrids usually have a shorter growing period than other hybrids (De Hertogh, 1989) and require lower minimum temperatures than the Oriental and *longiflorum* hybrids (IBC).

Temperature is the primary factor controlling lily growth and development, both in the field and in the greenhouse (Roberts et al., 1985). In some species, great variation exists with respect to time of flower initiation due to the different locations where they are grown (Le Nard and De Hertogh, 1993). The level of cold stimulus perceived during commercial bulb production depends on natural field temperatures and is one of the reasons for annual differences in the greenhouse forcing performance of Easter lilies (Lin and Wilkins, 1975) and Asiatic hybrids (Roh, 1989).

For all hybrids, plants from bulbs grown in the south, EP and TR, had a shorter cycle than those coming from the other sites, although it was detrimental to plant height (Table 2). The reason was that in the south, bulbs were exposed to vernalizing temperatures in the field (Table 1), in addition to those temperatures by the vernalization treatment in chamber, before forcing. It is well known that the more extended the vernalization treatment, the shorter the time to harvest and the shorter the stems produced (Beattie and White, 1993; Miller, 1993). Le Nard and De Hertogh (1993) also observed shortening of the cycle with increasing periods of storage of bulbs at low temperatures, in tulip. In addition, bulbs from lower latitudes (BB, HA, and TU) were harvested one to three months earlier than bulbs from the South (EP and TR), and had to be kept at 20-22°C until the harvest of those grown in the South; then, all the bulbs were stored at 4°C until planting. It is also known that storage at high temperatures prior to vernalization causes a lengthening of the cycle and greater plant height (Blaney et al., 1963; Miller and Kiplinger, 1966; Beattie and White, 1993; Miller, 1993).

The shortest cycle of the bulbs of LA *Fa* 16-18 (Table 2) and *L. longiflorum Wh* (Table 3) coming from The Netherlands can be attributed to the long time storage at low temperatures (vernalization at 4°C and storage at -1.5°C), close to 10 months at planting time. As reported by Stuart (1946) for bulbs of *L. longiflorum* 'Croft', as storage time increased, days to flower decreased. However, cold storage reduces the number of flower buds, and the reduction is greater as storage time increased. This is what happened with LA *Fa* (16-18) from The Netherlands that reached harvest with fewer buds per stem and smaller stem caliber than plants coming from Argentinean origins (Table 2). These results are in good agreement with those of Brierley (1941), Kays et al. (1971), Roh and Wilkins (1977) and Wilkins (1980).

The number of buds per stem and the length of the first colored bud are the most important attributes of quality, along with the stem length (height to harvest). Length of stem and number of buds per stem were comparable to those reported by the brokers for the hybrids assayed, except for Asiatic *Na* and LO *Tr*, in 2007 (Table 2) with a length of stem always shorter than reported, and for Asiatic *Na* in BB and EP, OT *Ye* in TR and EP, Oriental *Ex* in EP and *Wh* in TR, in 2008 (Table 3), that showed a lower number of buds per stem. This kind of variability is generally found in *Lilium longiflorum* crops caused by variable environmental conditions under which the bulbs were grown, as well as the lack of uniformity in the greenhouse environment during forcing (Fisher and Lieth, 2000).

The behavior regarding the origin of the bulbs was different for the several groups of hybrids (Tables 2 and 3) and a direct relationship was found between its environmental

requirements (Miller, 1993; Blaney and Roberts, 1957) and the agro-climatic characteristics of each site of origin (Table 1). The three main hybrid groups, *longiflorum*, Asiatic and Oriental, behave differently according to temperature conditions. Asiatic and Oriental hybrids are better adapted to cooler climates and grow without difficulty in these latitudes, while *longiflorum* are better adapted to warmer climates. *L. longiflorum Av* (2007) and *L. longiflorum Wh* (2008) produced more buds and longer stems if they were produced in TU and BB. On the other hand, bulbs from TR of the Asiatic hybrid *Na*, adapted to colder climates, produced more buds per stem. Bulbs of the LA hybrid *Fa* showed no difference in the quality of flowers with respect to the bulb growth site or it performed better when coming from the south (TR).

Plants from bulbs grown in BB had the highest number of aborted buds in almost all hybrids, although in most cases without significant differences with other sites. In general, there was a high number of aborted buds, especially in Oriental and Asiatic hybrids which are more susceptible to this disorder, and also in the intergroup hybrids like OA *Fc* and LO *Tr* (Tables 2 and 3). Alteration in these quality parameters was probably due to high daytime temperatures during the second half of the crop cycle, especially in the season 2008 when temperatures were higher (Fig. 1). Wang and Roberts (1983) proved that high air or soil temperatures during growth reduce the diameter of the meristem and, therefore, the number of buds formed. This could be another cause for fewer flowers in the spring crop. In other cases, the presence of malformed buds was associated with the presence of virus (data not shown).

Argentinean bulbs of different hybrids and sites produced cut flowers of good quality, especially regarding the number and size of flower buds. Bulbs of LA *Fa* produced floral stems of higher quality than those of the other hybrids and showed no difference in quality attributes with respect to the bulb growth site. Plants from bulbs grown in the south had a shorter cycle due to extra chill hours in field previous to harvest, but had shorter stems. In commercial culture the differences in the cycle length should disappear because the bulbs harvested in the north and central part of Argentina could be subjected earlier to vernalizing temperatures.

Overall quality of stems grown from local bulbs of the hybrid *Wh* was similar to that produced from imported ones.

Despite the conditions during the forcing period in the greenhouse, that were the same for all hybrids, the differences in performance observed in bulbs of the same hybrid clearly show the importance of the site of production of the bulb in relation to the agro-climatic conditions, mainly temperature, and how it affects the growth and flower development. Also the post-harvest handling and storage conditions of the bulbs prior to forcing are important.

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**Literature Cited**

Balzarini, M. and Di Rienzo, J.A. 2004. Info-Gen: Software estadístico para análisis de datos genéticos. RDNDA, OS, N 362964.

Beattie, D.J. and White, J.W. 1993. *Lilium*-hybrids and species. p.423-453. In: A. De Hertogh and M. Le Nard (eds.), The Physiology of Flower Bulbs, Elsevier, Amsterdam.

Benschop, M., Kamenetsky, R., Le Nard, M., Okubo, H. and De Hertogh, A. 2010. The global flower bulb industry: production, utilization, research. Hort. Rev. 36:1-115.

Blaney, L.T. and Roberts, A.N. 1957. Bulb Growing and Forcing. Northwest Bulb Growers Association.

Blaney, L.T., Hartley, D.E. and Roberts, A.N. 1963. Preheating before precooling benefits Easter lily bulbs. Flor. Rev. 133:23-24, 70-71.
Brierley, P. 1941. Effect of cool storage of Easter Lily bulbs on subsequent forcing performance. J. Agric. Res. 62:317-335.
CETEFHO-JICA. 1998. Cultivo de *Lilium*. Informe Técnico. CETEFHO, Buenos Aires. 50p.
De Hertogh, A.A. 1989. Lilies (colored) - cut flowers, p. C63, and Lilies (colored) -potted plants, p. C73. In: Holland Bulb Forcer's Guide, 4th ed., International Flower Bulb Centre, Hillegom, The Netherlands: p.369
Fisher, P.R. and Lieth, J.H. 2000. Variability in flower development of Easter lily (*Lilium longiflorum* Thunb.): model and decision-support system. Comput. Elect. Agric. 26:53-64.
IBC. International Flower Bulb Centre. www.bulbsonline.org.
International Flower Bulb Centre. 2002. The lily as a cut flower and potplant. IFBC, Hillegom, The Netherlands.
Kays, S., Carlson, W., Blakely, N. and De Hertogh, A.A. 1971. Effects of exogenous gibberellins on the development of *Lilium longiflorum* Thunb. 'Ace'. J. Amer. Soc. Hort. Sci. 96:222-225.
Le Nard, M. and De Hertogh, A.A. 1993. *Tulipa*. p.617-682. In: A.A. De Hertogh and M. Le Nard (eds.), The physiology of flower bulbs. Amsterdam: Elsevier.
Lin, W.C. and Wilkins, H.F. 1975. Influence of bulb harvest date and temperature on growth and flowering of *Lilium longiflorum*. J. Amer. Soc. Hort. Sci. 100:6-9.
Marinangeli, P., Delmastro, S. and Curvetto, N. 1999. Propagación de *Lilium* por Técnicas Mejoradas de Scaling y de Cultivo de Tejidos. Boletín de divulgación de XXVII Congreso Nacional de Viveristas. Escobar. Buenos Aires.
Miller, R.O. and Kiplinger, D.C. 1966. Interaction of temperature and time of vernalization on northwest Easter lilies. Proc. Amer. Soc. Hort. Sci. 88:635-645.
Miller, W.B. 1993. *Lilium longiflorum*. p.391-416. In: A.A. De Hertogh and M. Le Nard (eds.), The physiology of flower bulbs. Amsterdam: Elsevier.
Roberts, A.N., Stang, J.R., Wang, Y.T., McCorkle, W.R., Riddle, L.R. and Moeller, F.W. 1985. Easter Lily growth and development. Oregon State Univ. Agric. Expt. Sta. Tech. Bull. 148, 74p.
Roh, M.S. and Wilkins, H.F. 1977. The control of flowering in *Lilium longiflorum* Thunb. cv. Nellie White by cyclic or continuous light treatments. J. Amer. Soc. Hort. Sci. 102:247-253.
Roh, M.S. 1989. Effect of high temperature on bud blast in Asiatic hybrid lily. Acta Hort. 266:141-146.
Stuart, N.W. 1946. Temperature and length of storage effects on lilies. Flor. Rev. 98:35-37.
VWS Export - Import of Flowerbulbs from Holland. www.vws-flowerbulbs.nl.
Wang, Y.T. and Roberts, A.N. 1983. Influence of air and soil temperatures on the growth and development of *Lilium longiflorum* Thunb. during different growth phases. J. Amer. Soc. Hort. Sci. 108:810-815.
Wilkins, H.F. 1980. Easter Lilies. p.327-352. In: R.A. Larson (ed.), Introduction to Floriculture, Academic Press, San Diego.

## Tables

Table 1. Localization and climatic characteristics of five sites of Argentina where bulbs were grown. T avr: average temperature; T max: average maximum temperature; T min: average minimum temperature; Precip,: annual precipitation; TU: Tucumán; BB: Bahía Blanca; HA: Hilario Ascasubi; EP: Epuyén; TR: Trevelin.

| Annual average | Sites | Geographic coordinate | Altitude (m) | T max (°C) | T min (°C) | T avr (°C) | Precip (mm) |
|---|---|---|---|---|---|---|---|
| 1999-2009 | TU | 26°56'S; 65°21'W | 399 | 26.5 | 14.6 | 19.8 | 1160 |
| 1995-2005 | BB | 38°44'S; 62°16'W | 65 | 21.9 | 8.9 | 15.2 | 648 |
| 1966-2008 | HA | 39°22'S; 62°38'W | 14 | 21.7 | 7.8 | 14.8 | 506 |
| 1996-2009 | EP | 42°14'S; 71°22'W | 200 | 17.3 | 2.8 | 10.2 | 1305 |
| 1970-2009 | TR | 43°03'S; 71°29'W | 450 | 16.2 | 3.3 | 9.7 | 1032 |

Table 2. Evolution of growth and yield parameters in cut flower production during 2007 of bulbs from nine lily hybrids produced in five sites of Argentina: Bahia Blanca (BB), Hilario Ascasubi (HA), Tucumán (TU), Trevelin (TR), Epuyén (EP), and in The Netherlands (HO). DVB: days to visible bud; HVB: height to visible bud; DCB: days to first colored bud (harvest); HH: height to harvest; NBH: number of buds at harvest; NAB: number of aborted buds; NMB: number of malformed buds; L1B: length of 1st bud; SCH: stem caliber at harvest. Different letters among sites for each hybrid mean differences at 5% by Tukey test.

| Origin | DVB | HVB (cm) | DCB | HH (cm) | NBH | NAB | NMB | L1B (cm) | SCH (cm) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Longiflorum* 'Avita' (*Av*) | | | | | |
| TU | 91.4 a | 76.1 a | 122.0 a | 105.8 a | 4.2 a | 0.46 b | 0 | 13.4a | 1.20 a |
| BB | 91.1 a | 64.5 b | 121.5 a | 92.2 bc | 4.3 a | 0.83 a | 0 | 12.6 b | 1.24 a |
| EP | 84.6 b | 76.1 b | 116.1 c | 89.4 c | 2.8 b | 0.13 c | 0 | 13.1ab | 0.97 b |
| TR | 89.6 a | 63.8 b | 119.1 b | 95.1 b | 2.4 b | 0.07 c | 0 | 13.8 a | 0.89 c |
| | | | | LO 'Triumphator' (*Tr*) | | | | | |
| BB | 88.8 a | 72.5 a | 121.3 a | 89.8 a | 2.4 b | 0.24 | 0.37 | 10.9 b | 0.96 b |
| EP | 88.2 a | 59.7 b | 109.7 b | 77.1 b | 3.1 a | 0.07 | 0.22 | 12.1 a | 1.15 a |
| TR | 78.1 b | 63.4 b | 110.8 b | 84.3 a | 3.2 a | 0.11 | 0 | 12.5 a | 0.95 b |
| | | | | LA 'Fangio' (*Fa*) 14-16 | | | | | |
| BB | 76.2 a | 74.0 a | 106.2 b | 108.2 | 4.0 ab | 0.21 a | 0.03 | 8.3 c | 0.99 a |
| HA | 76.0 a | 74.9 a | 111.9 a | 104.2 | 3.6 b | 0.27 a | 0.1 | 7.9 c | 0.90 bc |
| EP | 57.4 c | 62.0 b | 93.9 d | 106.9 | 4.1 ab | 0.00 b | 0 | 9.6 a | 0.98 ab |
| TR | 64.8 b | 60.4 b | 96.9 c | 103.1 | 4.5 a | 0.00 b | 0 | 8.8 b | 0.88 c |
| | | | | LA 'Fangio' (*Fa*) 16-18 | | | | | |
| BB | 72.1 a | 82.7 a | 105.9 a | 122.2 | 5.8 a | 0.15 | 0 b | 8.9 b | 1.27 a |
| EP | 56.1 c | 64.2 c | 92.9 c | 118.9 | 5.3 b | 0.00 | 0 b | 9.7 a | 1.09 b |
| TR | 62.1 b | 61.6 c | 94.9 b | 114.1 | 5.8 a | 0.03 | 0.07 b | 9.3 ab | 1.03 c |
| HO | 56.7 c | 75.1 b | 93.7 c | 118.5 | 4.8 c | 0.05 | 0.25 a | 9.5 a | 0.96 d |

Table 2. Continued.

| Origin | DVB | HVB (cm) | DCB | HH (cm) | NBH | NAB | NMB | L1B (cm) | SCH (cm) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | LA 'Royal Respect' (*Rr*) | | | | | |
| BB | 81.3 b | 72.4 a | 113.2 b | 102.5 a | 4.9 bc | 0.025 | 0 | 8.4 | 1.04 a |
| HA | 84.8 a | 71.6 a | 114.8 a | 100.8 a | 4.4 c | 0.025 | 0 | 8.1 | 0.96 b |
| EP | 65.6 c | 45.6 b | 105.9 d | 81.5 b | 5.1 b | 0 | 0 | 8.2 | 0.96 b |
| TR | 63.6 d | 41.9 c | 107.2 c | 79.5 b | 5.9 a | 0.2 | 0 | 8.2 | 1.04 a |
| | | | | Asiatic 'Navona' (*Na*) | | | | | |
| BB | 72.2 a | 38.6 a | 107.7 a | 69.3 a | 5.6 b | 0.65 | 0.026 | 6.9 | 1.08 a |
| EP | 57.3 c | 27.1 b | 94.7 b | 62.2 b | 5.4 b | 0.44 | 0.052 | 6.9 | 0.87 b |
| TR | 59.9 b | 26.3 b | 95.3 b | 63.6 b | 6.5 a | 0.52 | 0 | 7.0 | 0.92 b |
| | | | | Asiatic 'Nello' (*Ne*) | | | | | |
| BB | 85.8 a | 89.4 a | 119.7 a | 124.5 a | 4.6 c | 0.17 | 0.15 a | 8.1 | 1.09 a |
| EP | 64.2 b | 49.2 b | 100.4 b | 98.7 b | 5.3 b | 0.17 | 0 b | 7.8 | 0.99 b |
| TR | 62.2 b | 45.8 b | 101.6 b | 100.1 b | 7.2 a | 0.45 | 0 b | 7.8 | 1.09 a |
| | | | | Oriental 'Dordogne' (*Do*) | | | | | |
| BB | 94.6 a | 73.9 a | 147.1 a | 98.3 a | 2.1 b | 0.22 a | 0.22 a | 9.0 | 0.79 a |
| EP | 88.1 b | 68.5 b | 131.6 b | 84.3 b | 2.5 a | 0.25 a | 0.20 a | 8.9 | 0.71 b |
| TR | 74.9 c | 58.1 c | 128.4 c | 80.1 b | 2.6 a | 0.03 b | 0.06 b | 9.4 | 0.77 a |
| | | | | Oriental 'Expression' (*Ex*) | | | | | |
| EP | 85.3 a | 49.5 b | 132.1 a | 70.3 a | 2.8 | 0.025 | 0.25 | 9.1 | 0.74 a |
| TR | 76.8 b | 56.1 a | 129.9 b | 62.9 b | 2.7 | 0 | 0.08 | 9.0 | 0.68 b |
| | | | | OT 'Yelloween' (*Ye*) | | | | | |
| BB | 77.7 | 98.4 | 120.8 a | 129.4 a | 3.9 ab | 0.05 | 0 | 11.1 | 0.95 |
| EP | 75.7 | 95.7 | 115.1 b | 123.6 b | 3.5 b | 0.025 | 0 | 11.3 | 0.98 |
| TR | 77.4 | 94.6 | 115.4 b | 123.7 b | 4.3 a | 0.05 | 0.075 | 11.4 | 0.99 |

Table 3. Evolution of growth and yield parameters in cut flower production during 2008 of bulbs from seven lily hybrids produced in three sites of Argentina: Bahía Blanca (BB), Epuyén (EP), Trevelin (TR), and in Holland (HO). DVB: days to visible bud; HVB: height to visible bud; DCB: days to first colored bud (harvest); HH: height to harvest; NBH: number of buds at harvest; NAB: number of aborted buds; NMB: number of malformed buds; L1B: length of 1st bud; SCH: stem caliber at harvest. Different letters among sites for each hybrid mean differences at 5% by Tukey test.

| Origin | DVB | HVB (cm) | DCB | HH (cm) | NBH | NAB | NMB | L1B (cm) | SCH (cm) |
|---|---|---|---|---|---|---|---|---|---|
| Asiatic 'Navona' (*Na*) | | | | | | | | | |
| BB | 77.6 a | 34.0 a | 108.8 | 60.3 a | 3.8 c | 1.70 | 3.3 a | 5.9 | 1.05 |
| EP | 68.5 b | 26.6 b | 106.2 | 57.1 a | 4.3 b | 1.50 | 0.0 b | 5.5 | 0.95 |
| TR | 70.9 b | 23.9 b | 105.8 | 51.2 b | 5.6 a | 2.38 | 3.3 a | 5.5 | 0.89 |
| OT 'Yelloween' (*Ye*) | | | | | | | | | |
| BB | 87.0 ab | 75.78 | 125.6 a | 95.3 a | 3.35 a | 1.1 | 0 | 9.69 | 0.94 |
| EP | 85.7 b | 71.62 | 124.1 b | 93.9 a | 2.13 b | 1.3 | 0 | 9.63 | 0.98 |
| TR | 88.9 a | 73.02 | 124.7 b | 86.7 b | 2.75 ab | 1.6 | 0 | 9.91 | 0.97 |
| OA 'Fancy Crown' (*Fc*) | | | | | | | | | |
| BB | 76.9 a | 43.3 | 119.7 a | 70.4 a | 3.8 b | 2.8 b | 1.25 a | 5.4 | 0.72 |
| EP | 70.7 b | 40.5 | 112.6 b | 64.9 b | 3.9 b | 2.8 b | 1.75 a | 5.6 | 0.73 |
| TR | 71.2 b | 32.6 | 111.5 b | 61.6 b | 5.3 a | 4.4 a | 0.25 b | 5.6 | 0.73 |
| LO 'Triumphator' (*Tr*) | | | | | | | | | |
| EP | 88.7 | 66.4 b | 122.6 | 84.0 | 2.88 | 1.26 | 0 | 11.7 a | 1.0 a |
| TR | 89.9 | 73.4 a | 121.2 | 88.2 | 2.67 | 1.35 | 0 | 11.5 a | 0.9 b |
| Oriental 'Expression' (*Ex*) | | | | | | | | | |
| EP | 92.4 | 44.5 b | 148.3 | 56.9 b | 1.5 b | 1.72 | 0 | 7.9 | 0.75 |
| TR | 93.7 | 54.5 a | 152.6 | 66.0 a | 2.3 a | 1.39 | 0 | 7.5 | 0.73 |
| *Longiflorum* 'White heaven' (*Wh*) | | | | | | | | | |
| BB | 79.9 b | 60.1 | 131.8 a | 83.8 | 2.6 a | 1.5 a | 0 | 12.5 | 1.10 a |
| EP | 92.9 a | 61.2 | 124.5 b | 78.6 | 2.1 b | 0.9 b | 0 | 12.8 | 0.98 b |
| TR | 96.7 a | 61.4 | 126.5 b | 81.9 | 1.9 b | 1.1 b | 0 | 12.7 | 0.87 b |
| *Longiflorum* 'White heaven' (*Wh*) HO-BB | | | | | | | | | |
| BB | 100.5 a | 78.3 | 126.2 a | 97.2 | 3.2 | 1.5 a | 0 | 12.6 | 1.05 b |
| HO | 84.4 b | 78.1 | 108.6 b | 100.3 | 3.4 | 0 b | 0 | 13.0 | 1.15 a |
| LA 'Fangio' (*Fa*) 14-16 | | | | | | | | | |
| BB | 78.2 a | 70.3 ab | 109.5 a | 110.6 | 3.6 | 1.25 a | 0 | 9.1 | 0.97 ab |
| EP | 67.8 c | 62.2 b | 102.8 c | 107.3 | 3.7 | 0 b | 0 | 9.3 | 1.03 a |
| TR | 72.1 b | 73.6 a | 106.1 b | 109.6 | 3.6 | 0 b | 0 | 9.0 | 0.92 b |

## Figures

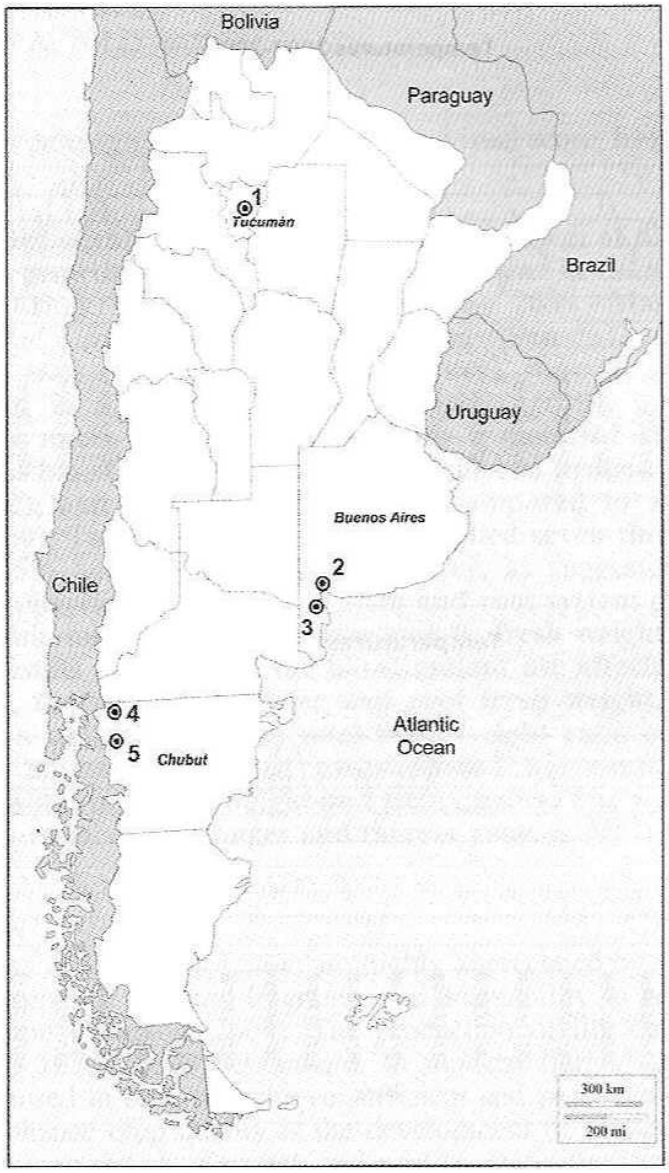
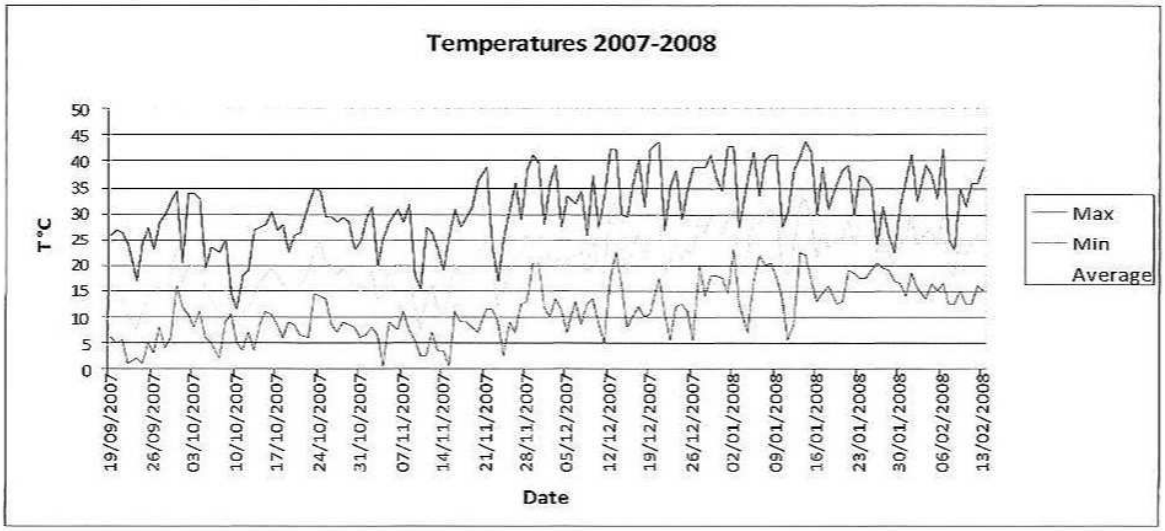



Fig. 1. Sites in Argentina where scaling bulblets were grown for two years. 1) Tucumán (26°56'S; 65°21'W), 2) Bahía Blanca (38°44'S; 62°16'W), 3) Hilario Ascasubi (39°22'S; 62°38'W), 4) Epuyén (42°14'S; 71°22'W), and 5) Trevelin, (43°03'S; 71°29'W).



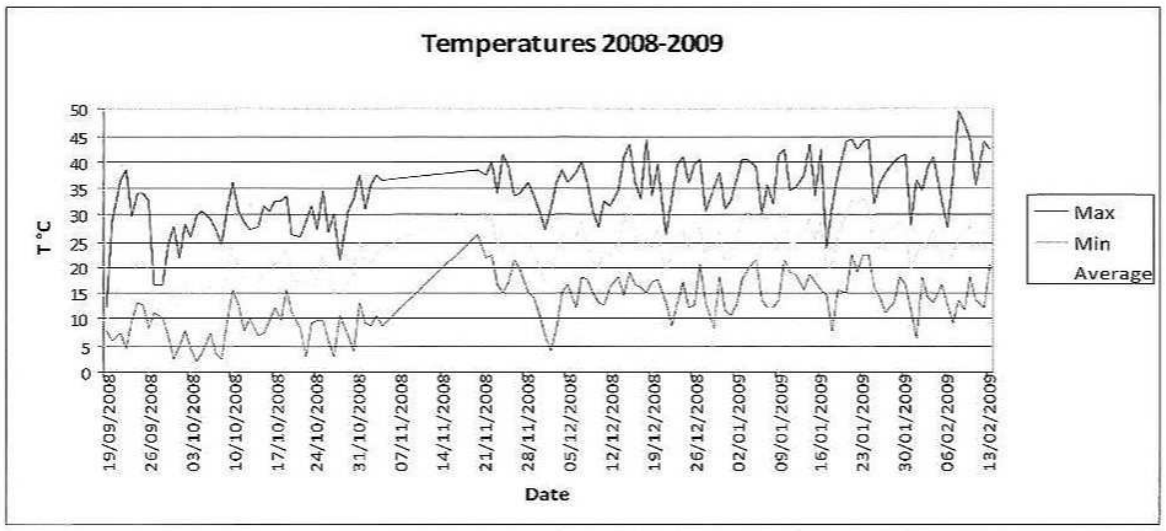




Fig. 2. Daily mean air temperature (°C) inside the greenhouse throughout the lily growing cycle for both the 2007-2008 and 2008-2009 periods.