

# Influence of Different Sites on *Lilium* Flower and Bulb Production in Cold Desert Region of Himachal Pradesh, India

M. R. Dhiman, R. S. Suman, Raj Kumar, Chander Parkash, Mahesh Guleria

Indian Agricultural Research Institute,  
Regional Station, Katrain, Kullu-Valley, Himachal Pradesh  
Email: mrarjun01@yahoo.co.in

**Abstract** – The present study was conducted in Lahaul-Valley of Himachal Pradesh in North western Himalayas with the objective to know the influence of different sites on cut flower and bulb production in different groups of *Lilium* hybrids. During the study an intensive survey was conducted and data were collected on existing genotypes from four different sites located at different altitudes viz., Kuthvihal (10302 feet), Gondhla (10726 feet), Dalang (9781 feet) and Phura (9600 feet). The results showed that bulbs grown at Dalang site had shorter growing cycle than those grown at other two sites. Plant height and number of flowers per stem were comparable except for Asiatic hybrid ‘Navona’ at Dalang and Gondhla; Oriental hybrids ‘Rubato’, ‘Tiara’ and ‘Mother Choice’ showed a lower number of flowers per stem at Dalang. The three main hybrid groups behaved differently according to temperature conditions. Asiatic and Oriental hybrids were better adapted to cooler climates. Fresh weight of Asiatic hybrids ‘Navona’ and ‘Brunello’ were significantly higher at Dalang, Kuthvihal and Phura. In Oriental hybrids fresh weight and size of harvested bulbs were higher at Kuthvihal. Moreover, the results indicated that dry temperate regions of Himachal Pradesh are suitable for quality cut flower and bulb production of *Lilium*.

**Keywords** – *Lilium*, Sites, Dry Temperate, Bulb, Himachal Pradesh.

## I. INTRODUCTION

Ornamental geophytes belong to more than 800 different genera. *Lilium* ranked as 4<sup>th</sup> most important cut flowers and the second in flower bulbs (Land- en tuinbouwcijfers 2011: <http://www.lei.dlo.nl/publicaties/PDF/2011/2011-029.pdf>). For many years, cultivation of flower bulbs was restricted to countries with developed ornamental horticulture industries and moderate climates such as the Netherlands. In the last two decades of the 20<sup>th</sup> century, production of bulb flowers in several other regions of the world has become important. Flower bulbs are utilized for commercial bulb and flower production, including forced fresh-cut flowers, potted plants, and for landscaping, including private gardening [2]. Species of genus *Lilium* originate from Asia, Europe, and North America [3] are mostly vegetative propagated monocot perennials and are one of the economically most important flower bulbs.

The genus *Lilium* belongs to *Liliaceae* family and comprises more than 80 species [1]. During the last 50 years, more than seven thousand cultivars have been developed (International Lily register, <http://www.lilyregister.com/>). These are classified mainly into three groups: Longiflorum (L), Asiatic (A), and

Oriental (O) hybrids that belong to different taxonomic sections. Longiflorum hybrids have trumpet shaped white flowers that are mostly side-facing and have a distinctive fragrance. They show strong growth vigour and year round forcing abilities [9]. Asiatic hybrids are important due to their wide variation in flower colours, shapes, sizes and early flowering. Oriental hybrids have large and attractive flowers with a wide range of white, pink, yellow colours and strong fragrance.

In India, bulbs of *Lilium* sourced from Holland are planted for production of cut flowers throughout the year. Generally, for early sprouting and flowering, *Lilium* bulbs require a cold treatments at 2-7°C for 6-8 weeks. Cold desert areas of Himachal Pradesh particularly in Lahaul - Valley and Kinnaur districts offer a wide variety of soil and climatic conditions that satisfy the different requirements of several hybrids of *Lilium*. However, the information existing in the state about the production of lily cut flower and bulbs is scarce. The recent expansion of the flower industry in the state 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 crop grown in the country. Due to its importance and potential, several programmes were carried in different parts of the country with the aim of testing flower and bulb production potential of different groups of *Lilium* hybrids.

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 goal is cut flower production and to a lesser extent, potted plants and gardening, the aim of this investigation was to study the influence of different sites in Lahaul- Valley of H.P. on cut flower production in different groups of *Lilium* hybrids.

## II. MATERIALS AND METHODS

### Study Area

The present study was conducted in Lahaul valley of Himachal Pradesh in northwest Himalayas which is known

for its seclusion, Buddhist culture, hostile climate, and unexplored, formidable, and breathtaking scenic beauty of the high snow clad mountains. It is a part of the Indian cold deserts which is situated between 31°44'57" and 32°59'57"N latitude and 76°46'29" and 78°41'34"E longitude. It is surrounded by the main Himalayan ranges on the North mainly Baralacha Pass, the mid Himalayan range or Pir Panjal on the South, the Kunjum range which separates Lahaul from Spiti on the East and the off-shoot of the Pir Panjal range on the West. The distinctive features of the valley are snow covered peaks, massive glaciers, view of bleak, sunny, higher mountain ranges and narrow river valleys. The whole area of Lahaul is divided into four valleys namely, Pattan Valley, Myar Valley, Todh Valley and Tennan Valley. In the valley soil is more or less loam to sandy loam with gravel. In the vicinity of villages and nearby, denuded slopes are subjected to concentrated year round grazing; hence the soil is equally poor. On the northern aspects, in folds and hollows as also on easier slopes, the soil is fairly deep and fertile for tree

growth. It is therefore, the best forests in the valley are on the left bank of the Chanderbhaga River (Fig.1a – 1c).

Climatic conditions are typical of dry temperate to alpine types and have distinct seasons. The summer is rainless due to high mountains. The rainy season receive very less rainfall. The winter season is comparatively a large *i.e.*, from late November to early April. During this period, heavy snow fall occurs in the Valley. The Lahaul-Spiti which is the largest district of Himachal Pradesh with an area of ca.13835 km<sup>2</sup> consists of two regions (Lahaul Valley and Spiti Valley) which are different in many aspects. Since the district possesses a great range of elevation, ranging from 2400 to 6500m, the vegetation is diverse, unique, and plentiful. It comprises dry temperate to high alpine type except for some parts of Pattan Valley (Lahaul) adjoining the Pangi area of Chamba district, where is of dry temperate to moist temperate type (Fig.1d). Agriculture is the main source of livelihood in the valley and the financial position of the people mainly depends on Potatoes, off season cultivation of garden pea, apples and cultivation of other medicinal and exotic vegetables.

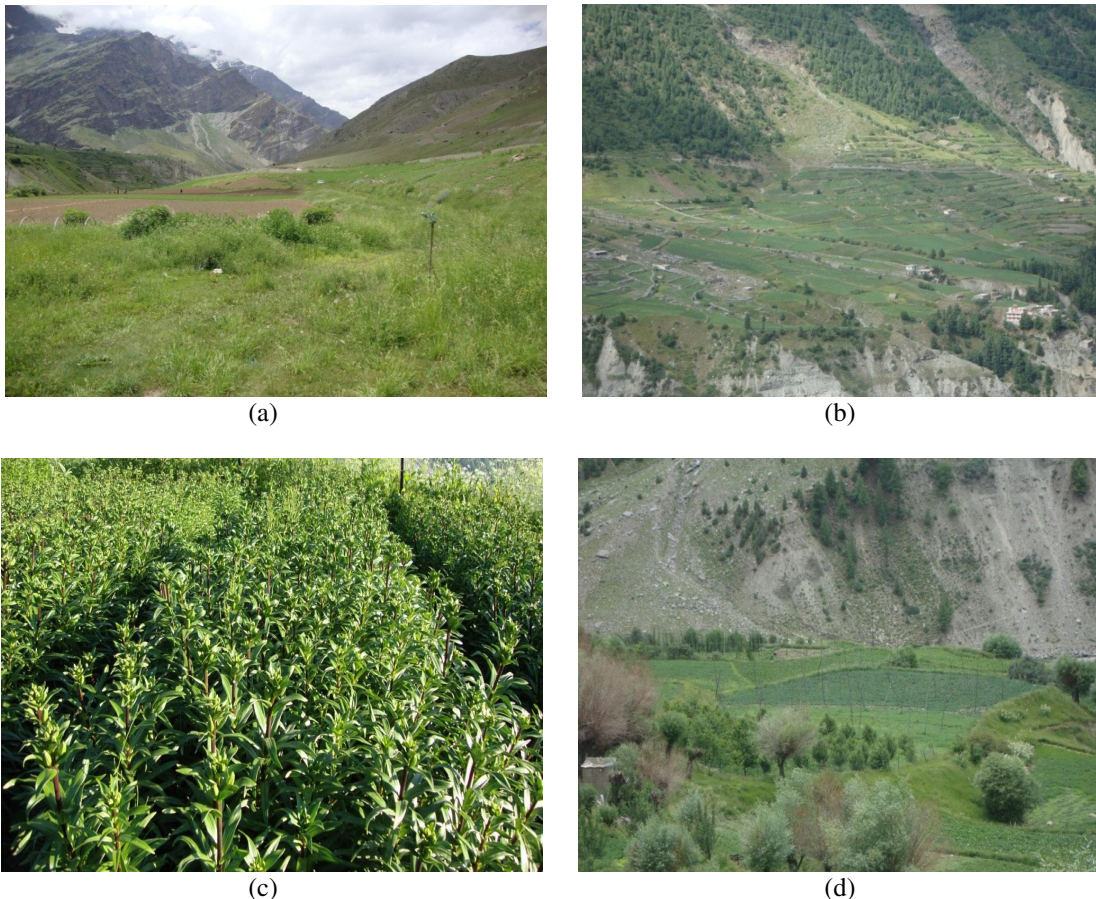


Fig.1. (a) Alpine pasture (b) Forests on the left bank of Chanderbhaga River (c) Liliium cultivation near Koksar (d) Apple and Vegetable cultivation in Valley.

Liliium cultivation recently started in the Lahaul valley and is cultivated as an off season crop during summer (August to October) in higher hill and dry temperate zone and most of the product is transported to the nearby market on remunerative prices. All the planting material is imported from Holland and bulbs are quite expensive. No

comprehensive attempt has been made so far to gather information on performance of different groups of liliium hybrids in the higher altitude and cold desert regions of Lahaul valley. Presently an attempt has been made to collect information on different groups of liliium hybrids grown in the valley to examine the influence of different

sites on cut flower and bulb production in different Lilium hybrid groups and find out the best site.

### Surveys and Data Collection

As the valley remains cut off from other parts of country for more than six months due to heavy snow fall, data collections were made between June and October. The Lahaul valley has been surveyed under an externally funded project by DST under Tribal Sub Plan Scheme of Science for Equity, Empowerment and Development (SEED) Division, Govt. of India, New Delhi during 2013-2014. During the intensive surveys of the valley, field data

were collected on existing genotypes of different groups of lilium hybrids from three different sites located at different altitudes viz., Site-1 (S-1) = Kuthvihhal (10302 feet amsl), Site-2 (S-2) = Gondhla (10726 feet amsl), Site-3 (S-3) = Dalang (9781 feet amsl), and site -4 (S-4)=Phura (9600 feet amsl) (Figure-2). Data collected from different sites were statistically analyzed by using the *COSTAT* software package. Where significant ( $P \leq 0.05$ ) treatment effects were determined by *ANOVA*, data means were separated by the Duncan's multiple range test at  $P = 0.05$ .



Fig.2. Map of Lahaul –Valley of Himachal Pradesh (India) showing the different sites in the study area.

### III. RESULTS AND DISCUSSION

In general, the forcing time for all the hybrids studied was longer than that reported by the bulb supplier companies, except for the Asiatic hybrids ‘Navona’ and ‘Brunello’ (Table 2) and for the LA-hybrid ‘Ceb-Dazzle’. This may be occurred because at the beginning of the cycle the night temperatures were lower than those

suggested by the International Flower Bulb Centre i.e. 12-13°C (Fig. 3&4) and lower temperature lengthen the growing season. Asiatic hybrids usually have a shorter growing period than other hybrids [4] and require lower minimum temperatures than oriental and LA- hybrids. Temperature is the main primary factor controlling lily growth and development both in field and in the greenhouse [12].

Table 1: Comparison of climatic conditions in Lahaul–Valley, the Mediterranean region and the Netherlands

Areas	Average temperature in January (°C)	Average temperature in July (°C)	Annual rain fall (mm)
Netherlands*	2.0	16.0	650-700
Mediterranean*	10.0	23.0	700
Keylong (Lahaul –Valley)**	-22.0	14.0	55

Source: 1. Xia *et al.* (2005)\*, 2. D.C. office Keylong (Lahaul – Valley)\*\*

For all hybrids, bulbs grown at Dalang site had a shorter cycle than those grown in other two sites (Gondhla and Kuthvihhal), although it was determinantal to plant height (Table 2). The reason was that in these two sites bulbs were remaining under snow cover for longer period in the field. These results are in agreement with those of [5] that bulbs from Lower latitudes (BB, HA and TU) were

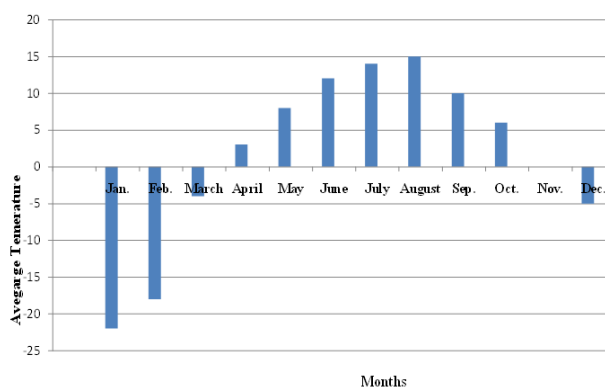
harvested one to three months earlier than bulbs from the south (EP and TR). The shortest cycle of the bulbs of Asiatic hybrid ‘Navona’, ‘Brunello’ and LA-hybrid ‘Ceb-Dazzle’ may be attributed to their low vernalization requirement.

Table 2: Evaluation of different lily hybrids for growth and flowering parameters during 2013-14 grown at three sites of Lahaul –Valley in Himachal Pradesh. Different letters among sites for each hybrid mean differences at 5% by Duncan Multiple Range Test.

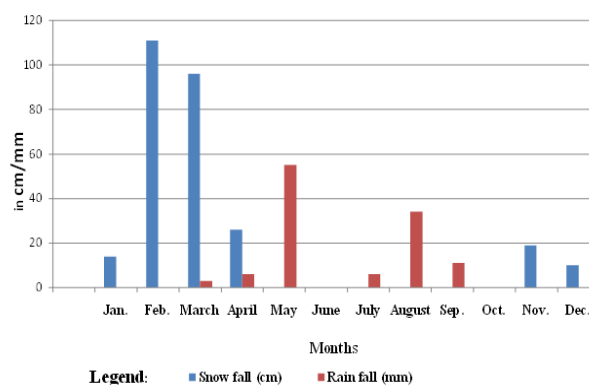
Sites	Plant height (cm)	Bud length (cm)	Days to flowering (days)	Flower diameter (cm)	Number of flowers/plant	Inflorescence length (cm)
<b>Asiatic hybrid ‘Navona’</b>						
Dalang	56.1 <sup>a</sup>	6.5 <sup>a</sup>	89.3 <sup>a</sup>	14.1 <sup>a</sup>	6.4 <sup>a</sup>	17.0 <sup>a</sup>
Gondhla	57.9 <sup>a</sup>	7.5 <sup>a</sup>	94.1 <sup>a</sup>	15.1 <sup>a</sup>	6.2 <sup>a</sup>	16.8 <sup>a</sup>
<b>Asiatic hybrid ‘Brunello’</b>						
Dalang	63.7 <sup>a</sup>	7.4 <sup>a</sup>	86.7 <sup>a</sup>	15.5 <sup>a</sup>	6.9 <sup>a</sup>	15.9 <sup>a</sup>
Gondhla	65.7 <sup>a</sup>	7.9 <sup>a</sup>	86.2 <sup>a</sup>	16.1 <sup>a</sup>	4.4 <sup>b</sup>	12.5 <sup>b</sup>
<b>LA hybrid ‘Ceb Dazzle’</b>						
Dalang	87.3 <sup>a</sup>	7.0 <sup>a</sup>	112.0 <sup>b</sup>	14.6 <sup>b</sup>	10.4 <sup>a</sup>	17.0 <sup>a</sup>
Gondhla	80.0 <sup>a</sup>	7.8 <sup>a</sup>	122.0 <sup>a</sup>	15.7 <sup>a</sup>	7.9 <sup>b</sup>	15.6 <sup>b</sup>
<b>Oriental hybrid ‘Rubato’</b>						
Dalang	91.4 <sup>b</sup>	8.8 <sup>a</sup>	123.8 <sup>b</sup>	18.5 <sup>a</sup>	5.6 <sup>b</sup>	17.7 <sup>c</sup>
Gondhla	107.9 <sup>a</sup>	8.9 <sup>a</sup>	123.5 <sup>b</sup>	19.4 <sup>a</sup>	8.7 <sup>a</sup>	27.3 <sup>b</sup>
Kuthvihah	116.8 <sup>a</sup>	9.9 <sup>a</sup>	132.7 <sup>a</sup>	19.9 <sup>a</sup>	8.5 <sup>a</sup>	36.8 <sup>a</sup>
<b>Oriental hybrid ‘Tiara’</b>						
Dalang	93.5 <sup>a</sup>	8.8 <sup>a</sup>	124.1 <sup>a</sup>	18.2 <sup>a</sup>	8.2 <sup>a</sup>	28.7 <sup>a</sup>
Gondhla	95.5 <sup>a</sup>	8.4 <sup>a</sup>	130.3 <sup>a</sup>	18.4 <sup>a</sup>	6.1 <sup>b</sup>	28.1 <sup>a</sup>
<b>Oriental hybrid ‘Mother Choice’</b>						
Dalang	65.2 <sup>b</sup>	8.3 <sup>b</sup>	123.6 <sup>a</sup>	17.6 <sup>a</sup>	4.7 <sup>b</sup>	17.5 <sup>b</sup>
Gondhla	129.9 <sup>a</sup>	11.6 <sup>a</sup>	126.3 <sup>a</sup>	22.1 <sup>a</sup>	13.2 <sup>a</sup>	33.7 <sup>a</sup>

The number of flowers per stem and the length of the first coloured bud are the most important attributes of quality along with the plant height. Plant height and number of flowers per stem were comparable, except for Asiatic hybrid ‘Navona’ in Dalang and Gondhla, Oriental hybrids ‘Rubato’, ‘Tiara’ and ‘Mother Choice’ in Dalang that showed a lower number of flowers per stem (Table 2). 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 growing environment during forcing [6]. The behaviour regarding the cultivation sites on the bulbs was different for several groups of hybrids (Table 2) and a direct relationship was found between its environmental requirements [10], [11] and the agro-climatic characteristics of each sites of cultivation (Table 1). The three main hybrid groups, LA-hybrid, Asiatic and Oriental behave differently according to temperature conditions. Asiatic and Oriental hybrids were better adapted to cooler climates and grow without difficulty in these altitudes, while LA-hybrid ‘Ceb-Dazzle’ produced more flowers and longer stem if they were produced at Dalang. These results are in close conformity with those of [5]. On the other hand, bulbs of Oriental hybrid ‘Mother Choice’ grown in Gondhla and Oriental hybrid ‘Rubato’ in Gondhla and Kuthvihah adapted to cooler climates, produced more number of flowers per stem.

Bulbs of oriental hybrid ‘Mother Choice’ in Gondhla significantly produced flower stems of good quality with respect to inflorescence length, bud length and flower diameter than those of other hybrids (Table 2).



Legend: ■ Average Temperature in degree centigrade  
 Fig.3. Average temperature (°C) in the Lahaul-Valley



Legend: ■ Snow fall (cm) ■ Rain fall (mm)  
 Fig.4. Average snow fall (cm) and rain fall (mm) in the Lahaul-Valley

Table 3: Evaluation of different lily hybrids for bulbous parameters during 2013-14 grown at three sites of Lahaul –Valley in Himachal Pradesh. Different letters among sites for each hybrid mean differences at 5% by Duncan Multiple Range Test.

Sites	Number of bulbs	Weight of bulbs (gm)	Size of bulbs (mm)
<b>Asiatic hybrid 'Navona'</b>			
Dalang	1.7 <sup>a</sup>	42.2 <sup>a</sup>	40.2 <sup>a</sup>
Gondhla	1.3 <sup>ab</sup>	25.3 <sup>b</sup>	35.5 <sup>a</sup>
Kuthvihai	1.0 <sup>b</sup>	40.6 <sup>a</sup>	38.9 <sup>a</sup>
<b>Asiatic hybrid 'Brunello'</b>			
Dalang	2.2 <sup>a</sup>	61.4 <sup>a</sup>	41.5 <sup>a</sup>
Gondhla	1.3 <sup>b</sup>	31.6 <sup>b</sup>	33.7 <sup>a</sup>
Phura	1.2 <sup>b</sup>	57.7 <sup>a</sup>	40.0 <sup>a</sup>
<b>Oriental hybrid 'Tiara'</b>			
Dalang	1.0 <sup>a</sup>	57.8 <sup>a</sup>	44.4 <sup>a</sup>
Gondhla	1.0 <sup>a</sup>	27.1 <sup>b</sup>	37.7 <sup>a</sup>
Kuthvihai	1.1 <sup>a</sup>	61.9 <sup>a</sup>	41.6 <sup>a</sup>
<b>Oriental hybrid 'Rubato'</b>			
Dalang	1.0	25.7 <sup>c</sup>	29.8 <sup>c</sup>
Gondhla	1.0	33.5 <sup>b</sup>	41.7 <sup>b</sup>
Kuthvihai	1.0	71.0 <sup>a</sup>	51.4 <sup>a</sup>
<b>Oriental hybrid 'Mother Choice'</b>			
Dalang	1.0 <sup>a</sup>	28.9 <sup>b</sup>	40.4 <sup>a</sup>
Gondhla	1.2 <sup>a</sup>	53.9 <sup>a</sup>	46.2 <sup>a</sup>

Even though the plant growth and the blooming capability of lily were normal when grown in natural conditions of the plains of the country, bulb reproduction was limited due to high temperatures that occurred from late May –June. The climatic conditions in dry temperate regions of Himachal Pradesh especially of Lahaul Valley is more or less similar to the Netherlands and Mediterranean regions, which was relatively cool for lily growth and bulb development during summer (Table 1). In lily bulb weight increased as the age of bulbs increased from 100 to 170 days, but the circumference did not increase as much: and they fluctuated in a different manner. This was probably due to a rapid accumulation of carbohydrates when the bulbs reached certain age and size [15]. Fresh weight of Asiatic hybrids 'Navona' and 'Brunello' were significantly higher at Dalang, Kuthvihai and Phura as compared to Gondhla (Table 3). As regards with the oriental hybrids (Tiara, Rubato and Mother Choice), fresh weight and size of the harvested bulbs were significantly higher at Kuthvihai than the other two sites. This indicated that Kuthvihai area in Lahaul valley was more suitable for the growth of bulbs. These results are in good agreement with those of [14].

#### IV. CONCLUSION

Despite the conditions during the growing period in the field, that were the same for all hybrids, the differences in performance observed in bulbs of the same hybrid clearly shows the importance of the sites of production in relation to the agro-climatic conditions, mainly temperature and how it affects the growth and flower development. Also, the dry temperate regions were suitable for plant growth and bulb development lilies.

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#### AUTHOR'S PROFILE



#### Mast Ram Dhiman

was born on August 8, 1969, in Bilaspur district of Himachal Pradesh in India. He earned his, Ph.D degree in Horticulture (Floriculture) from Indian Agricultural Research Institute, New Delhi-12. He is currently posted at Indian Agriculture Research Institute, Regional Station, Katrain, Kullu (H.P.) and

works on breeding of bulbous ornamentals.