# Stem Bending and Stem Hollowness in Gerbera: A Review

U.K. Pun* and K. Ichimura

*Horticulturist, Himalayan Flora Enterprises (P) Limited, Lalitpur Metropolitan*

*National Institute of Vegetables and Floricultural Science, Tsukuba, Japan (ichimu@affrc.gov.jp)*

**Corresponding author: umedpun @gmail.com*

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## Abstract

*Gerbera ranks fifth among the top ten cut flowers in the world, and comes in all different colors. It is primarily grown in temperate countries; but since the last few decades ago it has also been grown in subtropics and tropics. Although stem bending is one of the major problems of gerbera effective remedial measure has been developed in major growing countries, and the loss has been largely eliminated. However, stem hollowness has become a major problem for gerbera growers in Nepal incurring heavy economic loss whereas in Japan it has been effectively managed. This problem is specific to farms located in the warm southern plains of Nepal, and is associated with high temperature and high humidity. This paper attempts to understand hollowness situation in Nepal, and proposes effective approach to mitigate this problem. Although this problem of stem hollowness in gerbera is not a major issue in developed countries it could be prevalent in the sub-tropical and tropical regions causing huge economic loss.*

**Keywords:** *stem bending, stem hollowness, temperature and relative humidity*

## Introduction

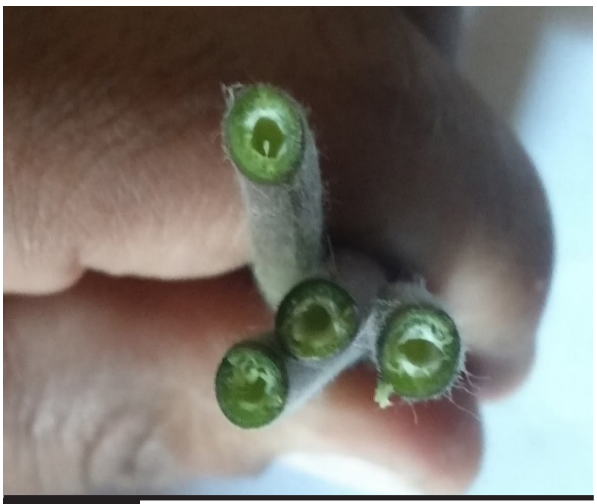
Gerbera ranks fifth among the top ten cut flowers in the world (Nazarideljour and Azizi, 2015). It comes in all different colors, and are very beautiful, but one major problem is stem bending resulting in shorter vase life (Ferrante and Serra, 2009). Stem bending has been researched well, and has been associated with poor lignifications of the stem about 10 cm below the flower head (Ferrante and Serra, 2009, Nazarideljour and Azizi, 2015). This impediment can be overcome by ensuring smooth flow of water to the flower head by application of anti-microbial agent and reducing pH to about 3.5 (Perik et al., 2014). However, in the warmer region another major problem of gerbera is hollow stem. Unfortunately, in case of hollow stems (Photo1), the stem bends even after application of anti-microbial agent thereby rendering those cut flowers unmarketable. It is causing heavy losses to farmers growing gerbera in warmer regions of Nepal.

### Occurrence of stem bending and hollowness in Gerbera

Several factors such as environment, culture, spacing, cultivars, nutrition (N, K and B) and irrigation have been attributed to influence stem hollowness in crops such as gerbera, tulip, iris, broccoli and cauliflower. Besides hollowness in gerbera, potato tuber has also been attributed to above factors. This disorder renders the product unmarketable, but it is still unknown how and why hollowness occurs.

In gerbera, vase life of flowers depends on the cultivars; some last longer while other don`t. This variation in vase life of cut flower is associated with water uptake; cultivars with higher water uptake had a longer vase life and lower stem bending percentage (Nazari deljour *et al.*, 2012). In gerbera, stem bending disorder is one of the major postharvest problems. The bending has been associated to lack of lignifications and this has been clearly demonstrated by assessing two cultivars of gerbera; Aqua, highly stem bending and Beaudine, slightly stem bending (Nazari deljour and Azizi, 2015). This difference in response of these two cultivars has been attributed to higher lignin content, PAL (Phenylalanine lyase) and POD (peroxidase) enzyme activities in Aqua as compared to Beaudine. Salicylic acid has also been found effective in increasing the lignin content in the upper stem of gerbera, and thereby increasing shear strength (Babler *et al*., 2016). To further confirm the role of PAL, inhibitor and promoter of PAL was tested and

found very conforming result (Ferrante et al., 2007). PAL inhibitor such as Amino-oxyacetic acid (AOA) (2mM) and aplha amino-oxy beta phenyl propionic acid (AOPP) (1mM) used as pulse treatment strongly increased stem bending in 1-2 days whereas with ethylene (100 micro liter per L) stem bending decreased. Similarly, addition of calcium chloride delayed stem bending, so did addition of Vandetta (inhibitor of hydrogen ion transport to cell wall), completely inhibiting stem bending. However, addition of fusicoccin (a promoter of hydrogen ion transport to cell wall) reversed the process (Perik *et al.,* 2014).



**Picture 1** Stem hollow in gerbera stem

Hollow stem has been associated with stem bending resulting in poor postharvest quality of gerbera. Stem bending has been further associated with poor lignifications of the stem below the flower head. Thus, the stem could be prevented from bending by application of calcium. Calcium can be applied few weeks before harvest. In other cut flowers such as tulip, iris and peonies, calcium supplementation has resulted positively in strengthening stem. Toppling of Tulip (Nelson and Niedziela, 1998a) or Iris (Doss *et al.,* 1979) has been reported, and has been attributed to calcium deficiency. Toppling was averted with application of calcium, and the best source of calcium was found to be calcium nitrate in hydroponics. However, at higher temperatures (22℃ day and 18℃ night) calcium deficiency could not be prevented in spite of lower temperatures (Day 18℃, and night 14℃) calcium carbonate at 5mM solution concentration continuously applied was effective. However, this resulted in another problem; elongation of Tulip scape making it unfit for market. This was resolved by treating Tulip with calcium carbonate (5mM) and ancymidol (0.18 mg) per pot (Nelson and Niedziela, 1998b). In Tulip, calcium deficiency is also associated with flower bud abortion (Klougart, 1980).

Stem hollowness has been observed in warmer region of Nepal beginning from July when rainy season begins and remains so until December (Prakash Pant personal communication, 2016). This disorder is severe through July to September (rainy months), but hollowness remains until December with lesser percentage of disorder. The disorder becomes normal beginning through January to June. The fact that the disorder begins from rainy months indicates that relative humidity (84-100%) and higher temperature (>33°C) may have a crucial role in the disorder. Besides, the temperature is even higher (38ºC) during the summer months especially in May and June but there is no disorder. However, in the hills where the temperature ranges between 28-30°C and where the humidity is similar to the warmer regions (78-81%), there is no disorder. Thus, it is suggesting that the disorder may be an interaction of temperature and humidity. Temperature above 33ºC with high humidity (84-100%) could be the condition when hollowness occurs in Gerbera stem. The underlying factor of how hollowness occurs is unknown.

Cultivar's sensitivity has been observed with regards to hollowness of stem, but most of the cultivars were affected. It has been reported earlier that the stem nearest to the flower head is the weakest as compared to the stem at the basal region. Stem hollowness is being attributed to less lignification to the region below flower head.

Chinese peonies have flexible peduncle or inflorescence stem due to weak stem strength and seriously impeded commercial cut flower production. This problem was overcome with the application of Calcium. Calcium chloride 4% w/v applied three times at bud emergence stage significantly increased the strength of the stem. It did so by increasing the endogenous calcium content in the top region of the peony stem. Similarly, correlation analysis showed that the breaking force of the top segment of peonies' stems was positively correlated with the ratio of water insoluble pectin to water soluble pectin ($R = 0.673$) as well as lignin contents ($R = 0.926$) after calcium applications (Li et al., 2012).

## Stem hollowness in vegetables

In vegetables such as broccoli, hollowness in stem has been observed and attributed to environmental factors, culture, spacing, nitrogen and potassium fertilization (Tremblay, 1989). However, variation on the response of the cultivars

was observed (Cutcliffe, 1972). Similarly, faster growing broccoli plants were more likely to have hollow stem as compared to slow growing types but this is not very consistent (Boersma et al., 2009). Nitrogen has been associated with hollowness in broccoli and the percentage of hollowness increased with increasing dose of nitrogen. The plant spacing also greatly influenced stem hollowness in broccoli. Boron application decreased stem hollowness and was best at 1.59 kg/ha whereas stem hollowness increased with higher N of 200 kg/ha (Mounirezman *et al.,* 2007). In potato tuber, hollowness has also been associated with several factors such as environment, water availability, nutrition and cultivar response. Hollowness in vegetables has been studied and intervention has been done with some success.

However, gerbera hollowness has not been studied although chemical intervention has been applied to reduce stem bending. Supplementation with salicylic acid or calcium has significantly improved the vase life of gerbera by lignifying stem and inhibiting stem bending.

## Economic loss due to stem hollowing

Hollow stem in gerbera is causing huge economic loss to farmers in the south of Nepal. The grower has to incur heavy losses due to this disorder and is estimated to be about 30% of the annual revenue (NPR 2.1 million; approximately US $ 21,000). The flower failed to maintain minimum vase life due to stem bending. Resolving this problem would not only benefit particularly the growers but also pave way for more investment in the region. The southern warmer region of Nepal is very important for round the year cut flower production especially during winter when the demand for cut flowers peaks and is also critical region for export of cut flowers. Earlier, stem hollowness has been reported, and is reported to have no problem in terms of quality; in fact, vase life was reported more in hollow stems as compared with solid and porous stems attributing to more uptake of water (Dong, 1986). In case of Nepalese gerbera production, however, the hollowness resulted stem toppling making it unmarketable. This production unit is 7-8 hours' drive from Kathmandu where there is cold storage facility but is transported in a van under ambient temperature.

## Control of hollowness

Hollowness in gerbera is a disorder that has been largely ignored. In vegetables such as broccoli (Boersma et al., 2009) and cauliflower (Scaife and Wurr, 1990) such hollowness has been attributed to environment, culture, irrigation and fertilizer application. Gerbera is also influenced by these factors but, unlike vegetables, gerbera has no marketing problem if the cold chain is maintained, and there is no quality issue. Hence, in developed countries where cold chain for cut flowers is effectively managed, there is no problem of stem bending or vase life. However, in warmer developing countries, gerbera hollowness has become a challenge and, therefore, the very commercial viability of gerbera farming. It is, therefore, important to understand effective postharvest management of gerbera grown in the tropics.

## Effective management of stem hollow in gerbera grown in warmer areas

Gerbera are mainly cultivated in the developed countries such as Japan in hi tech greenhouses and transported from the farm to collection center with cooling facility within few hours of harvest (13°C and 70% RH). Thereafter, flowers are cooled, graded, packed and sent to the auction in a refrigerated truck (15ºC and 70%) in about 5 hours. The transportation may take about 5 (Ota Auction) or 8 (Osaka) hours depending on the destination of the auction market. This process goes on and the cold chain reaches to the florist and, therefore, there is no problem of stem bending. In last decades or so, this crop is also commercially grown in many developing countries in hi-tech to semi hi-tech greenhouses. In semi hi-tech greenhouses, high temperature coupled with high humidity results hollowness in stem. This hollow stemmed gerbera when transported to the wholesale market bends and becomes unmarketable causing huge loss to the grower.

The lack of cold chain in the warmer region perhaps is the main cause in rapid deterioration of the quality of gerbera flowers due to acute water stress. In developed countries, effective cold chain from growers to florist ensures good quality of gerbera cut flowers even with hollow stem. This has been found effective for both wet and dry transport from growers to florist. The following are some of the important steps that can be followed to effectively manage stem hollowness in gerbera.

1. The production area should be located in area where the maximum summer temperature does not exceed 30ºC and minimum does not fall below 15°C.
2. Use of cultivars not sensitive to hollowness such as Amati, Candida, Ninike, Dolores, Diego, Byoux and avoiding sensitive cultivars such as Flora, Diane, Dino, Ornella, Ruby Red, Tamara, Constance, Gaby, Deep purple, Stanza, Lieke, Pinta, Venezia.
3. Reducing nutrition and irrigation during rainy season.
4. Supplementation for lignification of cell wall using calcium and others.
5. Manage effective cold chain at the grower (13ºC/70%), during transport (15°C/70%), wholesale (15º/70%) and the florist (15°/70%).
6. Postharvest treatment of hollow stems pulsing for 24h with mixture of calcium chloride 50mg/L, 0.05 mM ancymidol, sucrose 25g/L buffered at pH 3.5 by citric acid and K2HPO4 (Perik et al., 2014).
7. Postharvest treatment of 1-2mg/L of Silver nano particles is effective to increase vase life of gerbera by one fold (Solgi et al., 2009)

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