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Impact of Pre-Harvest Biochar Soil Amendments on Stem Hydration, Membrane Integrity and Post-Harvest Longevity of Cut Carnations

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INTRODUCTION

Carnation (*Dianthus caryophyllus* L.) is one of the most dominant traded cut flowers, prized for its aesthetically appealing flowers, varieties of color, and relatively greater vase life, it is grown around the year in temperate regions or protected conditions like poly houses/glass houses in sub-tropical regions.

General vase life of commercially important cut carnation varieties ranges between 8 to 14 days. 'Liberty' and 'Bizet' recorded 12.63 and 8.18 days of vase-life respectively under mid hill condition (mid hill area,

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Thunag valley, HP) (Sharma et al. 2025). A couple of days of additional shelf life can lead to higher market price, lower wastage, and greater buyer satisfaction for the grower.

Vase-life is mostly considered a post-harvest subject. However, the quality of the flower is largely determined long before harvest during crop production. Availability of water, balancing nutrients, salinity, root health and pest load prior to harvest ultimately determine the stem physiology at the time of cutting. Therefore, pre-harvest modifications in the root zone can serve as a potential measure to enhance the post harvest performance.

The vase-life of cut carnation starts from the root zone and not the vase. This article deals with possible contribution of biochar as a pre-harvest soil additive in enhancement of stem hydration, membrane integrity and hence, vase life of cut carnations.

BIOCHAR AS A FUNCTIONAL SOIL AMENDMENT IN FLORICULTURE

Biochar is a porous, carbon-rich material produced by heating organic biomass such as crop residues, wood, bark or rice husk under limited oxygen conditions. This process is known as pyrolysis.

Because of its porous nature and high surface area, biochar can hold water, improve aeration and retain nutrients such as potassium, calcium, magnesium and ammonium. It also provides a favourable habitat for beneficial soil microorganisms. In protected floriculture, where repeated cropping and fertigation may gradually affect soil or substrate quality, these properties can be useful.

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For carnation production, biochar may help by:

- improving root-zone moisture,
- increasing plant-available water,
- reducing nutrient loss,
- improving soil aeration,
- buffering salinity stress, and
- supporting stronger stem development before harvest.

However, biochar should be used carefully. Its effect depends on the raw material, pyrolysis temperature, pH, electrical conductivity, ash content and application rate. Poor-quality biochar or very high doses may reduce growth and flowering. Hence, in ornamental crops, biochar should be considered a **precision input**, not a bulk soil filler.

Pre-Harvest Regulation of Post-Harvest Quality

Carnation is an ethylene-sensitive flower. Ethylene is a natural plant hormone that accelerates petal ageing and senescence. Once ethylene activity increases, petals lose freshness rapidly.

Before visible wilting appears, changes begin inside the petal cells. One of the earliest signs is loss of membrane stability. Cell membranes help retain water and solutes inside the cells. When membranes become weak, leakage increases, petals lose turgidity and the flower begins to senesce. Earlier physiological work in carnation has shown that membrane leakage can appear before a major rise in ethylene and abscisic acid (Thompson et al., 1982; Eze et al., 1986).

This is important from a grower's point of view. If the plant suffers hidden water stress or nutrient imbalance during cultivation, the stem may already be weak at harvest. Such stems usually show poor water uptake, faster wilting and shorter vase life. A better root-zone environment before cutting can therefore help produce stronger, better-hydrated stems.

Good harvesting and handling remain essential. Standard carnations are usually harvested at the **paintbrush stage**, while spray carnations are harvested when about two flowers have opened. Morning harvesting, immediate placement in clean water or preservative solution, conditioning for 4–6 hours and storage at **4–6°C** are recommended practices (Nayak et al., 2025). Still, post-harvest care cannot fully correct stress already suffered during crop growth.

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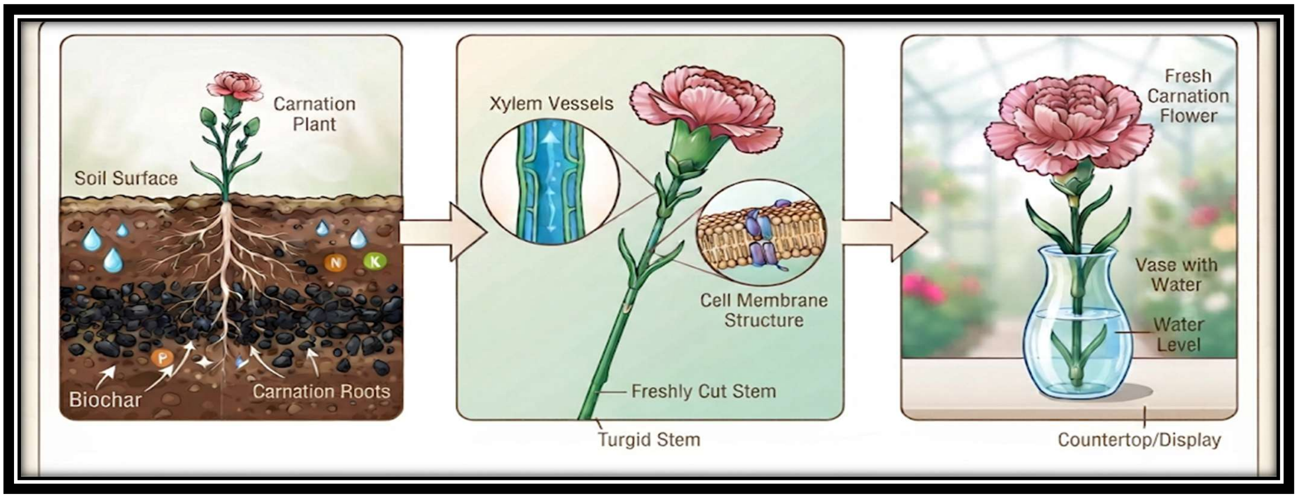

Figure 1. Proposed pathway of biochar action in carnation.

Biochar, Soil Moisture and Stress Reduction

The strongest practical value of biochar lies in its ability to improve water availability. In low-organic soils, biochar can increase easily available water by nearly **50 per cent** and also improve nutrient retention (Seyedsadr et al., 2022). This is relevant for protected carnation cultivation, where beds or substrates may lose structure after repeated cropping cycles.

Biochar also has value under salinity stress. At moderate levels, particularly around **2 per cent of pot medium**, biochar has improved plant growth, chlorophyll content, relative water content and reduced electrolyte leakage in ornamental plants (Nallapotala et al., 2024; Mohammadi Kabari et al., 2024). These effects are important because salinity often reduces water uptake and damages cell membranes.

The major lesson from ornamental crop work is that **dose matters**. Moderate rates may improve performance, but excessive biochar can reduce growth and flowering. For practical floriculture use, small-scale testing is necessary before large-scale application.

Stem Hydration and Membrane Integrity in Cut Carnation

After harvest, a carnation stem depends completely on water movement through the xylem. If xylem vessels are blocked by bacteria, air or physiological stress, water uptake declines and flowers wilt early. Clean water uptake is therefore one of the most important factors determining vase life.

Several post-harvest treatments have extended carnation vase life by improving water uptake, reducing oxidative damage and maintaining membrane stability. Thyme essential oil increased solution uptake and almost doubled vase life from **9.25 to 18.50 days**. Melatonin extended vase life up to **20 days** by preserving fresh weight and membrane stability. Blue light and ethylene inhibitors have also improved vase life through better antioxidant activity and membrane protection (Aalifar et al., 2020; Gururani et al., 2023; Hassan et al., 2020; Lezoul et al., 2022).

Although these are post-harvest interventions, they point to the same principle: **a carnation lasts longer when the stem remains hydrated and petal membranes remain stable.**

This principle supports the possible role of biochar. If biochar improves the physiological condition of the plant before harvest, the cut stem may enter the vase with better water balance and stronger membranes.

Pre-Harvest Conditioning and Its Relevance to Biochar

A useful example comes from pre-harvest silicon nutrition in carnation. Silicon supplied before harvest improved relative water content, reduced membrane leakage and extended vase life by about **2.0–2.8 days** under transport-related vibration stress (Safaei Far et al., 2026).

This provides a clear message: what happens before harvest can continue to influence flower life after harvest. Biochar may work in a similar indirect way by improving root-zone moisture, reducing stress and strengthening the stem before cutting.

Table 1. Evidence Supporting the Biochar–Carnation Link

Aspect	Key information	Practical meaning for carnation	Source
Soil water availability	Biochar can increase easily available water by nearly 50% in low-organic soils	May reduce hidden pre-harvest water stress and improve stem hydration at harvest	Seyedsadr et al., 2022
Salinity stress (ornamentals)	Moderate biochar improves	Better water balance and lower membrane	Nallapotala et al., 2024; Mohammadi

	relative water content and reduces electrolyte leakage under salinity	injury under stress conditions	Kabari et al., 2024
Dose response (ornamentals)	Very high biochar levels can reduce growth and flowering	Biochar must be applied at optimum rates; excess can harm quality	Conversa et al., 2015; Fornes & Belda, 2018
Xylem function and hydration	High bacterial load in vase water reduces water uptake and shortens vase life	Hydration failure alone can end commercial life of cut carnation	van Doorn et al., 1995
Membrane ageing and ethylene	Ethylene accelerates membrane lipid changes and speeds senescence	Stronger membranes help delay visible wilting and senescence	Thompson et al., 1982
Timeline of senescence	Membrane leakage appears before major ethylene and ABA rise	Membrane damage is an early trigger; preventing it may delay senescence	Eze et al., 1986
Hydration–membrane linkage	Even transient water stress reduces vase life and affects	Field-stage water stress can weaken	Drory et al., 1992

	membrane phospholipids	membranes and shorten vase life	
Post-harvest proof of principle	Treatments that improve water uptake and membrane stability extend vase life markedly	Confirms hydration and membrane stability as central levers for longevity	Gururani et al., 2023; Aalifar et al., 2020; Lezoul et al., 2022; Hassan et al., 2020
Pre-harvest conditioning carry-over	Pre-harvest silicon improves water status, reduces leakage and extends vase life by 2.0–2.8 days	Shows pre-harvest physiological conditioning can improve post-harvest life	Safaei Far et al., 2026

Box 1. Practical Guidelines for Biochar Use in Floriculture

Recommended practices

- Use biochar from a known and clean source.
- Check pH and electrical conductivity before application.
- Start with low to moderate rates, preferably **1–2 per cent** of the growing medium.
- Mix biochar uniformly in the bed or pot substrate.
- Test on a small area before adopting it on a large scale.
- Record both flower yield and vase life.

Avoid

- Using biochar from unknown or contaminated feedstock.
- Applying very high doses without testing.
- Treating biochar as a replacement for irrigation or fertilization.
- Ignoring drainage, salinity and substrate condition.

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Conclusion

The most important factors regulating the vase life of carnations are three factors interconnected: stem hydration, the vitality of membranes and ethylene metabolism. Biochar can help in indirectly influencing these factors by improving the availability of water in the root zone, facilitating the supply of nutrients and increasing the tolerance of the plants to pre-harvest stresses.

Figure 2. Comparison of two carnation stems.

Although carnation-dedicated studies are absent at present, current knowledge from soil science, ornamental crops and carnation physiology form a good starting point to future dedicated investigations. For the Indian floriculture sector, particularly under protection, biochar is likely to find new potential use as a pre-harvest tool to promote stem quality, minimise post-harvest loss and value generation.

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References

- Aalifar, M., Aliniaeifard, S., Arab, M., Zare Mehrjerdi, M., Dianati Daylami, S., Serek, M., Woltering, E., & Li, T. (2020). Blue light improves vase life of carnation cut flowers through its effect on the antioxidant defense system. *Frontiers in Plant Science, 11*, 511.
- Adedeji, O. S., Naing, A. H., Kang, H., Xu, J., Chung, M. Y., & Kim, C. K. (2024). Editing of the ethylene biosynthesis gene in carnation using CRISPR-Cas9 ribonucleoprotein complex. *Plant Methods, 20*, 20.
- Conversa, G., Bonasia, A., Lazzizera, C., & Elia, A. (2015). Influence of biochar, mycorrhizal inoculation, and fertilizer rate on growth and flowering of *Pelargonium* (*Pelargonium zonale* L.) plants. *Frontiers in Plant Science, 6*, 429.
- Drory, A., Borochov, A., & Mayak, S. (1992). Transient water stress and phospholipid turnover in carnation flowers. *Journal of Plant Physiology, 140*(1), 116–120.
- Eze, J. M. O., Mayak, S., Thompson, J. E., & Dumbroff, E. B. (1986). Senescence in cut carnation flowers: Temporal and physiological relationships among water status, ethylene, abscisic acid and membrane permeability. *Physiologia Plantarum, 68*(2), 323–328.
- Fornes, F., & Belda, R. M. (2018). Biochar versus hydrochar as growth media constituents for ornamental plant cultivation. *Scientia Agricola, 75*(4), 304–312.
- Gururani, M. A., Atteya, A. K., Elhakem, A., El-Sheshtawy, A. N. A., & El-Serafy, R. S. (2023). Essential oils prolonged the cut carnation longevity by limiting the xylem blockage and enhancing the physiological and biochemical levels. *PLOS ONE, 18*(3), e0281717.
- Hassan, F., Ali, E., & Mazrou, R. (2020). Involvement of ethylene synthetic inhibitors in regulating the senescence of cut carnations through membrane integrity maintenance. *Journal of Horticultural Research, 28*, 39–48.
- Lezoul, N. E. H., Serrano, M., Ruiz-Aracil, M. C., Belkadi, M., Castillo, S., Valero, D., & Guillen, F. (2022). Melatonin as a new postharvest treatment for increasing cut carnation (*Dianthus caryophyllus* L.) vase life. *Postharvest Biology and Technology, 184*, 111759.
- Mohammadi Kabari, S. F., Asadi-Gharneh, H. A., Tavallali, V., & Rowshan, V. (2024). Differential response of biochar in mitigating salinity stress in periwinkle (*Catharanthus roseus* L.) as an ornamental-medicinal plant species. *International Journal of Phytoremediation, 26*(8), 1181–1192.
- Nallapotala, K., Swarajya Lakshmi, K., Naga Madhuri, K., Raja Naik, M., & Padmaja, V. V. (2024). Efficacy of biochar and gypsum in amelioration of soil with saline water irrigation in ornamental plants. *Journal of the Indian Society of Coastal Agricultural Research, 41*(2), 1–14.

- Nayak, A., Pattanaik, A., Samantaray, P., Pradhan, I., Sahoo, R., & Mohanty, S. (2025). Cultivation and cultural practices followed in carnation (*Dianthus caryophyllus* L.) for better production: A review. *Agricultural Reviews, 46*(4), 612–620.
- Safaei Far, A., Mousavi-Fard, S., Rezaei Nejad, A., Shahbazi, F., Hosseinzadeh Samani, B., & Fanourakis, D. (2026). Preharvest silicon nutrition mitigates vibration-induced senescence and extends vase life in cut carnation. *BMC Plant Biology, 26*, 850.
- Seyedsadr, S., Sipek, V., Jacka, L., Snehota, M., Beesley, L., Pohorely, M., Kovar, M., & Trakal, L. (2022). Biochar considerably increases the easily available water and nutrient content in low-organic soils amended with compost and manure. *Chemosphere, 293*, 133586.
- Sharma, P., Gupta, J., Kumari, B., Sharma, H., & Ghabru, A. (2025). Varietal evaluation of carnation (*Dianthus caryophyllus* L.) under mid-hill conditions of Thunag valley, Himachal Pradesh, India. *Archives of Current Research International, 25*(10), 79–84.
- Thompson, J. E., Mayak, S., Shinitzky, M., & Halevy, A. H. (1982). Acceleration of membrane senescence in cut carnation flowers by treatment with ethylene. *Plant Physiology, 69*(4), 859–863.
- van Doorn, W. G., de Witte, Y., & Harkema, H. (1995). Effect of high numbers of exogenous bacteria on the water relations and longevity of cut carnation flowers. *Postharvest Biology and Technology, 6*(1–2), 111–119.
- Verdonk, J. C., van Ieperen, W., Carvalho, D. R. A., van Geest, G., & Schouten, R. E. (2023). Effect of preharvest conditions on cut-flower quality. *Frontiers in Plant Science, 14*, 1281456.
- Wang, H., Zhao, C., Pan, Z., Li, X., Wang, S., Yuan, X., Zhu, C., Sun, Z., Wang, M., Feng, S., Li, Z., Zhong, L., Cheng, Y., Bao, M., & Zhang, F. (2025). Dynamic m6A RNA methylation correlates with ethylene-induced petal senescence and may modulate antioxidant and metabolic pathways in carnation (*Dianthus caryophyllus* L.). *The Plant Journal, 123*(2), e70318.