Effect of Pre and Postharvest factors on Vase life of Gladiolus or Effect of Different Floral Preservatives on Vase life of Gladiolus

Corrected one:

Abstract: Gladiolus is a popular ornamental and cut flower grown globally. However, the vase life of gladiolus flowers is relatively short due to physiological factors such as water stress, carbohydrate depletion, microbial activity, and ethylene exposure. This review discusses various preharvest and postharvest factors that influence the vase life of gladiolus flowers. Genetic factors, environmental conditions like temperature and humidity, and biotic stresses can impact vase life during the preharvest stage. Postharvest factors such as ethylene production, carbon dioxide levels, and pest/disease issues also play a crucial role. The use of chemical preservatives like sucrose, salicylic acid, and growth regulators like gibberellic acid have been found effective in extending the vase life and maintaining the quality of cut gladiolus flowers. Integrated management of these factors can help improve the postharvest longevity and marketability of gladiolus as a cut flower.

Keywords; Gladiolus, Vase life, PGR, Preservatives, Flower quality, Microbialgrowth,Postharvest management.

Corrected one:

Introduction

Gladiolus (*Gladiolus grandiflorus L.)* is one of the most important ornamental andbulbousfloweringplants,itcarriesnoblehistorywithit.ThenameofGladiolusderived from latin word "Gladius (Sword)", hence it known as Sword lily. It originates fromSouthAfricaandAsiabelongstomonocotfamilyIridaceae(Prabhesh*etal.*,2022).Gladiolus also known as "Queen of bulbous plant" and is well known in every cornerof the globe which ranks 8th position in cut flowers, 1st position in bulbous plants andhasmorethan150speciesintheworld(lamichhane*et al.,* 2022).The number ofspeciesfound inthe genusis 255 (Shaukat*et al.,* 2013).The main goal is to grow beautiful cut flowers that can be sold in local flower marketsor used for decoration in gardens. However, it's worth mentioning that the dried bulbsofthesefl owershavemedicinalbenefitswhengroundintopowder.Gladiolusisa perennial bulbous and half-hardy flowering plant containing attractive, elegant anddelicate florets opening in sequence from bottom to top along with the spikes. Theyvary in their height from one to four feet; some are soft and light, others robust andstrong adapted to any climate except the frigid condition (Childs, 1873). Vase life ofgladiolus floweris noticeablyshort dueto blockageofthe vascularsystembyair orbacterialgrowth,reducingwateruptakeandblockingxylemvessels called as Vascular occlusion. Shortvaselifeofcutflowerhasbeenamajorprobleminfloricultureindustryasthelongevityof vase life is a crucial factor in consumer preference (Marandi *et al.,* 2011).

Differentstudies and experiments have proved that vase life of gladiolus can be extended byadding or subjecting to different chemical solutions at various concentration such as;chlorine hydroxyquinoline, sulphates, salicylic acid, humic acid, silver nanoparticles,sugar solutions, diethyl sulphonate, and different plant growth regulators(Lamichhane *et al.,* 2022). The American Conference of Governmental IndustrialHygienistshasrecommendedexposurelimitofsolublesilvercompoundsby0.01mg /m^3. While ionic silver compound has a toxic effect on human as well asenvironment, organicacidandessentialsoil also haveanoticeableeffectontheimprovementofvaselifeofcutgladiolusflowerswhichmightbed uetotheirantibacterial properties that reduce bacterial proliferation in the stem vessels of cutflowers (Jowkar *et. al.,* 2012; Marandi *et al.,* 2011). Therefore, this study aims toevaluate various vase solutions and their effectiveness in extension of vase life, qualityoftheproduce and in turn about the cost of vase solutions.

Corrected one:

VaselifeofGladiolus

Vase life of a flower is influenced by respiration, carbohydrates, deterioration, diseaseand pests andwater absorption.Ethylenesynthesisplaysa crucialrole invase life. Various factors including water stress, carbohydrate depletion, microbial activity andethylene exposure can impact floralsenescence. To prolong the vase life of cutflowers by mitigating the aboveeffects, preservative solutions are employed post-harvest.Thesesolutionsenhanceassimilatedistribution,regulatewateruptake,shieldfloral stemsfrommicrobialdamageandminimizetheinfluenceofethylene,therebydelayingtheon setoffloralsenescence(Pulido*etal.*,2021).Carbohydratesandsoluble sugars help to maintain quality of petals for longer time. Flowers are treatedwith sufficient amounts of sugars like sucrose and an appropriate preservative likesilver thiosulfate can greatly enhance the longevity of cut flowers (Hussan *et al.*,2016). As discussed earlier, not only sucrose but along with sucrose there are otheragentsalso that are effective in extending the vaselifeof cutflowers.

Gladiolus (Gladiolus grandiflorus L.) is Grown for its inflorescences, a commercially significant decorative plant. For growers and sellers, improving its quality and vase life is essential. Gladiolus' diverse vase lives among species and cultivars are crucial for flower quality, consumer pleasure, and commercial viability. They hold the greatest economic significance in the floriculture business. The publication is useful to the scientific community because it addresses vase solutions and pre- and post-harvest factors that influence the vase life of gladiolus.

Corrected one:

Pre and Postharvest affecting factors.

A. Preharvest affecting factors:

i.ConstitutionofInheritantcharacters:

The genetic composition of the cultivars as well as differences in cell wall thickening,peroxidaseandlignificationlevels,ethyleneformingenzyme(EFE)andaminocyclopropane carboxylic acid (ACC) production have all been linked to thesevariations (Khanal, 2014). Khanal (2014) assessed sixgladiolus cultivars in Hissar, India and discovered variance in the responses of thevarietals for various attributes. Miniature had the shortest vase life among the testedcultivars while Pusa Suhagain had the longest. Similarly, five gladiolus cultivars i.e.Agnerekha, American Beauty, Friendship, Mansoer red and true Yellow were assessed in acourse of two seasons in Kerala, India by Khanal (2014) mentioned that Agnirekha and Mansoer were the best for a longer vase life, while American BeautyandFriendshipwerefoundtobesuperiorforcutfloweryield.Variations in stem lignification, flower diameter,freshweight,water uptake,andother factors are caused by genetic diversity and ultimately result in differences in thevase life of various flowers or different types of the same flowers. Even geneticvariations existamongstmany cultivarsof thesamecrop, asfollowing differentvarieties with different days of vase life,IIHR-G-12 (14.20), Urmil (8.97), AmericanBeauty (9.67),Moon Magic(5.39)(Vermaand Singh,2021). Differencesin thegenetic structureof flowerspeciesand varietiesresult in significantdifferencesintheirpost-harvestlifespan(GuptaandDubey2017).Anexperimentwasconductedon the different varieties of gladiolus, it showedthe best performance for maximumnumber of corms per plot was “Legend” (37.67) and “Trader Horn” was maximumnumberofcormelsperplant(70.83).Themaximumvaselifewasobservedin “Darshan” (17.56 days) and maximum number of florets remaining open at a time invasewasobservedin“Hunting Song”(6.78 florets) (Singh *etal.*,2017).

Corrected one:

ii.Environmental Factors:

a.Temperature

By an increase in respiration rate, high temperatures can reduce floral quality andcarbohydrate supplies. According to some observations, the longevity of cut flowerswas reduced by temperatures as low as 12°–15°C or as high as 27°C during the threeweeksbeforetoharvest.Theknowledgeoftemperatureimpactsonvaselifeiscomplicatedbythepotentialinterplayoftemperaturewithotherfactors.The reduced amount ofcarbohydrates in petals as a result of the cold temperature and weak light will causethe vase life to be shortened. Sugar level has been found to be closely associated withthe postharvest life of cut flowers because temperature and light intensity directlyaffectthephotosynthatelevelinflowertissues(Khanal, 2014).

b. Relative Humidity:

High relative humidity (RH)levels (over 80% to 90%) shorten the postharvest life of cutflowersbecausetheynegativelyimpacttheamountofcalciumcontent(Mortensenand Fjeld, 1998). High relative humidity of 90–95% is advised and is crucialfor long-term storage because calcium level in the tissue is thought to affect theformation and function of the cell wall and membrane (Hardenburg *et al.*, 1986).RHof 80% or above isgenerally utilised in practicefor shorttermstorage (1-2days)because it is safe enough to delay withering due to moisture loss. Verma and Singh (2021) mentioned Humidity useful in preventing water loss from the plant's surface andpreserving the temperature of the plant. While high humidity promotes photosynthesis,it canalsolead to fungus-relatedillnesses.Reducedhumidity canleadto greaterwater loss, senescence, thin leaves, browning of the leaf margins and chilling injury.Waterstresscanthereforeclearlyshortenaflower'svaselife(BhattacharjeeandDe, 2005) and flowers produced at varying humidity levels will exhibit variations in theirvaselife(Vermaand Singh,2021).

Corrected one:

B.Postharvest affecting factors

i.Ethylene:

Senescence is the time when flower petals produce ethylene. The two primaryenzymes in charge of producing ethylene are ACC oxidase and ACC synthase (Vermaand Singh, 2021). Certain essential growth stages, such as the wilt of flowers and theabscission of leaves, togetherwith otherexternal conditions like mechanical injuryand environmental stress, drive the production of ethylene(Vehniwal and Abbey,2019).Carbonmakesupthemajorityofplantdrymatter(45%).Throughtheirstomata , plants absorb it from the surrounding air and fix it through the process ofphotosynthesis(Vermaand Singh, 2021).

ii.Carbondioxide:

When cultivated at low and high CO_2 levels during the vegetative phase respectively,plants grown at elevated CO_2 during the generative growth phase produces 10-15 %more plants with multiple spikes and a better floral stem quality. The quantity ofspikeswasnotsignificantlyaffectedbyelevatedCO_2throughoutthevegetativegrowth phase, but the pattern suggests that spike quality was on the rise (Kromwijk *etal.*,2014)

iii.Pestanddiseases

Fusarium wilt, Yellow or corm rot, Storage rots, Dry or neck rot, Botrytis blight andflower rot, virus diseasearesome of the common diseasesof gladiolus whichcanbedirectlyor indirectlyinloworhighpercentageaffectedthevaselifeofgladiolus.Thiscanbemanagedbyf ollowingvariousmanagement practices.

Corrected one:

ImportanceofSucrose

Adding sugars in a vase solution has been found to be beneficial for prolonging thefreshnessandlifespanofcutflowers,itassociatedwiththeimprovementwaterbalance, improvement of color in case of carnation and rose, it helps to stimulate floweropening (Ichimura, 1998). Sucrose, administered via pulse therapy, suppressed thegenes involved in ethylene biosynthesis, leading to a decrease in ethylene production.However, in contrast to the control group, sucrose treatment notably increased xylemblockage on the cut stem surfaces while decreasing antioxidant activity, relative freshweight and the expression of the cysteine proteinase inhibitor gene (DcCPi) (Park *etal.*, 2017). Sugar plays a crucial role in extending the life span of flowers, particularlywhen they are cut, as they no longer receive essential nutrients and hormones from theparentplant (Muraleedharan and Joshi 2017).

EffectofSucrose

Han 1992, conducted research on effectof sucrosesolution has showed that thepresenceofsucroseinthevasesolutionimprovesthequalityofcutspikesbyprolonging their display life and enhancing the length of inflorescence with visiblecolor. When a consistent supply of sucrose is provided in the vase solution, it leads tothe complete opening of flower heads, achieving a 100% opening rate, 200ppm ofcitric acid with 4% of sucrose is good to extend the vase life of gladiolus (Koirala *et al.*,2022). Sucrose 4% combine with $CoSO_4$@100 ppm proved long duration of vase lifewith 12.3days and maximum blooming period of 22.3days (Singh and Beura 2002). Incase of *Vriesea incurvata Gaudich*, (Bromeliaceae), the application of sucrose for 8hours has beenshown to enhancethe preservation ofcolor, brightness, and turgidityin floral scapes. It aids in maintaining water balance, reducing the loss of fresh weight,and extending the vase life of flowers by up to 24 days (Pulido *et al.*, 2021). Sucrosepreserved a noticeably better water balance in spikes when combined with cobaltchloride and silver nitrate, which extended the vaselife. Cobalt chloride is veryeffective at preventing vascular blockages that result from bacteria blocking vasculartissues.Ithasalsobeenshownthattreatingirisspikeswith$CoCl_2$greatlyextendstheir vaselife(Singhand Sharma, 2003).

ImportanceofChemicals

Chemical treatments considerably enlarged the spikes, floret diameter and increasedholdingsolutionconsumptionandsolutionabsorptiontoitsmaximumcompared to thecontrol.(Singh and Sharma, 2003). The calcium effectivenessin enzymes activation, enhancesantioxidant activities and delays senescence in gladiolus and also helps to increasediameter of xylem with good water flow, it can delays senescence (Ahmad and Rab,2020). Salicyclic acid (SA) considered as the messenger of molecules it involves in disease in plantswhich response to pathogenic attack, it plays key role to tackle the environmentalstressand plantgrowthdevelopment (Mohammadi*et al.*, 2013).

Effectofchemicals

Gladiolus spikes were treated with vase holding solution ofcalcium of 0, 100, 200, 300 and 400 mM and the results found that200mM calcium delayed flower opening and fading, superior in quality retaining(Ahmed and Rab, 2020). Calciumsulphate also increases the vase life of flower spike (Kumar *et al.*, 2007). According to theMarandi (2011), Salicylic acid (Acidifying agent) also known as SA, is a basic compoundfound in plants that helps regulate various aspects of their growth and development. Itplays a role in processes like the opening and closing of tiny pores called stomata, thesprouting of seeds, the absorption of essential minerals, the determination of plantgender and the activationof defense mechanisms against diseases,The findings ofthis study indicate that among all the treatments, Acidifying agent salicylic acid (SA)had the most positive impact on the fresh weight percentage, solution uptake in termsof volume (cm^3) and overall vase life of the cut flowers. Somestudies have found that the application of salicylic acid can extend the vase life offlowersbyreducingtheirrespirationrateandinhibitingethyleneproduction.

Additionally, research has demonstrated that salicylic acid enhances the ability offlowers to withstand water deficit stress, resulting in improved vase life for cut roseflowers(Mehdikhah*etal.*,2016).Theuseofsucroseinconjunctionwithantimicrobialagents(Germicide i.e. HQSandAgNO_3)andanethyleneinhibitor(AgNO_3)enhancedthecarbohydratecontentinflowers,improvedwateruptake,delayedsenescence,preservedflowerturgidity,decreasedbacterialgrowth,andminimizedxylemblockage.Thesecombinedeffectsresultedinsuperiorflowerqualityandprolonged longevity(Mishraand Khanal,2019).

EffectofGrowthRegulatorsonphysiologicalparameters

Sable*etal.*,(2015)studiedtheeffectoffoliarapplicationofPlantgrowthregulatorsgladiolus cv.H.B.Pitt,cormstreatedwithBavistin0.1%andplantssprayed with GA_3, NAA, CCC in different range it founds GA_3 at 200ppm waseffective for elongation of cell and internodal length, height of plant and maximum noof leaves, increase the no. of florets and its weight, overall it enhance the growth andquality of flower. Padmalatha *et al.,* (2015) was conducted a study ontwocultivars,DarshanandDhirajitfoundstheinfluenceoffoliarapplicationof Boron(10 ppm) along with GA_3 (150ppm) significant effect in increasingno. of corms andcormels at the stage of 3^{rd} and 6^{th} leaf stage, increase weight and size of corms, it canbe suggest for multiplication of high-quality planting material and extending vase lifeof gladiolus. The use of Gibberellic acid on gladiolus cormshasproventobeasuccessfulmethodforovercomingdormancyandenhancingvarious aspects of plant development. This treatment has been found to have a positiveimpact on vegetativegrowth,improvethequalityofflowers,andcontributetotheenlargement of both corms and cormels in gladiolus plants (Priyanka 2018 and Holkar *et al.*,2018).

Conclusion:

Gladious is one of the most demanding cut flowers throughout the world, however flowersare perishable and day by day gladiolus industry is growing, due to this moreresearch into new technologies ishighlynecessary to address the severe decline in vase life of gladiolus flowers.It has been shown that the aforementioned strategies canprolong the flower's post-harvestlife.

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