

Original Research Article

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Post-harvest Management of Orchid Spikes and Florets

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ABSTRACT

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Orchids are consistently ranked among the best sellers in the global potted plant trade and also comprise *c.* 10% of all fresh cut flowers traded internationally. The orchids have taken a significant position in cut flower industry due to its attractiveness, long shelf life, high productivity, right season of bloom, and easy packing and transportation but lack a complete information module starting from pre-harvest to harvest and subsequently postharvest techniques including cooling, pulsing, impregnation, bud opening, holding solutions, storage, packaging, drying and transportation of different commercial genera of orchids. In the present investigation, the works on post-harvest technologies of cut spikes and florets of different orchid genera and species have been carried out.

Introduction

Orchids are the second largest families of flowering plants (Willis, 2017) and are globally distributed. Till date, 29199 species have been identified and accepted (Govaerts *et al.*, 2017). One of the best-known plant groups in the global horticultural and cut flower trades (De, 2015; FloraHolland, 2015), orchids are also harvested, grown and traded for a variety of purposes, including as ornamental plants, medicinal products and food. Most popular global orchid trade is in artificially propagated cut flowers and plants

grown under controlled conditions. During the period of 1996 to 2015, Taiwan and Thailand were the largest exporters, with most plants sent to South Korea (40%), the USA (27%) and Japan (20%) (UNEP-WCMC, 2017). Orchids are consistently ranked among the best sellers in the global potted plant trade (Flora Holland, 2015; USDA, 2016) and also comprise *c.* 10% of all fresh cut flowers traded internationally (De, 2015). This represents an economically significant global trade, with exports of potted orchids from the Netherlands alone valued at almost €500 million in 2015 (Flora Holland, 2015). The

largest areas of production are found in Thailand, Taiwan, The Netherlands and Japan, with demand for both potted and cut flowers growing in economic value annually (Hanks, 2015). Thailand, for example, sells roughly half of the orchids it produces in the domestic market (Thammasiri, 2015). Important orchid genera used as potted plants in the international market are *Phalaenopsis*, *Oncidium*, *Cymbidium*, *Paphiopedilum*, *Dendrobium*, *Cattleya*, *Ascocenda*, *Vanda*, *Brassia*, *Miltonia* and *Epidendrum* (Lopez and Runkle, 2005). Several local species of *Ascocentrum*, *Calanthe*, *Cymbidium*, *Dendrobium*, *Paphiopedilum* and *Vanda*, etc. are in great demand in international market for breeding materials (Kumar and Sheela, 2007). The orchids have taken a significant position in cut flower industry due to its attractiveness, long shelf life, high productivity, right season of bloom, and easy packing and transportation but lack a complete information module starting from pre-harvest to harvest and subsequently postharvest techniques including cooling, pulsing, impregnation, bud opening, holding solutions, storage, packaging and transportation of different commercial genera of orchids. In the present investigation, the works on post-harvest technologies of different orchid genera have been carried out.

Materials and Methods

Experiment No-1: Evaluation of cut spikes of different species and hybrids of orchids

Species: *Lycaste* spp., *Phaius tankervillae*, *Vanda coerulea*, *Cymbidium tracyanum*, *C. elegans*, *C. cochleare*, *C. pendulum*, *C. lowianum*, *C. iridioides*, *Zygopetalum intermedium*, *Renanthera imschootiana*, *Vanda tessellata*, *Vanda stangeana*.

Hybrids: *Cymbidium*, *Dendrobium*, *Phalaenopsis*, *Mokara*, *Aranda*, *Oncidium*, *Paphiopedilum*

Experimental Design: CRD

No of replication: 5.

Observations: Days to first floret opening, diameter of first floret, spike length, No of florets/spike, rachis length, changes in fresh weight, total water uptake, days to last floret opening, senescence of last floret

Experiment No -2: Post-harvest life of *Cymbidium* hybrids as affected by different stages of harvest maturity

Miniature Cym. 'Sun Gold': S – 30-39cm, M- 40-49cm, L- 50-59 cm, XL- >60cm

Standard Cym, 'H.C. Aurora': A- 75-80cm, AA- 81-90cm, AAA- >90cm

Intermediate Cym. 'PCMV': A- 60-64cm, AA- 65- 69cm, AAA- 70-74cm

Experimental Design: CRD

No of replication: 5

Observations: Days to first floret opening, diameter of first floret, spike length, No of florets/spike, rachis length, changes in fresh weight, total water uptake, days to last floret opening, senescence of last floret

Experiment-3: Evaluation of *Dendrobium* hybrids at different stages of harvest maturity Stages of harvest

S1: Bud stage, S2: 25% open stage, S3: 50% open stage, S4: 100 % open stage

Experimental Design: CRD

No of replication: 5

Observations: Days to first floret opening, diameter of first floret, No of partially opened florets/spike, No. of half opened florets/spike, No. of unopened florets/spike, rachis length,

changes in fresh weight, total water uptake, days to last floret opening, senescence of last floret.

Experiment No-4: Standardization of harvesting stages in *Cymbidium* hybrid 'Pine Clash Moon Venus'

Stage I : Loose bud stage, Stage II : One bud opened stage, Stage III: Two buds opened stage, Stage IV: 3-4 buds opened stage, Stage V: Fully opened stage.

Experiment No-5: Standardization of pulsing solutions for cymbidium hybrids 'Pine Clash Moon Venus'

T₀ : Control (Distilled water), T₁: Sucrose (5%), T₂: Sucrose (8%), T₃: Sucrose (10%), T₄: 8-HQS (200 ppm), T₅: Sucrose (10%) + 8-HQS (200 ppm), T₆: Sucrose (10%) + 8-HQS (200 ppm) + BA (50ppm), T₇: AOA (1mM). Pulsing duration: 2, 4 & 6 hours.

Experiment No-6: Post-harvest life of *Cymbidium* hybrid 'PCMV' and *Phalaenopsis* as influenced by impregnation

T₀: Control (Distilled water), T₁: AgNO₃ (1000 ppm) for 15 minutes, T₂: AgNO₃ (1500 ppm) for 15 minutes, T₃: CoCl₂ (1000 ppm) for 15 minutes, T₄: CoCl₂ (1500 ppm) for 15 minutes, T₅: NiCl₂ (1000 ppm) for 15 minutes, T₆: Ni Cl₂ (1500 ppm) for 15 minutes.

Experiment No-7: Effect of chemical preservatives on vase life of *Cymbidium* orchids cv. Pine Clash Moon Venus'

T₀: Distilled water, T₁: Glucose (4%), T₂: Sucrose (4%), T₃: AgNO₃ (50 ppm), T₄: 8-HQS (200 ppm), T₅: Physan (200 ppm), T₆: Al₂ (SO₄)₃, T₇: Aspirin (200 ppm), T₈: Glucose (4%) + HQS (200 ppm), T₉: Sucrose (4%) + HQS (200 ppm).

Experiment No-8: Standardization of bud opening chemicals for *Cymbidium* and *Dendrobium* orchids

T₀: Distilled water, T₁: Glucose/Sucrose (4%) + Al₂(SO₄)₃(100 ppm), T₂: Glucose/Sucrose (4%) + 8-HQS (200 ppm), T₃: Glucose/Sucrose (4%) + N:P:K(200: 200: 200) + Aspirin (200 ppm), T₄: Glucose/Sucrose (4%) + Aspirin (100 ppm), T₅: Glucose/Sucrose (4%) + Ca(NO₃)₂ (1%), T₆: Glucose/Sucrose (4%) + Citric acid (200 ppm) + Ag NO₃ (50 ppm), T₇: Glucose/Sucrose (4%) + Boric acid (200 ppm) + KCl (5mM), T₈: Glucose/Sucrose (4%) + Ag NO₃ (50 ppm) + 8-HQS (200 ppm), T₉: Glucose/Sucrose (4%) + BA (50 ppm) + 8-HQS (200 ppm), T₁₀: Glucose/Sucrose (4%) + N:P:K(200: 200: 200) + Aspirin (200 ppm), T₁₁: STS pulsing (4mM) for 10 min + 8-HQS (200 ppm) + Glucose/Sucrose (4%), T₁₂: Glucose/Sucrose (4%) + 0.5mM AOA.

Observations to be recorded: Vase life, physiological changes in weight, longevity of first floret, water uptake, changes in fresh weight, bud opening, percentage of flower dropping.

Experiment No-9: Post-harvest life of *Cymbidium* hybrid 'PCMV' as influenced by cane sugar

T₀: Control (Distilled water), T₁: Cane sugar (2%), T₂: Cane sugar (4%), T₃: Cane sugar (8%)

Experiment No-10: Effect of chemical preservatives on vase life of *Cymbidium* orchids cv. PCMV

T₀: Distilled water, T₁: 2% sucrose (2%) + 100 ppm Al₂(SO₄)₃, T₂: 2% sucrose + 100 ppm Ca (NO₃)₂, T₃: 2% sucrose + 8-HQS (200 ppm), T₄: 2% sucrose + 25 ppm BA, T₅: 2% sucrose + 100 ppm salicylic acid, T₆: 2% sucrose.

Experiment No-11: Evaluation and biochemical analysis of backbulbs and mature bulbs of *Cymbidium* hybrids

Experiment No. 12: Effect of chemicals on vase life of *Dendrobium* orchids at different stages of harvesting maturity

T₁: Sugar (4%) + Salicylic acid (100 ppm), T₂: Sugar (4%) + Ca (NO₃)₂ (1%), T₃: Sugar (4%) + Al₂ (SO₄)₃ (100 ppm), T₄: Sugar (4%) + 8-HQS (200 ppm), T₅: Sugar (4%) + K₂SO₄ (0.5%), T₆ : Sugar (4%), T₇ : Control (Distilled water)

Experimental Design: CRD No. Of Replication: 5

Observations: Changes in fresh weight, Days to senescence of first floret, days to senescence of last floret, No. of partially opened buds, No. of half opened buds and number of unopened buds, solution uptake.

Experiment No. 13. Evaluation of keeping quality of tropical and subtropical orchid hybrids as effected by packing materials

Orchid hybrids

Aranda, Mokara, Oncidium, *Dendrobium*, Vanda, Cattleya

Packing materials: Cotton swab, foam, Plastic vial

Observations: Changes in fresh weight, longevity (days)

Experiment No-14: Effect of packaging materials on post-harvest life of *Cymbidium* hybrid 'PCMV'

Packaging materials: T1: Polypropylene-150 gauge; T2: Cellophane; T3: LDP-100 gauge; T4: HDP -150 gauge; T5: Newspaper; T6: Control (Without packing).

Experimental Design: CRD

No. of Replication: 5

Observations: Changes in fresh weight, Total water uptake, longevity of first floret and longevity of last floret.

Experiment No-15: Evaluation of terrestrial orchids for vase life

Stage of harvest in *Phaius tankervilleae*: Loose bud stage, one bud open stage, two buds opened stage, 3 buds open stage, 5 buds open stage, 7 buds open stage, 9 buds open stage.

Stage of harvest in *Epidendrum*: One bud open, all floret open except top 5 buds, all florets open except top 10 buds.

Observations: Changes in fresh weight, diameter of first floret, Longevity of first floret, longevity of last floret and solution uptake.

Experiment No. 16: Post harvest management of orchid florets

Orchid genera: *Cymbidium*, Cattleya, *Phalaenopsis*

Packing materials: Cellophane papers

Experiment No. 17: Enhancement of keeping quality of loose florets of orchids

Orchid genera: Bamboo orchid, *Phalaenopsis*, *Cymbidium*, *Epidendrum*

Chemical treatments: Al₂(SO₄)₃ at 0.1%,0.2%,0.4%, 0.6%, 0.8% and 1.0% solutions and control (water)

Experiment No. 18: Flower drying in orchids

Orchid hybrids and species: Cattleya, *Cymbidium*, *Phalaenopsis*, *Dendrobium*, *Oncidium*, *Paphiopedilum*, Aranda, Mokara, *Coelogyne flaccida*, *Coelogyne cristata*,

Dendrobium nobile, *Dendrobium williamsonii*, *Dendrobium aphyllum*, *Vanda teres*, *Dendrobium moschatum*, *Arundina graminifolia*, *Epidendrum spp.*

Drying techniques: Embedded drying in sand, borax, silica gel in oven and under room conditions

Results and Discussion

Evaluation of cut spikes and florets of different species and hybrids of orchids for vase life

Orchids species namely *Cymbidium iridioides*, *Zygopetalum intermedium*, *Phaius tankervillae* and *Lycaste* species were evaluated for their vase life and found out that *Cymbidium iridioides* is having the vase life of 29.50 days followed by *C. cochleare* (29 days), *C. tracyanum* (24 days), *C. elegans* (10 days) and *Zygopetalum intermedium* is having the vase life of 18.10 days. *Phaius tankervillae* is having 24.20 days and *Lycaste* sp having 9 days of vase life. *Renanthera imschootiana* had vase life of 24 days, *Vanda tessellata* 16 days and *Vanda stangeana* 10 days.

Cut spikes of *Cymbidium* hybrids namely Pine Clash Moon Venus, Red Princess, White Beauty; H.C. Aurora, Sun Gold, Ensikhan, Florance, Valley Legand and Platinum Gold were evaluated for their post harvest life. *Cymbidium* hybrid Florance is having the highest vase life of 53.66 days followed by White beauty 53.05 days. Lowest vase life was noticed in Platinum Gold (22.44 days).

In another experiment, cut spikes of *Cymbidium* hybrids namely 'Baltic Glacier Mint Ice', 'Sleeping Nymph', and 'Valley Pink Inspiration' and 'Valley Flower Powder Puff' were evaluated for their post harvest life. Among the hybrids

highest vase life was recorded in 'Sleeping Nymph' 56.90 days followed by 'Valley Flower Powder Puff' (52.86 days) and Baltic Glacier Mint Ice (41.81 days). Vase life was lowest in 'Valley Pink Inspiration' 29.00 days.

Out of cut spikes of ten *Cymbidium* hybrids evaluated, Bob Marlin Lucky' had shown maximum longevity of first floret (51 days) and vase life (57 days) followed by 'Fire Storm Blaze' (47 days & 53 days). Minimum longevity of first floret (21 days) was recorded in Hana Akari and minimum vase life (35 days) recorded in 'Rocky Creek Pebbles' and 'Hee Haw Sagun'.

In cut spikes of *Mokara* hybrids, vase life ranges from 17 days (Walter Ouame White) to 58 days (Jitti Orange), *Aranda* from 13 days (Thailand Sunspot) to 45 days (Propine Spot), *Vanda* from 12.5 days (Pat D) to 41 days (V. Sirilak x V. Thongchai Gold') and in *Oncidium* from 20 days (Taka Yellow) to 38 days (Wild Cat Bob Cat).

In *Mokara*, 'Walter Oumae White', cut spikes harvested at all florets opened except top 4-5 buds had maximum vase life (18.5 days) followed by all florets opened except one bud (17 days) and all florets opened (13 days.)

In *Phalaenopsis*, cut spikes of 11 hybrids evaluated and 'Manchester' had highest vase life (62.2 days).

Out of 9 advance lines and 2 species of *Paphiopedilum* evaluated , highest vase life was recorded in PL x PW-28 (79 days) followed by Sheetal -1 (52 days) and lowest in PL x PW 39 (15 days).

In *Cymbidium*, out of 15 hybrids evaluated for florets, 30-40 days vase life were recorded in Hazel Fay Tangerine, Levis Duke Bella Vista, Everett Stockstill Bullai, Valley Teaser, and Samurai Hee Haw Sagun; 41-50 days vase life recorded in Fire Strom Blaze, Rocky Creek

Pebbles, Bob Marlin Lucky, Satrun Doll, Sun Gold and MT Perfection and 51-60 days vase life recorded in Valley Legend Steff, H.C. Aurora and Pine Clash Moon Venus (PCMV).

In *Cymbidium* 'PCMV', fully open florets had maximum vase life (48 days) followed by half open floret (41 days with 100% opening), loose bud florets (35 days with 50% opening) and tight bud florets (26 days with 25% opening).

Post-harvest life of *Cymbidium* hybrids as affected by different stages of harvest maturity

In *Cymbidium*, out of four different stages of harvest maturity of Miniature hybrid 'Sun Gold', three different stages of standard hyb. 'H.C. Aurora', and three different stages of intermediate hyb.'PCMV', stage-III (spike length: > 90cm) of standard hybrid had maximum vase life (59 days).

Among different types of *Cymbidium* hybrids, vase life ranges from 30-34 days in miniature, 35-37 days in intermediate and 55-59 days in standard hybrids. The enhanced vase life of *Cymbidium* due to stages of harvest was explained by De et al, 2014.

Evaluation of *Dendrobium* hybrids at different stages of harvest maturity

At bud stage, out of 12 hybrids of *Dendrobium* evaluated, maximum vase life recorded in Den. Big White Jumbo (45 days) and maximum per cent of fully opened flowers in Den. Kating Dang (45%).

At 50 % opened stage, highest vase life recorded in Den. Big White Jumbo (60 days) and more than 90% fully opened flowers recorded in Den. Big White Jumbo, Thongchai Gold and Lervia.

Standardization of harvesting stages in *Cymbidium* hybrid 'Pine Clash Moon Venus'

In *Cymbidium* hyb. 'PCMV', out of five different stages of harvest maturity, two buds opened stage had maximum vase life (66.8 days) and floret opening followed by 3-4 buds opened stage (64.8 days) and minimum with loose bud stage (59 days). Maximum water uptake was recorded in two buds opened stage (46ml). Percentage of flower bud opening ranges from 81 % (loose bud stage) to 100 % (3-4 buds opened stage). The stage V i.e. fully opened stage had maximum reduction in weight (24.6g).

Standardization of pulsing solutions for *Cymbidium* hybrids 'Pine Clash Moon Venus'

Among the different pulsing solutions used sucrose at 5% for 2 hours increased the vase life of flower (56 days) followed by Sucrose @ 8% (54.78 days).

Post-harvest life of *Cymbidium* hybrid 'PCMV' and *Phalaenopsis* as influenced by impregnation

In the experiment on impregnation of cut spikes of Cym. 'PCMV', maximum water uptake was recorded with CoCl_2 (1000ppm) for 15 minutes (38ml) followed by CoCl_2 (1500ppm) for 15 minutes (35 ml). Highest longevity was recorded with CoCl_2 (1000ppm) for 15 minutes (46 days) followed by CoCl_2 (1500ppm) for 15 minutes (44days) over control (39 days).

In *Phalaenopsis* 'Detroit', among five impregnation treatments CoCl_2 (1000 ppm) for 45 minutes had maximum vase life (75.6 days) followed by NiCl_2 (1000 ppm) for 45 minutes (62 days) over control (45 days).

Effect of chemical preservatives on vase life of Cymbidium orchids cv. Pine Clash Moon Venus'

Experiment on the effect of sucrose and anti-ethylene agents on vase life of cymbidium flowers with damaged pollinia was carried out with twelve different chemicals in Cymbidium Hybrid 'PCMV'. Treatments were given in two different forms like pulsing and holding to the flowers with pollinia and flowers without pollinia. Among the different treatments pulsing of flowers with 5 % sucrose followed by 150 ppm 8HQS increased the vase life of flowers with pollinia (49.33 & 46.33 days) and without pollinia (44.00 & 41.67 days). In case of holding solutions, 8HQS 150 ppm increased the vase life of flowers with pollinia (48.33 days) followed by 8 HQS 200 ppm (46.80 days). 8 HQS 200 ppm increased the vase life (36.67 days) of flowers without pollinia.

Standardization of bud opening chemicals for Cymbidium and Dendrobium orchids

Reducing sugar analysis was carried out in Dendrobium hybrid 'Thanchai Gold'. Three stages of flowers like opened flowers, half opened flowers and bud has taken for analysis. It was found out that opened flower contains 29.00 %, half opened flower contains 28.25 % and buds contain 16.17 % of reducing sugars.

In Cymbidium hybrid 'Ensikhan', chemicals like 4% sucrose + 1% $\text{Ca}(\text{NO}_3)_2$, 4% sucrose + 100 ppm salicylic acid and 4% sucrose + $\text{Al}_2(\text{SO}_4)_3$ were found effective for opening of maximum number of buds, least bud drop and highest vase life (27days) over control(19 days in distilled water).

Opening of tight buds of cut flowers of Cymbidium 'PCMV' was improved with all chemical treatments except control. Minimum duration (18 days) for opening

of first floret was observed with Sugar 4% + 8-HQS (200 ppm). The treatment combination of sugar 4% + Salicylic acid 200 ppm had first floret with maximum diameter (6.6cm). Per cent of half opened buds was recorded maximum (30.7%) with sugar 4% + 8-HQS (200 ppm) whereas per cent of fully opened buds was highest (75%) in sugar 4% + Salicylic acid 200 ppm. In control, all flower buds dropped on 27th days. Vase life of cut spikes was found maximum (45days) with sugar 4% + Salicylic acid (200 ppm) followed by Sugar 4% + $\text{Al}_2(\text{SO}_4)_3$ (100 ppm) and sugar 4% + 8-HQS (200 ppm) (44 days) (Table 1). Bud opening, improved flower size and enhancement of vase life of tight bud cut flowers of Cymbidium orchids as treated with Sugar 4% + Salicylic acid (200 ppm) may be attributed to effect of salicylic acid as anti-transpirant by induction of stomatal closure or by blocking the conversion of a amino cyclopropane -1-carboxylic acid to ethylene (Leslie and Romani, 1986).

Changes in carbohydrate content of cut flowers of Cymbidium at senescence stage had shown significant variations starting from flower bud to flower opening stage. Highest content of carbohydrate (140mg/g) was estimated at bud stage in fresh condition followed by at bud stage (131mg/g) at senescence in control. Minimum carbohydrate content (60mg/g) was observed with Sugar 4% + 8-HQS (200 ppm) followed by Sugar 4% + Salicylic acid 200 ppm) (64mg/g) (Table 2). Flower opening has been reported to be dependent on carbohydrate levels in the petals (Van Doorn et al., 1991b).

In Dendrobium hybrid 'Thongchai Gold', per cent of fully opened buds (66%) was recorded maximum with sucrose(4%) + $\text{Ca}(\text{NO}_3)_2$ (1%) followed by sucrose (4%) + acetyl acetic acid (100 ppm) (60%). Longest vase life (36 days) was found

with sucrose (4%) + $\text{Al}_2(\text{SO}_4)$ (100 ppm) followed by sucrose (4%) + acetyl acetic acid (100 ppm) (33 days) (Table 3). Beneficial effect of 8-HQS on bud opening of *Dendrobium* cutflowers was reported by Ketsa et al, 2001.

Post-harvest life of *Cymbidium* hybrid 'PCMV' as influenced by cane sugar

In the experiment on the effect of cane sugar in holding solution on vase life of *Cym.* 'PCMV', out of four treatments (0%, 2% cane sugar, 4% cane sugar and 8% cane sugar), 2% cane sugar had shown maximum depletion of stored carbohydrates, maximum longevity of first floret (54 days), zero per cent of flower dropping, maximum solution uptake (24ml) and highest vase life (61.2 days) followed by 4% cane sugar. 8% cane sugar had least longevity of first floret (27.2 days) and vase life (36.2 days).

Effect of chemical preservatives on vase life of *Cymbidium* orchids cv. PCMV and *Zygopetalum*

In the experiment, out of 8 different chemicals for holding chemicals on post-harvest life of *Cym.* 'PCMV', longevity of first floret was recorded maximum with BA (25 ppm) (49.2 days) followed by $\text{Al}_2(\text{SO}_4)_3$ (100 ppm) (45.2 days). Maximum vase life (54.8 days) was found with $\text{Ca}(\text{NO}_3)_2$ (100 ppm) followed by $\text{Al}_2(\text{SO}_4)_3$ (100 ppm) (53.4 days). Solution uptake (33 ml) was observed maximum with $\text{Al}_2(\text{SO}_4)_3$ (100 ppm) and 8-HQS(200 ppm).

In *Cymbidium* hybrid, 'PCMV', out of six treatment combinations, 2% sucrose + 200 ppm 8-HQS had shown maximum longevity

of first floret (66 days) and vase life (77.6 days) followed by 2% sucrose + 100 ppm $\text{Al}_2(\text{SO}_4)_3$ (65.4 days & 77.4 days) over control in tap water (33 days & 61.4days).

In *Cymbidium* hybrid, 'PCMV', treatment with 2% sucrose + 100 ppm salicylic acid showed maximum longevity (63 days) of cut spikes in fully opened stage followed by one bud opened stage (62 days) whereas 2% sucrose + 100 ppm $\text{Al}_2(\text{SO}_4)_3$ had highest longevity of cut spikes (56 days) at two buds opened stage followed by fully opened stage (55.6 days).

Treatment with 2% sucrose + 100 ppm $\text{Al}_2(\text{SO}_4)_3$ enhanced post-harvest life of *Zygopetalum* cut flowers to the extent of 15 days over control 10 days in tap water.

Evaluation and biochemical analysis of backbulbs and mature bulbs of *Cymbidium* hybrids

Out of sixteen hybrids of *cymbidium* orchids, fourteen hybrids came into flowering. Maximum width (9.0cm) and length (14.5cm) of flowering pseudobulb and spike length (81cm) was recorded in 'Fire Storm Blaze'. Longevity of flowers on plants was recorded highest in 'Caripepper Peachy Keen'(70 days). In backbulbs, carbohydrate content ranges from 70mg/g in 'Pink' to 152 mg/100g in 'Fire Storm Blaze' whereas in flowering pseudobulbs it varied from 88mg/g in 'Pink' to 180mg/100g in 'Fire Storm Blaze'. Fire storm Blaze had maximum chlorophyll content (71.20 mg/100g) followed by 'Hazel Fay Tangerine'(58.80mg/100g) and minimum in 'Red' (19.20mg/100g).

Table.1 Effect of chemicals on bud opening in *Cymbidium* hyb. ‘Pine Clash Moon Venus’

Treatment	Days to first floret opening	Diameter of first floret (cm)	Per cent of half opened buds	Per cent of Fully opened buds	Vase life (Days)
Distilled water	---	----	0	0	27
Sugar 4%	20	5.1	5.8	44	37.8
Sugar 4% + Al ₂ (SO ₄) ₃ (100 ppm)	21	5.4	0	57	44
Sugar 4% + 8-HQS (200 ppm)	18	5.5	30.7	53.8	44
Sugar 4% + Salicylic acid (200 ppm)	21	6.6	0	75	45
Sugar 4% + Ca (NO ₃) ₂ (1%)	25	4.85	2	22.8	37.8
Sugar 4 % + Boric acid 200 ppm + K ₂ SO ₄ (2mM)	20.5	5.5	6.25	25	36.2
CD 5%	2.86	0.32	0.34	2.55	3.10

Table.2 Changes in total carbohydrates as affected by effect of chemicals on bud opening of *Cym.* ‘PCMV’ harvested at bud stage

Treatment	Sample	Stage	Carbohydrate content (mg/g)
	Bud	Fresh	140
Distilled water	Bud	Senescence	131
Sugar 4%	Flower	Senescence	96
Sugar 4% + Al ₂ (SO ₄) ₃ (100 ppm)	Flower	Senescence	64
Sugar 4% + 8-HQS (200 ppm)	Flower	Senescence	60
Sugar 4% + Salicylic acid 200 ppm)	Flower	Senescence	64
Sugar 4% + Ca (NO ₃) ₂ (1%)	Flower	Senescence	70
Sugar 4 % + Boric acid 200 ppm + K ₂ SO ₄ (2mM)	Flower	Senescence	76

Table.3 Effect of chemicals in bud opening in Dendrobium ‘Thongchai Gold’

Treatments	% of bud swelling	% of half opened buds	% of fully opened buds	Vase life (days)
Distilled water	10	0	0	21
Sucrose (4%) + Al ₂ (SO ₄) ₃ (100 ppm)	11	22.2	33.3	36
Sucrose (4%) +HQS-200 ppm	0	11	44.4	27
Sucrose(4%) + Acetyl salicylic acid (100ppm)	10	20	60	33
Sucrose(4%) + Ca(NO ₃) ₂ (1%)	8.5	8.5	66	32

Table.4 Longevity of florets in Cymbidium hybrids

Hybrid	Packed florets	Unpacked florets	Hybrid	Packed florets	Unpacked florets
Cym. H.C. Aurora	25 days	10 days	Cym. Valley Legend Steff	26 days	21 days
Cym. Hazel Fay Tangerine	25 days	19 days	Cym. BGMI	26 days	21 days
Cym. Bob Marlin Lucky	37 days	15 days	Cym. Samuari Hee Haw Sagun	26 days	7 days
Cym. Fire Storm	35 days	14 days	Cym. PCMV	25 days	7 days
Cym. C. Peachy Keen	39 days	13 days	Cym. rocky Creek Pebbles	31 days	10 days
Cym .WBSG	33 days	22 days	Cym. LDBV	25 days	14 days
Cym. Soul Hunt 6	15 days	9 days			

Recommendations

Stages oh harvest of orchids for enhanced vase life

Stage of Harvest in orchids			
Orchid hybrid	Commercial stage of harvest	Spike length (cm)	Vase life (days)
Aranda	50% bloom	45-60 cm	18-28 days
Cattleya	2-4 days before bud open	25-40 cm	10- 20 days
Cymbidium	75% bloom	60cm -1.25 m	55-60 days
Dendrobium	All flowers except top bud	40-60cm	14-21 days
Oncidium	80 % bloom	60 cm	25-35 days
Paphiopedilum	3 to 4 days after opening of flowers	25-40 cm	30-56 days
Phalaenopsis	Fully open flowers	40-60 cm	25-40 days
Vanda	Fully open flowers	50-75 cm	14- 30 days

Post-harvest technology in Cymbidium

Sl.No.	Particulars	Recommendations
1.	Evaluation of elite hybrids for vase life	Bob Marlin Lucky (57 days), Fire Strom Blaze (53 days), Hazel Fay Tangerine (50 days), Everett Stockstill Bullai (48 days), Caripepper Peachy Keen (43 days), Hana Akari (41 days), Fire Storm Ruby (36 days)
2.	Spike length and vase life of different classes of Cymbidium	Miniature (30-60cm): 30-34 days Intermediate (60-75cm): 35-37 days Standard (> 75cm): 55-59 days
3.	Optimal stages of harvest of Cymbidium 'PCMV' for maximum vase life	Two buds opened stage (66.8 days)
4.	Best impregnation treatment of Cymbidium 'PCMV' for maximum vase life	CoCl ₂ (1000ppm) for 15 minutes (46 days)
5.	Best pulsing treatment of Cymbidium for maximum vase life	5% sucrose for 8 hours (56 days)
6.	Best pre-harvest spray of Cymbidium for maximum growth and vase life	GA ₃ (50 ppm) + BA (200 ppm)
7.	Best chemical treatment for opening of tight buds of Cymbidium cutflowers	Sucrose 4% + Salicylic acid 200 ppm with 75% opening and vase life of 45 days
8.	Best holding solution for improved vase life of Cymbidium	2% sucrose + 200 ppm 8-HQS with vase life of 76.6 days
9.	Best packaging material of Cymbidium spikes and florets for improved vase life	Cellophane (56 days)
10.	Best harvesting stage of Cymbidium florets for improved vase life	Fully opened florets with vase life of 48 days.

Post-harvest technology in Dendrobium

Sl.No.	Particulars	Recommendations
1.	Evaluation of commercial hybrids of Dendrobium for vase life	Triple Pink (40 days), Emma White (37 days), Madam Pompadour (37 days), Erika (34.8 days), Ear Sakul (33.5 days), Thongchai Gold (30.4 days), Big White Jumbo (29.5 days), Kating Dang (28 days), Lervia (28 days), Daang Saard (27.5 days), Julie (25 days)
2.	Best harvesting stage of Dendrobium for maximum vase life	50 % opened stage with 60 days of vase life
3.	Best bud opening of Dendrobium for improved vase life	4% Sucrose + 100 ppm Salicylic acid
4.	Best holding solution of Dendrobium for improved vase life	2% sucrose + 200 ppm ASA and 2% glucose + 100 ppm ASA were found as best holding solutions for maximum vase life (80 days) over control (without treatment) (48 days).

Flower drying in orchids

Sl.No.	Species / varieties of orchids	Recommendations
1.	<i>Vanda teres</i> , <i>Dendrobium moschatum</i> , <i>Arundina graminifolia</i> , <i>Den.</i> 'Madam Pink', <i>Den.</i> 'Lervia', <i>Den.</i> 'Abraham', <i>Phal.</i> 'Casa Blanca', <i>Phal.</i> 'Detroit' and <i>Oncidium</i> 'Sweet Sugar'	Embedded drying with borax at 50°C in oven
2.	<i>Epidendrum</i> spp., <i>Cattleya bowringiana</i> and <i>Cattleya</i> hybrids, <i>Phal.</i> 'Ox Plum Rose x Black Jack' and <i>Den.</i> 'Big White', <i>Vanda coerulea</i>	Embedded drying with borax at 60°C in oven
3.	<i>Coelogyne flaccida</i> , <i>Coelogyne cristata</i> , <i>Dendrobium nobile</i> , <i>Dendrobium williamsonii</i> , <i>Dendrobium aphyllum</i> , <i>Den.</i> 'Erika', <i>Den.</i> 'Big White 4N', <i>Den.</i> 'Bangkok Blue', <i>Phal.</i> 'Nagasaki' and <i>Cym.</i> 'Sungold'.	Embedded drying with borax and silica gel at 55°C in oven
4.	<i>Dendrobium</i> , <i>Phalaenopsis</i> , <i>Cattleya</i> , <i>Cymbidium</i> , <i>Aranda</i> , <i>Mokara</i> hybrids	Perlite, Perlite + borax and Perlite + Silica gel under room condition (24-25°C and 75-79% RH)
5.	<i>Cattleya</i> 'Guanmian City', <i>Dendrobium</i> 'Lervia', <i>Phalaenopsis</i> 'Vienna', <i>Vanda tessellata</i> , <i>Oncidium</i> 'Taka Yellow', <i>Phalaenopsis</i> 'Taida S.Red'	Embedded drying with sand at 50°C in oven

Effect of chemicals on vase life of Dendrobium orchids at different stages of harvesting maturity

In Den. ‘Thongchai Gold’, at 50% bud opened stage, treatment with 4% sucrose + 100 ppm $Al_2(SO_4)_3$ had maximum vase life (49 days) over control (35 days).

Evaluation of keeping quality of tropical and subtropical orchid hybrids as effected by packing materials

In foam, longevity of cut spikes of *Aranda* ranges from 27 days (Propine spot) to 40 days (Thailand Sunspot), in *Mokara*, from 13 days (Happy Beauty) to 27 days (Walter Ouame White), in *Oncidium*, 17 days (Taka Yellow), in *Dendrobium*, 9 days (Lervia to Bangkok Blue (34 days), in *Vanda*, 9 days (Sansai Blue) to Prao Sky Blue (17 days) and in *Cattleya*, 10 days (Queen Sirikhit). **In plastic vials**, longevity of cut spikes of *Aranda* ranges from 22 days (Propine Spot) to 34 days (Thailand Sunspot), in *Mokara*, from 26 days (Kultana Gold) to 50 days (Happy Beauty), in *Oncidium*, from 20 days (Sweet Fragrance) to 27 days (Taka Yellow), in *Dendrobium*, from 21 days (Erika) to 58 days (Emma White), in *Vanda*, from 27 days (Pat D) to 60 days (Prao Sky Blue) and in *Cattleya* 14 days (Queen Sirikhit).

Effect of packaging materials on post-harvest life of cut spikes of different orchids

Out of five packaging materials used in *Cymbidium* hybrid ‘PCMV’, highest keeping quality was recorded with cellophane (56 days) followed by polypropylene (150 gauge) (54 days) and low density polyethylene (54 days) over control (50 days) without packing. Maximum water uptake was found with control (35ml) followed by newspaper

packing (34.2 ml).

In *Cym.* ‘Sun Gold’, packing of 25% bud open stage cut spikes with cellophane paper had maximum vase life (48 days) followed by 50% bud open stage (46 days).

In *Cym.* ‘PCMV’, packing of loose bud stage cut spikes with cellophane paper had maximum vase life (60 days) over control (49 days).

In *Cym.* ‘Sleeping Nymph’ the longevity of cut flowers of value added packed items had shown upto 33 days.

In *Dendrobium*, ‘Emma White’, Cellophane paper packaging of cut flowers had shown maximum vase life (30.3 days) over control (without packing) (17 days).

Evaluation of terrestrial orchids for vase life

In *Phaius tankervilleae*, out of seven harvest stages, cut flowers of loose bud stage had maximum vase life (33 days) and minimum at 9 buds opened stage (20 days).

In *Epidendrum*, cut flowers harvested at all florets opened stage except 5 buds showed maximum vase life (28 days) followed by all florets opened stage except top 10 buds (22 days.)

Post harvest management of orchid florets

In elite *Cymbidium* hybrids, longevity of cellophane paper packing of fully open florets ranges from 15 days (Soul Hunt 6) to 39 days (Caripepper Peachy Keen) over unpacked florets i.e. 9 days and 13 days, respectively (Table 4).

In *Cattleya* hybrids, longevity of cellophane paper packing of fully open florets ranges from 14 to 45 days over unpacked florets i.e. 7 to 11 days.

In *Phalaenopsis* hybrids, longevity of cellophane paper packing of fully open

florets ranges from 14 days (Phal. 'Boston') to 33 days (Phal. 'Ox Plum Rose x Black Jack').

Enhancement of keeping quality of loose florets of orchids

Out of seven treatments of $Al_2(SO_4)_3$, 0.1 to 1.0 % was found best in Bamboo orchid, 0.1 to 0.4% in *Epidendrum*, 0.8 to 1.0 % in *Phalaenopsis* and 0.4 to 0.6% in *Cymbidium* for enhancement of keeping quality of loose florets of orchids.

Flower drying in orchids

Embedded drying with borax and silica gel at 55°C in oven was found successful *Coelogyne flaccida*, *Coelogyne cristata*, *Dendrobium nobile*, *Dendrobium williamsonii*, *Dendrobium aphyllum*, Den. 'Erika', Den. 'Big White 4N', Den. 'Bangkok Blue', Paphs.'Nagasaki' and *Cym.* 'Sungold'.

Embedded drying with borax at 50°C in oven was found successful in *Vanda teres*, *Dendrobium moschatum*, *Arundina graminifolia*, Den. 'Madam Pink', Den. 'Lervia', Den. 'Abraham', Phal. 'Casa Blanca', Phal. 'Detroit' and *Oncidium* 'Sweet Sugar' and embedded drying with borax at 60°C was found successful in *Epidendrum* spp., *Cattleya bowringiana* and *Cattleya* hybrids, Phal. 'Ox Plum Rose x Black Jack' and Den. 'Big White'.

Under room condition (24-25°C and 75-79%RH), perlite can be used for drying of spikes and florets of orchids within 15 to 20 days.

Embedded drying with borax and silica gel at 45-55°C was found successful Den. Thongchai Gold, Bangkok Blue, *Paphiopedilum*, *Vanda*, *Phalaenopsis* 'Detroit', Buenos Aires' *Plumeria*, *Hydrangea*, *Gladiolus* and *Lilium*.

Embedded drying with borax at 50-60°C was

found successful in Phal. 'Nagasaki', 'Manchester', 'Boston', 'Detroit', Den. 'Emma White', 'Lervia', 'A. Abraham', 'Triple Pink', *Epidendrum* spp. and *Cym.* 'Valley Teaser', 'N. Cherry', 'Bartha Peterson', and 'Platinum Gold'. Embedded drying with silica gel with best success has been reported by Dhatt et al, 2007; Desh Raj and Gupta, 2003.

Under room condition (25-28°C and 60% RH), perlite, perlite + borax and perlite + silica gel were found successful for drying florets of *Phalaenopsis*, *Cattleya*, *Dendrobium* and *Oncidium* orchids.

Economics of packaging technology

Yield of spikes varies from genus to genus and variety to variety. A healthy well grown *Cymbidium* orchid will produce flowers spikes every year and a plant 10 years old can produce from 10 to 20 flower spikes. On an average, 6-8 spikes are available from commercial varieties of *Dendrobium*. Pricing of spikes depends upon the type of orchid and the grade of spikes. The cost of one *Dendrobium* spike ranges from Rs. 10 to Rs. 25 depending upon the grade. For *Cymbidium*, the cost of one spike ranges from Rs.100/- to Rs.200/-. The benefit cost ratio of packaging of *Cymbidium* ranges from 1.0 in spikes to 1.5 in florets whereas in *Dendrobium* benefit cost ratio of packaging of spikes is 0.67.

References

- De L.C., Vij S.P., Medhi R. P. 2014. Post-Harvest Physiology and Technology in Orchids. *J Horticulture*, 1: 102. doi:10.4172/horticulture.1000102.
- De LC. 2015. *Commercial orchids*. Berlin: De Gruyter Open. Available at: <http://www.degruyter.com/view/product/456245>
- Dhatt KK, Singh Kushal and Ramesh Kumar.

2007. Studies on methods of dehydration of rose buds. *Journal of Ornamental Horticulture*, 10(4): 264-267.
- Desh Raj and Gupta Prashant, K.2003. Standardizing dehydration technology for ornamental plant parts of shrubs from mid-hills of Himachal Pradesh. *Journal of Ornamental Horticulture*, 6(4): 357-361.
- Flora Holland. 2015. Facts & figures. FloraHolland facts and figures 2015. Available at: [https://www.royalfloraholland.com/media/5685262/Royal Flora Holland_Annual_Report_2015_ENG_facts_and_figures.pdf](https://www.royalfloraholland.com/media/5685262/Royal_Flora_Holland_Annual_Report_2015_ENG_facts_and_figures.pdf).
- Govaerts R., Bernet P., Kratochvil K., Gerlach G., Carr G., Alrich P, Pridgeon A.M., Pfahl J., Campacci M.A., Holland Baptista D., Tigges H., Shaw J., Cribb P., George A., Kreuz K. and Wood J.J. 2017. *World checklist of Orchidaceae*. Kew: Facilitated by the Royal Botanic Gardens. Available at: <http://apps.kew.org/wcsp/> (accessed 23 March 2017).
- Hanks F. 2015. *Orchid cut flower industry*. Report for the UK Agriculture and Horticulture Development Board and National Cut Flower Centre. Available at: https://horticulture.ahdb.org.uk/sites/default/files/u3089/A%20review%20of%20cut-flower%20and%20foliage%20production%20statistics%202015_0.pdf
- Ketsa S., Uthairatanakij A. and Prayurawong A. 2001. Senescence of diploid and tetraploid cut inflorescences of *Dendrobium 'Caesar'*. *Scientia Hort.*, 91: 133141.
- Kumar, K. Madhu and Sheela, V.L. 2007. Status of breeding in orchids-A review. *Journal of Ornamental Horticulture*, 10: 199-208.
- Leslie C.A., and Romani, R.J., 1986, Salicylic acid-a new inhibitor of ethylene biosynthesis, *Plant Cell Report*, 5: 144-146
- Lopez, R. G. and Runkle. E.S. 2005. Environmental physiology of growth and flowering of orchids. *Hort. Science*, 40(7): 1969-73.
- Thammasiri K. 2015. Current status of orchid production in Thailand. In: Uthairatanaki A, Wannakrairoj S, eds. *Acta Horticulturae, Vol. 1078*. Leuven: *International Society for Horticultural Science*, (ISHS).25–33.
- UNEP-WCMC. 2017. *CITES trade statistics derived from the CITES Trade Database*. Cambridge: UNEP World Conservation Monitoring Centre. Available at: <https://trade.cites.org>
- Van Doorn W.G., de Stigter H.C.M. de Witte Y. and Boekestein A., 1991b. Microorganisms at the cut surface and in the xylem vessels of rose stems: a scanning electron microscope study, *Journal of Applied Bacteriology*, 70: 34-39
- Willis K.J. (ed) .2017. State of the world's plants 2017. Report. Royal Botanic Gardens, Kew.

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