Effect of pulsing and holding solutions on vase life of *Melaleuca bracteata* foliage

Comment [r1]:

Comment [r2]: Write authority

ABSTRACT

Comment [r3]: Needs improvement as it is missing in many things

The experiment was conducted to vase life of*Melaleuca bracteata* foliage by using distilled water (control) and different pulsing, holding solutions following factorial CRD design. ~~Effect of pulsing, holding solutions and distilled water on different modules was studied in *Melaleuca bracteata* foliage~~. Pulsing solution containing Sucrose (2%) + $Al_2(SO_4)_3$ (1000ppm) (9.89 days) resulted long vase life of foliage followed by solution containing Sucrose (2%) + BA (50ppm) (9.10 days) in module VI. Whereas holding solution containing Sodium Benzoate (150ppm) (9.10 days) showed long vase life of foliage followed by Sodium Benzoate (100ppm) (9.02 days) in module VI.

Keywords: *Melaleuca bracteata*, Pulsing solution, Holding solution, Sodium Benzoate, Sucrose

Introduction:

Melaleuca bracteata is commonly known as Golden Bottle Brush, Black Tea-Tree, River Tea-Tree. The genus *Melaleuca* consists of 300 species and is the third-largest angiosperm genus in Australia after *Acacia* and *Eucalyptus* (Craven, 2009; Edwards *et al*., 2010). The genus *Melaleuca* is a member of the Myrtaceae or myrtle family. There are approximately 130 genera and 3,000 species recorded in this family (Serbesoff-King, 2003). Family Myrtaceae consists of trees and shrubs, usually evergreen, mostly with simple leaves, commonly opposite leaves, and rarely found with alternate leaves (Mabberley, 2008). This family is noted for its spicy, aromatic scent because of the variety of essential oils present in the oil glands on the leaves (Gentry, 1993).

Melaleuca bracteata is a large shrub to a medium tree usually up to 15 m tall, with small, narrow, and hairy leaves, (3-12 mm long) (Byrnes, 1986). Flowers are small bottlebrushes up to 20 mm long and occur near the end of the twigs. Their fruits are woody, small, cup-shaped capsules. *M. bracteata* the capsules are 2-3 mm long and 2.5-3 mm wide appearing on branches. Generally, *M. bracteata* can flower for the whole year, but more in spring and summer (Van *et al*., 2002).

Cut foliage is used as fillers along with flowers in bouquets, floral arrangements, and floral ornaments or alone to create variability in colors, textures shapes, and forms of the foliage.

The cut foliage is in demand throughout the year and comprises 10% of world floriculture trade with an annual growth rate of 4% (Nair *et al.*, 2017). ..

Comment [r4]: Add objective of the study ,, means what is the need of this study//

Material and methods

The freshly harvested twigs were used for the vase life studies by keeping them in distilled water (control) and different pulsing, holding solutions following factorial CRD design. Three twigs were taken in each replication and the vase life of the twigs is expressed in days. The details of chemicals used in pulsing and holding solutions are given in Table 1…

Comment [r5]: Mention ,year of experiment, length and stage of harvested twigs, environmental conditions of experiment, how the termination of vase life was determined?

Table 1:The treatment details of vase life studies of cut foliage

	Pulsing solutions		Holding solutions
T_1	BA (25ppm)	T_1	NaOCl (25ppm)
T_2	BA (50ppm)	T_2	NaOCl (50ppm)
T_3	GA_3 (25ppm)	T_3	$Al_2(SO_4)_3$ (200ppm)
T_4	GA_3 (50ppm)	T_4	$Al_2(SO_4)_3$ (300ppm)
T_5	8-HQS (100ppm)	T_5	Citric acid (200ppm)
T_6	8-HQS (200ppm)	T_6	Citric acid (300ppm)
T_7	$Al_2(SO_4)_3$ (100ppm)	T_7	Sodium Benzoate (100ppm)
T_8	$Al_2(SO_4)_3$ (200ppm)	T_8	Sodium Benzoate (150ppm)
T_9	NaOCl (50ppm)	T_9	Sucrose (2%) + NaOCl (25ppm)
T_{10}	NaOCl (100ppm)	T_{10}	Sucrose (2%) + NaOCl (50ppm)
T_{11}	Sucrose (2%) + BA (25ppm)	T_{11}	Sucrose (2%) + $Al_2(SO_4)_3$ (200ppm)
T_{12}	Sucrose (2%) + BA (50ppm)	T_{12}	Sucrose (2%) + $Al_2(SO_4)_3$ (300ppm)
T_{13}	Sucrose (2%) + GA_3 (25ppm)	T_{13}	Sucrose (2%) + Citric acid (200ppm)
T_{14}	Sucrose (2%) + GA_3 (50ppm)	T_{14}	Sucrose (2%) + Citric acid (300ppm)
T_{15}	Sucrose (2%) + 8-HQS (100ppm)	T_{15}	Sucrose (2%) + Sodium Benzoate (100ppm)
T_{16}	Sucrose (2%) + 8-HQS (200ppm)	T_{16}	Sucrose (2%) + Sodium Benzoate (150ppm)
T_{17}	Sucrose (2%) + $Al_2(SO_4)_3$ (100ppm)	T_{17}	Sucrose (2%)
T_{18}	Sucrose (2%) + $Al_2(SO_4)_3$ (200ppm)	T_{18}	Control (Distilled water)
T_{19}	Sucrose (2%) + NaOCl (50ppm)		
T_{20}	Sucrose (2%) + NaOCl (100ppm)		
T_{21}	Sucrose (2%)		
T_{22}	Control (Distilled water)		

Results and Discussion

The effect of Pulsing and holding solutions on cut foliage of different modules of*Melaleucabracteata*are presented in Table 2 and 3.

Comment [r6]: Define modules in materials and methods

Pulsing solutions

Vase life of *Melaleuca* was significantly influenced by the pulsing treatments (A), but non-significant with modules (B) and interactions (AxB) (Table 2).

Among the different modules the longest vase life (8.17 days) of leaves was recorded in Module VIfollowed by Module V (8.09 days) and shortest in Module I (7.45 days).

The longest vase life (9.60 days) was recorded in T_{18} (Sucrose (2%) + $Al_2(SO_4)_3$@200ppm) followed by T_{12} (Sucrose (2%) + BA @50ppm) (8.81 days) and lowest (6.92 days) was recorded in T_{22} (distilled water) among different pulsing solutions.

Among the interactions longest vase life (9.89 days) was recorded in the treatment combination of M_6T_{18} (Module-VI with Sucrose (2%) + $Al_2(SO_4)_3$@ 200ppm) followed by the treatment M_6T_{12} (Module-VI withSucrose (2%) + BA @50ppm) (9.10 days) and the lowest days (7.40 days) was recorded in the treatment combination M_6T_{22} (Module-VI with distilled water).

Holding solutions

Vase life of *Melaleuca* was significantly influenced by the holding treatments (A), but non-significant with modules (B) and interactions (AxB) (Table 3).

Among the different modules the longest vase life (8.15 days) of leaves was recorded in Module VIfollowed by Module V (8.02 days) and shortest in Module I (7.24 days).

The longest vase life (8.74 days) was recorded in T_8 (Sodium Benzoate@150ppm) followed by T_7 (Sodium Benzoate@100ppm) (8.56 days) and lowest (6.87 days) was recorded in T_{18} (distilled water) among different holding solutions.

Among the interactions longest vase life (9.10 days) was recorded in the treatment combination of M_6T_8 (Module-VI + Sodium Benzoate@150ppm)) followed by the treatment M_6T_7 (Module-VI +Sodium Benzoate (100ppm)) (9.02 days) and the lowest days (7.28 days) was recorded in the treatment combination M_6T_{18} (Module-VI +distilled water)

Table 2: Effect of pulsing solution on vase life in different modules of *Melaleuca bracteata*

	Treatments (A)	Vase life (Days)						
		Modules (B)						
		M_1	**M_2**	**M_3**	**M_4**	**M_5**	**M_6**	**Mean**
T_1	BA (25ppm)	8.22	8.39	8.50	8.69	8.76	8.83	**8.57**

T_2	BA (50ppm)	8.32	8.59	8.72	8.83	8.91	8.97	**8.72**
T_3	GA_3 (25ppm)	7.00	7.06	7.12	7.30	7.38	7.46	**7.22**
T_4	GA_3 (50ppm)	6.00	6.11	7.21	7.31	7.38	7.49	**6.92**
T_5	8-HQS (100ppm)	7.11	7.26	7.40	7.48	7.54	7.65	**7.41**
T_6	8-HQS (200ppm)	6.99	7.03	7.19	7.30	7.39	7.46	**7.23**
T_7	$Al_2(SO_4)_3$ (100ppm)	7.69	7.74	7.98	8.17	8.20	8.25	**8.01**
T_8	$Al_2(SO_4)_3$ (200ppm)	7.69	7.81	7.99	8.21	8.30	8.36	**8.06**
T_9	NaOCl (50ppm)	6.71	6.87	7.04	7.18	7.29	7.39	**7.08**
T_{10}	NaOCl (100ppm)	6.82	6.91	7.06	7.28	7.34	7.40	**7.14**
T_{11}	Sucrose (2%) + BA (25ppm)	8.35	8.58	8.73	8.87	8.98	9.02	**8.76**
T_{12}	Sucrose (2%) + BA (50ppm)	8.36	8.69	8.83	8.90	9.00	**9.10**	**8.81**
T_{13}	Sucrose (2%) + GA_3 (25ppm)	6.75	6.99	7.12	7.32	7.41	7.49	**7.18**
T_{14}	Sucrose (2%) + GA_3 (50ppm)	7.02	7.20	7.35	7.45	7.50	7.59	**7.35**
T_{15}	Sucrose (2%) + 8-HQS (100ppm)	7.76	7.98	8.13	8.31	8.40	8.46	**8.17**
T_{16}	Sucrose (2%) + 8-HQS (200ppm)	7.98	8.11	8.37	8.49	8.59	8.65	**8.37**
T_{17}	Sucrose (2%) + $Al_2(SO_4)_3$ (100ppm)	8.01	8.21	8.58	8.74	8.81	8.86	**8.54**
T_{18}	Sucrose (2%) + $Al_2(SO_4)_3$ (200ppm)	9.19	9.43	9.57	9.72	9.80	**9.89**	**9.60**
T_{19}	Sucrose (2%) + NaOCl (50ppm)	7.02	7.32	7.57	7.97	8.07	8.14	**7.68**
T_{20}	Sucrose (2%) + NaOCl (100ppm)	7.01	7.20	7.42	7.61	7.70	7.79	**7.46**
T_{21}	Sucrose (2%)	7.19	7.47	7.69	7.84	7.92	8.00	**7.69**
T_{22}	Control (Distilled water)	6.67	6.87	7.05	7.24	7.33	**7.40**	**7.09**
	Mean	**7.45**	**7.63**	**7.85**	**8.01**	**8.09**	**8.17**	
		A	**B**	**A x B**				
	SE (m)±	0.354	0.238	0.868				
	CD (5%)	0.698	NA	NA				

M_6- Spacing - 210cm X 210cm; Pit size - 60 cm^3; FYM - 25Kg/pit; Basal fertilizer dose - N:P_2O_5: K_2O @ 40:40:40 g /plant; Fertilizer-19:19:19@0.2% and BAP- 150 ppm.

Table 3: Effect of holding solution on vase life in different modules of *Melaleuca bracteata*

	Treatments (A)	Vase life (Days)						
		Modules (B)						
		M_1	M_2	M_3	M_4	M_5	M_6	Mean
T_1	NaOCl (25ppm)	6.12	6.67	6.89	7.04	7.21	7.31	**6.87**
T_2	NaOCl (50ppm)	6.52	6.69	6.83	7.00	7.20	7.29	**6.92**
T_3	$Al_2(SO_4)_3$ (200ppm)	7.64	7.80	7.89	8.01	8.14	8.22	**7.95**
T_4	$Al_2(SO_4)_3$ (300ppm)	7.39	7.58	7.76	7.93	8.03	8.17	**7.81**
T_5	Citric acid (200ppm)	6.76	6.99	7.20	7.39	7.57	7.76	**7.28**
T_6	Citric acid (300ppm)	6.53	6.80	6.99	7.17	7.39	7.53	**7.07**
T_7	Sodium Benzoate (100ppm)	7.99	8.21	8.54	8.70	8.89	**9.02**	**8.56**
T_8	Sodium Benzoate (150ppm)	8.31	8.58	8.70	8.81	8.96	**9.10**	**8.74**
T_9	Sucrose (2%) + NaOCl (25ppm)	7.03	7.35	7.59	7.77	7.90	8.08	**7.62**
T_{10}	Sucrose (2%) + NaOCl (50ppm)	7.00	7.29	7.50	7.63	7.85	8.00	**7.55**
T_{11}	Sucrose (2%) + $Al_2(SO_4)_3$ (200ppm)	7.41	7.68	7.83	8.01	8.19	8.30	**7.90**
T_{12}	Sucrose (2%) + $Al_2(SO_4)_3$ (300ppm)	8.08	8.32	8.50	8.69	8.83	8.98	**8.57**
T_{13}	Sucrose (2%) + Citric acid (200ppm)	7.67	7.81	8.04	8.15	8.31	8.47	**8.08**
T_{14}	Sucrose (2%) + Citric acid (300ppm)	7.74	8.00	8.28	8.41	8.53	8.67	**8.27**
T_{15}	Sucrose (2%) + Sodium Benzoate (100ppm)	7.42	7.75	7.98	8.10	8.26	8.34	**7.98**
T_{16}	Sucrose (2%) + Sodium Benzoate (150ppm)	7.89	8.10	8.34	8.50	8.68	8.79	**8.38**
T_{17}	Sucrose (2%)	6.40	6.69	6.95	7.07	7.21	7.35	**6.95**
T_{18}	Control (Distilled water)	6.46	6.76	6.90	7.01	7.15	**7.28**	**6.93**
	Mean	**7.24**	**7.50**	**7.71**	**7.86**	**8.02**	**8.15**	
		A	**B**	**A x B**				
	SE (m)±	0.241	0.291	0.590				
	CD (5%)	0.672	NA	NA				

M_6- Spacing - 210cm X 210cm; Pit size - 60 cm^3; FYM - 25Kg/pit; Basal fertilizer dose - N:P_2O_5: K_2O @ 40:40:40 g /plant; Fertilizer-19:19:19@0.2% and BAP- 150 ppm.

Discussion

Comment [r7]: Discussion part needs more elaboration and support with reasoning

The longer vase life might be due to optimum availability of nutrients and higher level of potash. Since, potash enhances the synthesis metabolism and translocation of carbohydrates, synthesis of protein with rapid cell division and differentiation, which results in better

postharvest life of flowers (Pal and Kumar 2004).Supplementation of sucrose in the vase solution increased the carbohydrate level in the plant tissue, which helped to carry out metabolic activity thereby extending longevity of twigs.

Vase life of twigs treated with aluminiumsulphate in combination with sucrose was longer as compared to control. This might be attributed toantimicrobial property of aluminium sulphate whichacidified the vase solution and reduced the microbial Growth (Hassanpour*et al*. 2004). Aluminium sulphate ($Al_2(SO_4)_3$), an antimicrobial compound has been recommended in commercial preservative solutions for increasing vase life of several cut flowers (Ichimura*et al*. 2006). Similar results were observed in Lilium by Anil *et al.*(2016) and in rose by Maryam *et al.*(2012).Sodium benzoate possesses antimicrobial properties and this can be the cause of vase life extension of Melaleuca twigs. Sodium benzoate as an antifungal compound reduces microorganism's activity and bacterial contamination in vase solution (Oraee*et al.* 2011).

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