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Dr. Preeti Hatibarua
Professor, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India

Dr. Madhumita Choudhury Talukdar
Professor, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India

Dr. Sangita Mahanta
Assistant Professor, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India

Dr. Ruby Sarmah
Assistant Professor, College of Horticulture & FSR, Assam Agricultural University, Jorhat, Assam, India

Kankana Deka
Assistant Professor, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India

Jugabrata Das
Assistant Professor, College of Horticulture & FSR, Assam Agricultural University, Jorhat, Assam, India

Corresponding Author:
Dr. Preeti Hatibarua
Professor, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India

Effect of different wet packaging methods on flower quality of Anthurium for long distance transportation

Dr. Preeti Hatibarua, Dr. Madhumita Choudhury Talukdar, Dr. Sangita Mahanta, Dr. Ruby Sarmah, Kankana Deka and Jugabrata Das

Abstract
An experiment was conducted in Department of Horticulture, Assam Agricultural University, Jorhat during 2018-19 to examine the effects of different wet packing methods on post-harvest quality of cut Anthurium *cv* 'Tropical Red'. The main aim of the work was to develop a cost-effective storage protocol to reduce the postharvest losses during transportation of cut flowers of Anthurium. The best flower turgidity without mechanical damages can be obtained under wet storage or a wet transportation method, *i.e*., when stem bases of flowers are stored in a container with water or with a floral preservative solution. In this study, cut anthurium flowers were wet transported with their stem bases kept in the holding solution (Aluminium sulphate 300 ppm) in nine different wet packing methods then packed in CFB boxes which were kept upright during the 10 hrs. transport period in AC van. The best results were found in cut anthurium flowers kept in the holding solution in rubber balloon tied with rubber band (T2) and Polythene tube tied with rubber band (T9) which showed delayed appearance of senescence symptoms (peduncle browning, loss of spathe glossiness, spadix blackening/necrosis and spathe discoloration/blueing) and longest vase life.

Keywords: Aluminium sulphate, Anthurium, holding solution, vase life, wet packaging

1. Introduction
The vibrant coloured spathe, the different sizes of flowers, long vase life, and the attractive foliage of Anthurium (*Anthurium andraeanum* Lind) have made it one of the most popular tropical cut flowers and contributing significantly to the floriculture business. Due to their unique characteristics, cut anthurium flowers are adored all over the world, but dry transporting them to other countries is challenging. Furthermore, a number of critical factors, such as temperature and moisture, influence the quality and freshness of the flowers during dry transport. Dry transportation may cause water stress due to vascular blockage of stems caused by microbial growth and entry of air bubbles through the cut ends, which may hamper the uptake of water or preservative solution in the vase, ultimately reducing vase life considerably. In order to satisfy consumer demands for a longer vase life, the problem must be overcome. Though, dry handling during transportation has several advantages, including better space utilisation because more stems are stored per unit area in the cold store or cargo space, resulting in lower costs due to reduced labour and water usage (Macnish *et al*., 2009; Mosqueda-Lazcares *et al*., 2011) [4, 5]. However, some species, such as dahlia (*Dahlia hybrida)*, freesia (*Freesia hybrida*), gerbera (*Gerbera jamesonii*), and gypsophila (*Gypsophila elegans*), are not tolerant of dry transportation (Nowak and Rudnicki, 1990) [6].
In this experiment the cut Anthuriums were immersed in preservative solution to evaluate the effect of different wet packing methods on shelf life of Anthurium during transit. Since flowers are transported in life-giving water or a preservative solution, it is believed that they arrive at their destination in the best condition possible when they are shipped in "wet packs." Hence the present investigation was conducted to evaluate the effect of different wet packing methods on flower quality of cut Anthurium for long distance transportation.

2. Materials and Methods
An experiment was conducted in Department of Horticulture, Assam Agricultural University, Jorhat during 2018-19 to examine the effects of different wet packing methods on post-harvest quality of cut Anthurium *cv* 'Tropical Red'.

In this study, cut anthurium flowers were wet transported with their stem bases kept in the holding solution (Aluminium Sulphate 300 ppm) in nine different wet packing materials *viz*., homoeopathic plastic vial, rubber balloon, cotton wool wrapped in aluminium foil, floral foam wrapped in aluminium foil, tissue paper in earthen thumb pot wrapped in aluminium foil, Hydrogel in earthen thumb pot, Tissue paper wrapped in PP-piece, PP 100 tube etc. Uniform amount of holding solution (15 ml) was used for each stem. These nine treatments were tested against control *i.e* spathes wrapped in 100-gauge polyethylene and dry transported after packing. The cut flowers of all the treatments along with control were finally packed in CFB boxes with side perforations in upright position and transported to HRS, Kahikuchi, Guwahati from AAU, Jorhat in AC van which took 10 hrs. On arrival at the final destination, the cut flowers were taken out and 1 cm of the basal stem ends were cut, initial fresh weight of each cut stems were recorded and dipped in conical flask containing 250 ml of 5% sucrose solution before recording observations.

3. Result and Discussion

The anthurium spathes in treatments T2 (holding solution Aluminium sulphate 300 ppm in rubber balloon + rubber band) and T9 (polythene tube + rubber band) showed delayed appearance of senescence symptoms *viz.* peduncle browning (8.2 days and 8.22 days after harvesting), loss of spathe glossiness (15.20 and 15.60 days, respectively), spadix blackening/necrosis (19.57 and 18.20 days, respectively), and spathe discoloration/blueing (18.44 and 18.50 days, respectively) followed by T1 (stem end in Aluminium sulphate 300 ppm in plastic vial) and were significantly superior to the rest of the treatments. In treatments, T2, T9 and T1 showed delayed senescence symptoms due to the packaging material's ability to hold the preservative solution for a long time and the flowers remain fresh and turgid since they were not subjected to water stress. In this study, solution uptake by flowers treated with aluminium sulphate as holding solution during transit in combination with 5% sucrose solution as vase solution was higher compared to control. This might be attributed to antimicrobial property of aluminium sulphate which acidified the vase solution and reduced the microbial growth (Singh *et al.* 2016) [1]. Studies by Jowkar *et al.* (2012) [2] also found that aluminum sulfate treatment of anthurium cut flowers significantly extended vase life and improved postharvest visual quality by retaining freshness even at the end of vase life. The vase solution used was 5% sucrose since sucrose acts as a source of energy for the continuation of vase life of the cut flowers as well as improving the keeping quality of the Anthurium cut flowers. Sucrose can act as a source of nutrition for tissues approaching carbohydrate starvation, as well as assist with flower opening and water relations. (Kuiper *et al*., 1995) [3].

Table 1: Different wet packing methods

Treatments	Holding solution + Wet packing materials
T1	Aluminium sulphate 300 ppm + homoeopathic plastic vial
T2	Aluminium sulphate 300 ppm + rubber balloon
T3	Aluminium sulphate 300 ppm in cotton wool + aluminium foil
T4	Aluminium sulphate 300 ppm in floral foam + aluminium foil
T5	Tissue paper soaked Aluminium sulphate 300 ppm + aluminium foil
T6	Hydrogel soaked in Aluminium sulphate 300 ppm + earthen thumb pot
T7	Tissue paper soaked in Aluminium sulphate 300 ppm + wrapped in PP-100
T8	Tissue paper soaked in Aluminium sulphate 300 ppm + earthen thumb pot
T9	Aluminium sulphate 300 ppm + PP-100 tube
T10	1 hour in water + 100-gauge polyethylene + dry transported

Table 2: Effect of different wet packaging methods on flower quality parameters of cut Anthurium spikes during long distance transportation

Treatments	Loss of spa the glossiness (days)	Spadix blackening (days)	Spathe bluing (days)	Economic vase life (days)	Water absorbed (ml)	Loss in weight (%)	Total vase life (days)	Peduncle browning (days)
T1 AS 300ppm + plastic vial	14.20	16.6	16.2	16.00	8.87	8.11	20.67	8.43
T2 AS 300ppm +Rubber balloon	15.20	19.57	18.44	17.67	10.2	6.55	22.5	8.2
T3 AS 300ppm+ cotton wool + Al foil	6.80	18.2	8.00	11.0	5.8	10.48	12.47	4.87
T4 AS 300ppm + floral foam + aluminium foil	10.18	13.80	8.27	10.75	4.49	9.97	12.00	5.00
T5 AS 300ppm in Tissue paper + Thumb pot	4.60	6.60	5.80	5.67	4.42	11.98	16.67	5.33
T6 AS 300ppm in Hydrogel + earthen thumb pot	9.20	13.60	14.70	12.5	5.6	9.37	12.00	4.88
T7 AS 300ppm in Tissue paper + wrapped in PP-piece	7.60	12.03	15.38	11.67	7.73	10.72	15.53	5.33
T8 AS 300ppm in Tissue paper + earthen thumb pot	8.02	10.40	11.79	10.07	5.07	11.96	13.57	4.53
T9 AS 300ppm in PP-100 tube	15.6	18.20	18.5	17.5	9.83	6.31	23.00	8.22
T10 spathes held in water 1hrs. + dry transported	9.25	12.03	10.07	10.45	4.07	12.06	14.12	4.07
S.Ed. (+)	0.52	0.20	0.28	0.40	0.17	0.17	0.53	NS
CD (5%)	1.10	0.41	0.59	0.85	0.36	0.35	1.12	NS

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