

## **BIBLIOGRAPHY**

CUEBES, DINAH T. OCTOBER 2007. Effect of Conditioning Treatments on the Postharvest Characteristics of Cold Stored Benguet Lily (*Lilium philippensis*) Cutflowers. Benguet State University, La Trinidad, Benguet.

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## **ABSTRACT**

The study was conducted at the Department of Horticulture Postharvest Laboratory Room, College of Agriculture, Benguet State University, La Trinidad, Benguet and at the Benguet State University Postharvest Facilities and Trading Center from May to June 2007.

Cutflowers of Benguet lily harvested at tight bud stage were conditioned with 3 tbsp (30 g) brown sugar, 3 tbsp vinegar (4%), and 1 m Clorox per liter and pulsed for 15 minutes, 30 minutes, 1 hour and 2 hours to determine the effect of pulsing on the postharvest characteristics of cold stored Benguet lily cutflowers.

Results revealed that cutflowers conditioned for 30 minutes had the longest vase life while cutflower held in tap water were the latest to attain full flower opening and showed better leaf and stem quality during the study.

Cutflowers pulsed in lukewarm solution had the longest vase life and were the latest to attain full flower opening, moreover, cutflowers pulsed in warm solution were earliest to attain full flower opening and showed higher degree of stem browning, wilting of petals and yellowing of leaves.

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## INTRODUCTION

Benguet lily belongs to the family *Liliaceae* that are herbaceous perennial plants. It is relative to the equally popular Raster lily (*Lilium longiform*). The distinguishing characteristics between them are, the leaves and flowers of the Benguet Lily are narrower than those of the Easter lily and the can be propagated through bulbs, seeds or bulblets.

The Benguet or mountain lilies are seldom used since they produce one or two flowers per plant and flowering is seasonal due to the absence of technologies in their production management. It was introduced to be the flower of Benguet, described as having round bulbs, erect stems, linear shaped leaves and profusely flowering during the months of July and August. The flowers measure 5-7 cm long with either one or two blossoms on a stalk. The seeds are born on the seed pod, which develops after the flowers had wilted.

Benguet lily plants became endangered species due to continued collection of the plant from its native habitat and lack of local domestication efforts. It is considered a very delicate flower and said to die if it is taken from its natural habitat. Postharvest studies on this delicate flower moreover were not yet available, hence, this study.

This study was conducted at the Department of Horticulture Postharvest Service Laboratory and Postharvest Facilities and Trading Center, College of Agriculture, Benguet State University, La Trinidad Benguet from May to June 2007 to determine the post harvest characteristics of Benguet lily as affected by duration of conditioning after cold storage and determine the temperature of conditioning solution on the postharvest characteristics of Benguet lily.



## **REVIEW OF LITERATURE**

### Quality of Cutflowers

Quality refers to all the attributes that make a commodity what it is. These attributes are ascribed to the commodity relative to standard of excellence and which has significance in determining the acceptability of the user (Bautista, 1983 ). Aspects quality are appearance, texture, flavor, nutritional, and safety factors. Appearance includes size, shape, form and freedom from damage caused by pests or adverse environmental conditions.

Waters (1966) concluded that proper storage methods, and postharvest procedures can extend vase life, but if not used correctly they may reduce vase life.

### Deterioration of Cutflower

Deterioration of cut flowers includes wilting of the cut flowers and senescence. The main reason for the failure of cut flowers to develop and survive as intact flower is lack of sufficient carbohydrates and water absorption due to stem blockage (Halevy and Mayak, 1974). Stem blockages in cut flowers has attributed by many workers as physiological and microbial-induced (Rogers,1973).

Rimando (1980) stated that the loss of turgidity, exposure to ethylene, and shortage respirable substances are the most decisive factor, which may trigger the onset of senescence of cutflower at any stage of their development whether they are still attached or already detached from the plant.

Hornet (1998) stated that microbial activities cause rotting and deterioration of the stem ends are active in solution that provides food for them.



### Pulsing

Pulsing is a process by which cut flowers absorb sugar for about 24 hours through their stem ends. Sugar for pulsing is several times higher than those used in preservative formulations. Pulsing provides the flower with sufficient nourishment to last them for their entire vase life, even when they are later held in the holding solution (Bautista, 1983).

The chemical solution and environment conditions used for bud opening are identical with those of pulsing, but since the time required for opening is much longer (several days) than that of pulsing. The sugar concentration for pulsing and the optimal temperature maybe somewhat lower. Too high concentrations may cause desiccation of tender foliage like that of chrysanthemum, because of accumulation in the free space (Halevy and Mayak, 1974). Similarly, Farnham (1979) found pulsing at too high temperature may damage the flowers or leaves.

Holding solution containing sugar provides substrate for respiration and an acidifying agent which help minimize microbial build up. Sucrose is known to enhance the water capacity of the tissues as well as provides additional nutrient necessary for further flower ginning (Alacyang, 1998).

### Methods to Prolong Postharvest of Cutflowers

Handling the cut flowers carefully can avoid breakage and bruising injury (Whealy, 1992). Physiological disorder acquired during handling affects quality of cutflowers (Janick, 1972). Injury results in deterioration of quality and appearance. In preparing lined-up by inverting stems and bunching heads on the surface, smashing the cutflowers



must be avoided. Re-cutting the stems and placing the ethylene absorbent in the package to maintain and prolong quality is recommended (Whealy, 1992).

Rimando (1980) stated that the loss of turgidity, exposure to ethylene, and shortage respirable substances are the most decisive factor, which may trigger the onset of senescence of cutflower at any stage of their development whether they are still attached or already detached from the plant.

Kofranek and Halevey (1972) stated that proper storage method and postharvest procedure can extend vase life. Although the storage life of freshly harvested cutflowers is usually prolonged at temperature near 0°C, many horticultural crops of tropical and subtropical in origin are sensitive to chilling and are injured if held at non-freezing temperature below 12°C.

#### Longevity of the Cutflowers

It is correlated with carbohydrate level in the flowers at various development stages. The bud stage is preferred harvesting stage due to convenience in handling and less susceptibility to adverse environmental conditions like high temperatures and ethylene (Rogers, 1973).

Whealy (1992) stated that 33-34°F, good air circulation and high relative humidity (90-95%) during storage and shipping reduces the production of ethylene, rate of senescence is reduced. At low temperature, open flowers can be stored within a maximum of 2-3 weeks.

Fungal spores are relatively inactive at about 6°C but once temperature become favorable, these multiply rapidly. Fungal spores germinate readily in the presence of free water on plant surfaces. Thus relative humidity and temperature need to be controlled



(Rimando,1996).

### Use of Preservatives

Preservatives are chemicals use to prolong the post harvest life of cut flowers and maintain the aesthetic value and quality of cut flowers for a longer period (Rimando, 1982).

It is important in maintaining water uptake in longer time preventing wilting and desiccation on the stems before the flower is fully opened (Rogers, 1973). Hans *et al.* (1992) added that preservatives also help in further development and opening of flower buds.

Special handling techniques are needed to improve cutflower visual quality and postharvest at selling time. These are conditioning, opening and pulsing (Rimando, 1996).

Rogers (1973) observed that chemical preservatives were used to maintain flower quality and extend vase life of cutflowers. They were also used as opening solutions for flowers at immature stage but excess chemicals added to the vase solutions may lead to early deterioration.

### Conditioning

Conditioning refers to the practice of the rehydration of the tissues resulting in a faster recovery from wilting. It is done by either re-cutting the stem ends by about 3-4 cm or by placing them in the preservatives or warm water for at least 2 hours before arranging in a vase.

Conditioning of cutflowers with silver thiosulfate treatment and sucrose reduced





fungus and bacterial infections. Fungal and bacterial contaminations reduce uptake due to the plugging of the vascular system (Whealy, 1992).



## MATERIALS AND METHODS

### Materials

The materials in the study were cutflowers of Benguet Lily harvested at 50% anthesis, catsup bottles, distilled water, sucrose (table sugar), pruning shear, thermometer, foot rule, graduated cylinder, Chlorox, vinegar, and cold room.

### Methods

Experimental design and treatments. The experiment was laid out in factorial completely randomized design (CRD) with duration of conditioning as factor A and the temperature of conditioning solution as factor B with three samples per replicate replicated three times. The different treatments were as follows:

#### Factor A

#### Duration of Conditioning

|                |            |
|----------------|------------|
| P <sub>1</sub> | Control    |
| P <sub>2</sub> | 15 minutes |
| P <sub>3</sub> | 30 minutes |
| P <sub>4</sub> | 1 hour     |
| P <sub>5</sub> | 2 hours    |

#### Factor B

#### Temperature of Pulsing Solution

|                |                              |
|----------------|------------------------------|
| T <sub>1</sub> | Ambient (20 <sup>0</sup> C)  |
| T <sub>2</sub> | Lukewarm (30 <sup>0</sup> C) |
| T <sub>3</sub> | Warm (45 <sup>0</sup> C)     |

Benguet lily cutflowers were harvested at close-bud stage and was brought immediately to the Horticulture Laboratory Room at the College of Agriculture Complex, Benguet State University for the conduct of the study.

Before the cold storage treatment, the leaves at the lower 1/3 of the stem of the Benguet lily cutflowers were removed. All cut flowers have a uniform length of 40 cm. The cutflowers were cold stored (dry-pack condition) for 2 weeks at 2<sup>0</sup>C before conditioning treatments was done where the stem-end of the cut flowers were re-cut (2.5 cm) in a slanting manner. The conditioning solution was 3 tbsp (30 g) brown sugar, 3 tbsp vinegar (4%) and 1 ml Chlorox per liter solution.

The data that was gathered and was subjected to variance analysis and mean separation test by Duncan's multiple range test (DMRT) were as follows:

1. Vaselife. This was obtained by number of days covering the period from holding of the cut flowers in the solution up to the termination of the aesthetic value of the flower.
2. Number of days from holding to full flower opening (100% anthesis). This was done by recording the number of days from holding to full flower opening.
3. Visual quality rating(VQR). It was taken daily until the onset of senescence.

a. Stern quality

| <u>Index</u> | <u>Description</u>                              |
|--------------|---|
| 1            | No browning                                     |
| 2            | Up to 2.0 cm browning from the base of the stem |
| 3            | Up to 4.0 cm browning from the base of the stem |
| 4            | Up to 6.0 cm browning from the base of the stem |

b. Flower quality



| <u>Index</u> | <u>Description</u>                 |
|--------------|------------------------------------|
| 1            | Excellent, field fresh, no defects |
| 2            | 1 petal wilted                     |
| 3            | 2 petals wilted                    |
| 4            | 3 petals wilted                    |
| 5            | 4 petals wilted                    |

c. Leaf quality

| <u>Index</u> | <u>Description</u>                 |
|--------------|------------------------------------|
| 1            | Excellent, field fresh, no defects |
| 2            | Yellowing of 2 leaves              |
| 3            | Yellowing of 3 leaves              |
| 4            | Yellowing of 4 leaves              |
| 5            | Yellowing of 5 leaves              |

4. Documentation by pictures.



## RESULTS AND DISCUSSION

### Vaselife

Effect of conditioning duration. Significant differences were observed on the vaselife of cutflowers conditioning durations (Table 1). Results showed that cutflowers conditioned for 30 minutes had significantly the longest vaselife with a mean of 11.04 days although comparable with those cutflowers held for 15 minutes and 1 hour while the shortest vaselife were observed on the cutflowers that were conditioned for 2 hours with a mean of 8.00 days. It was further observed that longer duration of conditioning tended to shorten vaselife.

Kofranek and Halevy (1972) stated that proper storage method and postharvest procedure can extend vaselife. Although the storage life of freshly harvested cutflowers is usually prolonged at temperature near 0°C, many horticultural crops of tropical and subtropical in origin are sensitive to chilling and are injured if held at non-freezing temperature below 12°C.

Table 1. Vaselife

| TREATMENT                              | MEAN (days) |
|--|-------------|
| <u>Duration of Conditioning</u>        |             |
| Control                                | 9.67b       |
| 15 minutes                             | 10.07ab     |
| 30 minutes                             | 11.04a      |
| 1 hour                                 | 9.78ab      |
| 2 hours                                | 8.00b       |
| <u>Temperature of Pulsing solution</u> |             |
| Ambient (20°C)                         | 9.78b       |
| Lukewarm (30°C)                        | 11.55a      |
| Warm (45°C)                            | 8.40c       |

Means with a common letter are not significantly different at 5% level of DMRT



Effect of pulsing solution temperature. Temperature of pulsing solution significantly affected the vase life of cutflowers as shown in Table 1. It was observed that the cutflowers pulsed with lukewarm solution had the longest vase life with a mean of 11.55 days, while the shortest vase life were the cutflowers pulsed with warm solution with a mean of 8.40 days. Warm solution could have damaged the stem-end of the cutflowers that may prevent absorption of conditioning solution that leads to shorter vase life.

Rimando (1980) stated that the loss of turgidity, exposure to ethylene and shortage respirable substances are the most decisive factor, which may trigger the onset of senescence of cutflower at any stage of their development whether they are still attached or already detached from the plant.

Waters (1966) concluded that proper storage, methods and postharvest procedures can extend vase life, but if not used correctly they may reduce vase life.

Interaction effect. There were significant interaction effect between conditioning duration and pulsing solution temperature on the vase life of Benguet lily cutflowers. (Fig. 2). Cutflowers conditioned for 30 minutes and pulsed in lukewarm solution had the longest vase life of 11.04 days while those conditioned in control (tap water), 15 minutes, 1 hour and 2 hours and pulsed in ambient and warm solution had the shortest vase life of 8.00 and 8.40 days, respectively.

#### Days from Holding to 100% Anthesis

Effect of conditioning duration. Statistical analysis showed significant differences on the number of days from holding to full flower opening as affected by the conditioning duration used as presented in Table 2. Results show that cutflowers held in



tap water only had the longest duration of flower opening with a mean of 6.52 days compared to cutflowers

Table 2. Days from holding to 100% anthesis

| TREATMENT                              | MEAN (days) |
|--|-------------|
| <u>Duration of Conditioning</u>        |             |
| Control                                | 6.52a       |
| 15 minutes                             | 4.00ab      |
| 30 minutes                             | 5.89a       |
| 1 hour                                 | 4.22b       |
| 2 hours                                | 3.78b       |
| <u>Temperature of Pulsing solution</u> |             |
| Ambient (20 <sup>0</sup> C)            | 5.20a       |
| Lukewarm (30 <sup>0</sup> C)           | 6.20a       |
| Warm (45 <sup>0</sup> C)               | 3.85b       |

Means with a common letter are not significantly different at 5% level of DMRT

conditioned for 2 hours which attained flower opening after 3.78 days. It was further observed that longer duration of conditioning tended to enhance faster flower opening of Benguet lily cutflowers.

Holding solution containing sugar provides substrates for respiration and acidifying agent which minimize microbial build up. Sucrose is known to enhance the water capacity of the tissues as well as provides additional nutrient necessary for further flower opening (Alacyang, 1998).

Effect of pulsing solution temperature. Table 2 shows that cutflowers pulsed in warm solution had the fastest flower opening with a mean of 3.85 days as compared to cutflowers that were pulsed in lukewarm solution which had the longest flower opening having a mean of 6.20 days. Results showed that cutflowers held in lukewarm conditioning solution had significantly longer flower opening of 6.20 days although



comparable with those cutflowers pulsed with ambient solution while those cutflowers held in warm conditioning solution and significantly earlier flower opening after 3.85 days. It was noted that warm conditioning solutions tended to enhance flower opening of Benguet lily cutflowers.

Interaction effect. There were significant interaction effect between conditioning duration and pulsing solution temperature. With regards to number of days from holding to full flower opening, cutflowers held in tap water which was the control had the longest duration of flower opening and those pulsed in warm solution were the earliest to attain 100% flower opening (Fig. 3).

### Stem Quality

Effect of conditioning duration. Table 3 shows that there were no significant differences observed on the effect of conditioning duration on the stem quality rating of Benguet lily cutflowers which means that from day 1 to day 10, stem quality in all treatments were comparable. Unconditioned cutflowers or control obtained lesser degree of stem damage.

Table 3. Stem quality rating

| TREATMENT                       | DAYS  |       |
|---------------------------------|-------|-------|
|                                 | 9     | 10    |
| <u>Duration of Conditioning</u> |       |       |
| Control                         | 1.78a | 2.30a |
| 15 minutes                      | 2.60a | 2.78a |
| 30 minutes                      | 2.30a | 2.60a |
| 1 hour                          | 2.18a | 2.44a |
| 2 hours                         | 2.60a | 2.78a |

### Temperature of Pulsing solution





|                              |       |       |
|------------------------------|-------|-------|
| Ambient (20 <sup>0</sup> C)  | 2.33a | 2.18a |
| Lukewarm (30 <sup>0</sup> C) | 2.36a | 2.53a |
| Warm (45 <sup>0</sup> C)     | 2.18a | 2.40a |

In a column, means with a common letter are not significantly different at 5% level of DMRT

The stem browning was caused by the gradual blockage of the xylem elements by microorganisms (Rimando, 1980). These results were due to the presence of microorganisms causing rotting and injury of the stem.

Effect of pulsing solution temperature. No significant differences were observed from day 1 to day 10 with regards to the effect of pulsing solution temperature on the stem quality rating (Table 3). However, results show that cutflowers pulsed in lukewarm had the higher degree of stem browning as compared to those pulsed in ambient and lukewarm solution on which had lesser degree of stem browning.

Hornet (1998) stated that microbial activities cause rotting and deterioration of the stem ends are active in solution that provides food for them.

Interaction effect. There were no significant effects between conditioning duration and temperature of pulsing solution on the stem quality of Benguet lily cutflowers throughout the study. However, with regards to the effect of pulsing solution temperature, cutflowers that were pulsed in warm solution obtained the higher degree of stem browning as compared to those pulsed in ambient and lukewarm solution.

### Flower Quality

Effect of conditioning duration. Table 4 shows that there were no significant differences on the flower quality on day 1, 9, 10 and 11. However, on day 8 and 12 cutflower conditioned for 15 minutes had lesser petals wilted with a mean of 2.00 while those conditioned for 1 hour had poorer quality of petals wilted with a mean of 5.00.



Result further show that the shorter the duration of conditioning tended to have better flower quality than those conditioned with longer duration of conditioning.

Table 4. Flower quality rating

| TREATMENT                              | DAYS  |       |       |       |       |
|--|-------|-------|-------|-------|-------|
|  | 8     | 9     | 10    | 11    | 12    |
| <u>Duration of Conditioning</u>        |       |       |       |       |       |
| Control                                | 2.07b | 2.33a | 2.15a | 2.26a | 3.56b |
| 15 minutes                             | 2.00b | 2.15a | 2.69a | 2.70a | 3.37b |
| 30 minutes                             | 2.78a | 2.39a | 2.17a | 2.67a | 4.67a |
| 1 hour                                 | 2.93a | 2.82a | 3.00a | 3.50a | 5.00a |
| 2 hours                                | 1.97a | 2.88a | 3.15a | 3.83a | 4.63a |
| <u>Temperature of Pulsing solution</u> |       |       |       |       |       |
| Ambient (20 <sup>0</sup> C)            | 2.80a | 2.36a | 2.55a | 2.80a | 3.98a |
| Lukewarm (30 <sup>0</sup> C)           | 1.78b | 2.49a | 1.88a | 2.00a | 3.98a |
| Warm (45 <sup>0</sup> C)               | 3.18a | 2.70a | 2.78a | 3.17a | 4.78a |

In a column, means with a common letter are not significantly different at 5% level of DMRT

Conditioning of cutflowers with silver thiosulfate treatment and sucrose reduced fungal and bacterial infections. Fungal and bacterial contaminations reduces uptake due to the plugging of the vascular system (Whealy, 1992).

Effect of pulsing solution temperature. There were no significant differences observed on Benguet lily cutflowers with regards to flower quality as affected by pulsing solution temperature on 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup> and 12<sup>th</sup> day of observation. However, on the 8<sup>th</sup> day of observation cutflowers pulsed in warm solution obtained the highest degree of petals wilted as compared to cutflowers pulsed in ambient and lukewarm solution. This implies that cutflowers that were pulsed in ambient and lukewarm solution had better flower quality.



(Rogers, 1973) observed that chemical preservatives were used to maintain flower quality and extend vase life of cutflowers. They were also used as opening solutions for flowers at immature stage but excess chemicals added to the vase solutions may lead to early deterioration.

Interaction effect. Figs. 4-6 showed that cutflowers conditioned for 15 minutes in lukewarm solution, on day 8 obtained less petals wilted as compared to the other duration of conditioning, on the other hand, cutflowers pulsed in warm solution conditioned for 1 hour had the highest degree of petals wilted while those that pulsed with lukewarm and ambient solution obtained least degree of petals wilted.

### Leaf Quality

Effect of conditioning duration. Significant differences were observed on the leaf quality of Benguet lily cutflowers as affected by conditioning duration (Table 5). Cutflowers that were not conditioned or the control showed better leaf quality on the 3<sup>rd</sup> day of observation with a mean rating of 1.26 days as compared to the other duration of conditioning. On the last day of observation the degree of leaf yellowing was almost similar on those 6 and 8 days. It was observed that tap water (control) enhances better leaf quality

Table 5. Leaf quality rating

| TREATMENT                       | DAYS   |       |       |       |        |
|---------------------------------|--------|-------|-------|-------|--------|
|                                 | 3      | 4     | 6     | 8     | 10     |
| <u>Duration of Conditioning</u> |        |       |       |       |        |
| Control                         | 1.26a  | 1.96a | 2.05a | 2.31a | 1.91b  |
| 15 minutes                      | 1.70ab | 2.72a | 2.24a | 2.65a | 3.02ab |
| 30 minutes                      | 2.37a  | 1.94a | 2.39a | 2.54a | 3.60a  |
| 1 hour                          | 1.74b  | 1.69a | 2.28a | 2.39a | 1.76b  |



|  |       |       |       |       |       |
|--|-------|-------|-------|-------|-------|
| 2 hours                                | 1.44b | 2.04a | 2.02a | 3.22a | 3.85a |
| <u>Temperature of Pulsing solution</u> |       |       |       |       |       |
| Ambient (20 <sup>0</sup> C)            | 1.49a | 1.77a | 2.28a | 2.52a | 2.87a |
| Lukewarm (30 <sup>0</sup> C)           | 1.96a | 2.50a | 2.73a | 2.83a | 2.87a |
| Warm (45 <sup>0</sup> C)               | 1.67a | 1.95a | 2.18a | 2.51a | 2.75a |

In a column, means with a common letter are not significantly different at 5% level of DMRT of the cutflowers.

Marousky (1969) mentioned that sucrose induces moisture stress in cutflowers by decreasing the aperture size of leaf stomata. This finding has proven that sucrose solution had also shown to increase cutflowers fresh weight and longevity.

Effect of pulsing solution temperature. There were no significant differences observed on the leaf yellowing as affected by pulsing solution temperature. However, on the 3<sup>rd</sup> day and 4<sup>th</sup> day of observations, cutflowers pulsed in ambient solution showed lesser yellowing of leaves while those pulsed in lukewarm and warm solution showed higher degree of yellowing. It was noted that cutflowers pulsed in ambient solution showed better leaf quality of Benguet lily cutflowers.

Interaction effect. There were no significant interaction effect between the conditioning duration and pulsing solution temperature on the leaf quality rating.



## **SUMMARY, CONCLUSION AND RECOMMENDATION**

### Summary

Benguet lily cutflowers was harvested at close-bud stage. The stem ends were recut in a slanting manner and had a stem length of 40 cm, before the cold storage treatment. The cutflowers were cold stored (dry-pack condition) for 2 weeks at 2<sup>0</sup>C. The stem end of the cutflowers were recut (2.5 cm) in a slanting manner before conditioning treatments and the conditioning solution were 3 tbsp (30 g) brown sugar, 3 tbsp (4%) vinegar and 1 ml Chlorox per liter solution.

Results show that cutflowers conditioned for 30 minutes had the longest vase life. The number of days from holding to full flower opening was delayed in cutflowers held in tap water (control). Unconditioned cutflowers showed better leaf and stem quality rating. On the other hand, cutflowers that were conditioned for 15 minutes obtained least petals wilted.

Benguet lily cutflowers pulsed in lukewarm solution had the longest vase life while those pulsed in ambient and warm solution obtained the shortest vase life. The number of days from holding to full flower opening was faster in cutflowers pulsed in warm solution as compared to those pulsed in lukewarm solution which were the latest to attain 100% anthesis flower opening. Cutflowers pulsed in warm solution showed higher degree of stem browning, wilting of petals and yellowing of leaves was notably observed.

### Conclusion

In order to attain longer vase life of Benguet lily cutflowers must be conditioned



for 30 minutes and pulsed with lukewarm solution. For the number of days from holding to full flower opening it is better to use tap water for conditioning and ambient solution for pulsing. Cutflowers conditioned for 15 minutes and pulsed in lukewarm solution had better flower quality rating, those conditioned in tap water and pulsed in ambient solution obtained better stem and leaf quality rating.

### Recommendation

Based on the findings, to prolong vase life of cold storage Benguet lily cutflowers should be conditioned for 30 minutes and pulsed with lukewarm solution. It is further recommended that cutflowers be conditioned with tap water and pulsed in ambient condition to have longer opening, with better stem and leaf quality rating while 15 minutes conditioning and pulsed in lukewarm solution is recommended for better flower quality rating.



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## APPENDICES

Appendix Table 1. Vaselife (days)

| TREATMENT                     | REPLICATION |       |       | TOTAL | MEAN  |
|-------------------------------|-------------|-------|-------|-------|-------|
|                               | I           | II    | III   |       |       |
| P <sub>1</sub> T <sub>1</sub> | 8.67        | 11.67 | 10.00 | 30.34 | 10.11 |
| P <sub>2</sub> T <sub>1</sub> | 12.33       | 12.33 | 10.67 | 35.33 | 11.78 |
| P <sub>3</sub> T <sub>1</sub> | 12.00       | 8.00  | 8.33  | 28.33 | 9.44  |
| P <sub>4</sub> T <sub>1</sub> | 7.00        | 7.00  | 10.33 | 24.33 | 8.11  |
| P <sub>5</sub> T <sub>1</sub> | 9.00        | 10.00 | 9.33  | 28.33 | 9.44  |
| P <sub>1</sub> T <sub>2</sub> | 11.00       | 12.33 | 11.33 | 34.66 | 11.55 |
| P <sub>2</sub> T <sub>2</sub> | 11.00       | 10.00 | 9.67  | 30.67 | 10.22 |
| P <sub>3</sub> T <sub>2</sub> | 18.00       | 17.33 | 13.33 | 48.66 | 16.22 |
| P <sub>4</sub> T <sub>2</sub> | 11.00       | 11.67 | 12.67 | 35.34 | 11.78 |
| P <sub>5</sub> T <sub>2</sub> | 6.30        | 8.33  | 9.33  | 23.96 | 7.99  |
| P <sub>1</sub> T <sub>3</sub> | 7.67        | 7.33  | 7.00  | 22.00 | 7.33  |
| P <sub>2</sub> T <sub>3</sub> | 9.33        | 7.00  | 8.33  | 24.66 | 8.22  |
| P <sub>3</sub> T <sub>3</sub> | 8.67        | 6.33  | 7.33  | 22.33 | 7.44  |
| P <sub>4</sub> T <sub>3</sub> | 9.67        | 9.33  | 9.33  | 28.33 | 9.44  |
| P <sub>5</sub> T <sub>3</sub> | 9.33        | 10.00 | 9.33  | 28.66 | 9.55  |

### Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 75.002         | 37.501      | 22.03**    | 3.32      | 5.39 |
| Factor B            | 4                  | 19.878         | 4.969       | 2.92*      | 2.69      | 4.02 |
| AB                  | 8                  | 123.930        | 15.491      | 9.10**     | 2.27      | 3.17 |
| Error               | 30                 | 51.078         | 1.703       |            |           |      |
| Total               | 44                 | 269.887        |             |            |           |      |

\* = Significant; \*\* = Highly significant

Coefficient of variation = 13.17%





Appendix Table 2. Number of days from holding to full flower opening

| TREATMENT                     | REPLICATION |       |       | TOTAL | MEAN  |
|-------------------------------|-------------|-------|-------|-------|-------|
|                               | I           | II    | III   |       |       |
| P <sub>1</sub> T <sub>1</sub> | 4.67        | 11.00 | 5.33  | 21.00 | 7.00  |
| P <sub>2</sub> T <sub>1</sub> | 7.33        | 8.33  | 6.67  | 22.33 | 7.44  |
| P <sub>3</sub> T <sub>1</sub> | 7.33        | 3.67  | 2.33  | 13.33 | 4.44  |
| P <sub>4</sub> T <sub>1</sub> | 2.67        | 2.67  | 4.33  | 9.67  | 3.22  |
| P <sub>5</sub> T <sub>1</sub> | 5.00        | 3.67  | 3.00  | 11.67 | 3.89  |
| P <sub>1</sub> T <sub>2</sub> | 7.00        | 8.33  | 6.33  | 21.66 | 7.22  |
| P <sub>2</sub> T <sub>2</sub> | 5.33        | 3.00  | 3.33  | 11.66 | 3.89  |
| P <sub>3</sub> T <sub>2</sub> | 9.00        | 12.00 | 11.00 | 32.00 | 10.66 |
| P <sub>4</sub> T <sub>2</sub> | 4.33        | 6.00  | 7.33  | 17.66 | 5.89  |
| P <sub>5</sub> T <sub>2</sub> | 4.00        | 2.00  | 4.00  | 10.00 | 3.33  |
| P <sub>1</sub> T <sub>3</sub> | 7.00        | 6.33  | 2.67  | 16.00 | 5.33  |
| P <sub>2</sub> T <sub>3</sub> | 4.67        | 2.00  | 4.33  | 11.00 | 3.67  |
| P <sub>3</sub> T <sub>3</sub> | 3.67        | 2.00  | 2.00  | 7.67  | 2.56  |
| P <sub>4</sub> T <sub>3</sub> | 3.33        | 4.00  | 3.33  | 10.66 | 3.55  |
| P <sub>5</sub> T <sub>3</sub> | 4.67        | 4.67  | 3.00  | 12.34 | 4.11  |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 41.878         | 20.939      | 7.94**     | 3.32      | 5.39 |
| Factor B            | 4                  | 46.428         | 11.607      | 4.40**     | 2.69      | 4.02 |
| AB                  | 8                  | 113.146        | 14.143      | 5.36**     | 2.27      | 3.17 |
| Error               | 30                 | 79.133         | 2.638       |            |           |      |
| Total               | 44                 | 280.584        |             |            |           |      |

\*\* = Highly significant

Coefficient of variation = 31.96%



Appendix Table 3. Stem quality rating (day 9)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 1.67        | 1.67 | 1.00 | 4.34  | 1.45 |
| P <sub>2</sub> T <sub>1</sub> | 2.00        | 2.33 | 2.67 | 7.00  | 2.33 |
| P <sub>3</sub> T <sub>1</sub> | 1.33        | 2.33 | 2.67 | 6.33  | 2.11 |
| P <sub>4</sub> T <sub>1</sub> | 3.00        | 4.00 | 2.33 | 9.33  | 3.11 |
| P <sub>5</sub> T <sub>1</sub> | 2.33        | 3.67 | 2.00 | 8.00  | 2.67 |
| P <sub>1</sub> T <sub>2</sub> | 2.00        | 1.33 | 1.33 | 4.66  | 1.55 |
| P <sub>2</sub> T <sub>2</sub> | 2.33        | 3.00 | 2.67 | 8.00  | 2.67 |
| P <sub>3</sub> T <sub>2</sub> | 3.33        | 2.00 | 3.00 | 8.33  | 2.78 |
| P <sub>4</sub> T <sub>2</sub> | 1.67        | 1.33 | 3.33 | 6.33  | 2.11 |
| P <sub>5</sub> T <sub>2</sub> | 2.33        | 2.67 | 3.00 | 8.00  | 2.66 |
| P <sub>1</sub> T <sub>3</sub> | 2.33        | 2.67 | 2.00 | 7.00  | 2.33 |
| P <sub>2</sub> T <sub>3</sub> | 2.00        | 3.00 | 3.33 | 8.33  | 2.78 |
| P <sub>3</sub> T <sub>3</sub> | 4.00        | 1.00 | 1.00 | 6.00  | 2.00 |
| P <sub>4</sub> T <sub>3</sub> | 1.00        | 1.00 | 2.00 | 4.00  | 1.33 |
| P <sub>5</sub> T <sub>3</sub> | 3.67        | 2.33 | 1.33 | 7.33  | 2.44 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 0.281          | 0.141       | 0.22ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 4.106          | 1.026       | 1.61ns     | 2.69      | 4.02 |
| AB                  | 8                  | 7.364          | 0.920       | 1.45ns     | 2.27      | 3.17 |
| Error               | 30                 | 19.077         | 0.636       |            |           |      |
| Total               | 44                 | 30.827         |             |            |           |      |

ns = Not significant

variation = 34.85%

Coefficient of



Appendix Table 4. Stem quality rating (day 10)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 4.00        | 1.67 | 1.00 | 6.67  | 2.22 |
| P <sub>2</sub> T <sub>1</sub> | 2.33        | 2.67 | 2.67 | 7.67  | 2.56 |
| P <sub>3</sub> T <sub>1</sub> | 2.00        | 2.67 | 3.00 | 7.67  | 2.56 |
| P <sub>4</sub> T <sub>1</sub> | 3.67        | 4.33 | 2.67 | 10.67 | 3.56 |
| P <sub>5</sub> T <sub>1</sub> | 3.00        | 4.33 | 2.00 | 9.33  | 3.11 |
| P <sub>1</sub> T <sub>2</sub> | 2.33        | 1.67 | 1.67 | 5.67  | 1.89 |
| P <sub>2</sub> T <sub>2</sub> | 2.67        | 3.00 | 2.67 | 8.34  | 2.78 |
| P <sub>3</sub> T <sub>2</sub> | 3.33        | 2.33 | 3.33 | 8.99  | 3.00 |
| P <sub>4</sub> T <sub>2</sub> | 1.67        | 1.67 | 3.33 | 6.67  | 2.22 |
| P <sub>5</sub> T <sub>2</sub> | 2.33        | 3.00 | 3.00 | 8.33  | 2.78 |
| P <sub>1</sub> T <sub>3</sub> | 3.00        | 2.67 | 2.67 | 8.34  | 2.78 |
| P <sub>2</sub> T <sub>3</sub> | 2.33        | 3.33 | 3.33 | 8.99  | 3.00 |
| P <sub>3</sub> T <sub>3</sub> | 4.00        | 1.00 | 1.67 | 6.67  | 2.22 |
| P <sub>4</sub> T <sub>3</sub> | 1.33        | 1.00 | 2.33 | 4.66  | 1.55 |
| P <sub>5</sub> T <sub>3</sub> | 3.00        | 3.00 | 1.33 | 7.33  | 2.44 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 1.252          | 0.626       | 0.88ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 1.583          | 0.396       | 0.56ns     | 2.69      | 4.02 |
| AB                  | 8                  | 8.060          | 1.008       | 1.41ns     | 2.27      | 3.17 |
| Error               | 30                 | 21.368         | 0.712       |            |           |      |
| Total               | 44                 | 32.265         |             |            |           |      |

ns = Not significant

variation = 32.74%

Coefficient of



Appendix Table 5. Flower quality rating (day 8)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 2.33        | 2.33 | 1.00 | 5.66  | 1.89 |
| P <sub>2</sub> T <sub>1</sub> | 1.00        | 1.00 | 1.00 | 3.00  | 1.00 |
| P <sub>3</sub> T <sub>1</sub> | 2.33        | 3.67 | 3.67 | 9.67  | 3.22 |
| P <sub>4</sub> T <sub>1</sub> | 3.67        | 5.00 | 3.67 | 12.34 | 4.11 |
| P <sub>5</sub> T <sub>1</sub> | 3.67        | 3.67 | 4.00 | 11.34 | 3.78 |
| P <sub>1</sub> T <sub>2</sub> | 1.33        | 1.00 | 1.00 | 3.33  | 1.11 |
| P <sub>2</sub> T <sub>2</sub> | 2.00        | 1.00 | 2.00 | 5.00  | 1.67 |
| P <sub>3</sub> T <sub>2</sub> | 1.00        | 1.00 | 1.00 | 3.00  | 1.00 |
| P <sub>4</sub> T <sub>2</sub> | 1.00        | 2.00 | 2.00 | 5.00  | 1.67 |
| P <sub>5</sub> T <sub>2</sub> | 4.00        | 4.00 | 2.33 | 10.33 | 3.44 |
| P <sub>1</sub> T <sub>3</sub> | 2.33        | 3.67 | 3.67 | 9.67  | 3.22 |
| P <sub>2</sub> T <sub>3</sub> | 3.00        | 4.70 | 2.33 | 10.03 | 3.34 |
| P <sub>3</sub> T <sub>3</sub> | 3.33        | 5.00 | 4.00 | 12.33 | 4.11 |
| P <sub>4</sub> T <sub>3</sub> | 2.67        | 2.67 | 3.67 | 9.01  | 3.00 |
| P <sub>5</sub> T <sub>3</sub> | 2.33        | 2.00 | 2.33 | 6.66  | 2.22 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 15.793         | 7.896       | 17.91**    | 3.32      | 5.39 |
| Factor B            | 4                  | 9.644          | 2.411       | 5.47**     | 2.69      | 4.02 |
| AB                  | 8                  | 28.260         | 3.532       | 8.01**     | 2.27      | 3.17 |
| Error               | 30                 | 13.228         | 0.441       |            |           |      |
| Total               | 44                 | 66.924         |             |            |           |      |

\*\* = Highly significant

Coefficient of variation = 25.68%



Appendix Table 6. Flower quality rating (day 9)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 3.00        | 3.00 | 1.67 | 7.67  | 2.56 |
| P <sub>2</sub> T <sub>1</sub> | 1.33        | 1.33 | 3.00 | 5.66  | 1.89 |
| P <sub>3</sub> T <sub>1</sub> | 1.50        | 1.00 | 2.33 | 4.83  | 1.61 |
| P <sub>4</sub> T <sub>1</sub> | 1.67        | 5.00 | 3.00 | 9.67  | 3.22 |
| P <sub>5</sub> T <sub>1</sub> | 1.50        | 3.00 | 3.00 | 7.50  | 2.50 |
| P <sub>1</sub> T <sub>2</sub> | 2.00        | 1.33 | 3.00 | 6.33  | 2.11 |
| P <sub>2</sub> T <sub>2</sub> | 2.33        | 2.67 | 4.00 | 9.00  | 3.00 |
| P <sub>3</sub> T <sub>2</sub> | 3.00        | 3.00 | 1.33 | 7.33  | 2.44 |
| P <sub>4</sub> T <sub>2</sub> | 1.67        | 3.00 | 2.67 | 7.34  | 2.45 |
| P <sub>5</sub> T <sub>2</sub> | 1.33        | 3.00 | 3.00 | 7.33  | 2.44 |
| P <sub>1</sub> T <sub>3</sub> | 1.00        | 3.00 | 3.00 | 7.00  | 2.33 |
| P <sub>2</sub> T <sub>3</sub> | 2.00        | 1.67 | 1.00 | 4.67  | 1.56 |
| P <sub>3</sub> T <sub>3</sub> | 2.67        | 5.00 | 1.67 | 9.34  | 3.11 |
| P <sub>4</sub> T <sub>3</sub> | 1.67        | 4.00 | 2.67 | 8.34  | 2.78 |
| P <sub>5</sub> T <sub>3</sub> | 4.70        | 2.67 | 3.67 | 11.04 | 3.68 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 0.866          | 0.433       | 0.40ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 3.635          | 0.909       | 0.84ns     | 2.69      | 4.02 |
| AB                  | 8                  | 10.104         | 1.263       | 1.16ns     | 2.27      | 3.17 |
| Error               | 30                 | 32.527         | 1.084       |            |           |      |
| Total               | 44                 | 47.132         |             |            |           |      |

ns = Not significant

variation = 41.45%

Coefficient of



Appendix Table 7. Flower quality rating (day 10)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 1.00        | 3.00 | 3.00 | 7.00  | 2.33 |
| P <sub>2</sub> T <sub>1</sub> | 2.00        | 2.67 | 1.33 | 6.00  | 2.00 |
| P <sub>3</sub> T <sub>1</sub> | 1.00        | 1.67 | 1.50 | 4.17  | 1.39 |
| P <sub>4</sub> T <sub>1</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>5</sub> T <sub>1</sub> | 1.33        | 3.00 | 1.67 | 6.00  | 2.00 |
| P <sub>1</sub> T <sub>2</sub> | 2.33        | 1.33 | 1.00 | 4.66  | 1.55 |
| P <sub>2</sub> T <sub>2</sub> | 3.33        | 4.00 | 1.50 | 8.83  | 2.94 |
| P <sub>3</sub> T <sub>2</sub> | 1.33        | 1.00 | 2.00 | 4.33  | 1.44 |
| P <sub>4</sub> T <sub>2</sub> | 2.33        | 1.67 | 1.33 | 5.33  | 1.78 |
| P <sub>5</sub> T <sub>2</sub> | 1.67        | 1.67 | 1.67 | 5.01  | 1.67 |
| P <sub>1</sub> T <sub>3</sub> | 1.67        | 3.00 | 3.00 | 7.67  | 2.55 |
| P <sub>2</sub> T <sub>3</sub> | 3.00        | 5.00 | 1.33 | 9.33  | 3.11 |
| P <sub>3</sub> T <sub>3</sub> | 1.00        | 5.00 | 5.00 | 11.00 | 3.67 |
| P <sub>4</sub> T <sub>3</sub> | 2.00        | 3.00 | 1.67 | 6.67  | 2.22 |
| P <sub>5</sub> T <sub>3</sub> | 1.67        | 2.00 | 3.00 | 6.67  | 2.22 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 6.310          | 3.155       | 3.03ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 6.736          | 1.684       | 1.62ns     | 2.69      | 4.02 |
| AB                  | 8                  | 26.398         | 3.300       | 3.17**     | 2.27      | 3.17 |
| Error               | 30                 | 31.227         | 1.041       |            |           |      |
| Total               | 44                 | 70.671         |             |            |           |      |

ns = Not significant; \*\* = Highly significant

Coefficient of variation = 42.64%



Appendix Table 8. Flower quality rating (day 11)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 1.33        | 1.33 | 1.00 | 3.66  | 1.22 |
| P <sub>2</sub> T <sub>1</sub> | 3.00        | 1.33 | 1.67 | 6.00  | 2.00 |
| P <sub>3</sub> T <sub>1</sub> | 1.00        | 5.00 | 1.67 | 7.67  | 2.56 |
| P <sub>4</sub> T <sub>1</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>5</sub> T <sub>1</sub> | 1.67        | 3.00 | 5.00 | 9.67  | 3.22 |
| P <sub>1</sub> T <sub>2</sub> | 3.00        | 3.00 | 2.67 | 8.67  | 2.89 |
| P <sub>2</sub> T <sub>2</sub> | 2.00        | 5.00 | 1.33 | 8.33  | 2.78 |
| P <sub>3</sub> T <sub>2</sub> | 1.33        | 1.00 | 2.33 | 4.66  | 1.55 |
| P <sub>4</sub> T <sub>2</sub> | 4.33        | 2.00 | 2.00 | 8.33  | 2.78 |
| P <sub>5</sub> T <sub>2</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>1</sub> T <sub>3</sub> | 2.00        | 3.00 | 3.00 | 8.00  | 2.67 |
| P <sub>2</sub> T <sub>3</sub> | 3.00        | 5.00 | 2.00 | 10.00 | 3.33 |
| P <sub>3</sub> T <sub>3</sub> | 1.67        | 5.00 | 5.00 | 11.67 | 3.89 |
| P <sub>4</sub> T <sub>3</sub> | 1.50        | 1.67 | 5.00 | 8.17  | 2.72 |
| P <sub>5</sub> T <sub>3</sub> | 5.00        | 3.33 | 1.50 | 9.83  | 3.28 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 1.073          | 0.536       | 0.29ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 15.233         | 3.808       | 2.06ns     | 2.69      | 4.02 |
| AB                  | 8                  | 31.053         | 3.882       | 2.10ns     | 2.27      | 3.17 |
| Error               | 30                 | 55.364         | 1.845       |            |           |      |
| Total               | 44                 | 102.722        |             |            |           |      |

ns = Not significant

variation = 45.40%

Coefficient of



Appendix Table 9. Flower quality rating (day 12)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 1.67        | 5.00 | 3.33 | 10.00 | 3.33 |
| P <sub>2</sub> T <sub>1</sub> | 3.33        | 2.00 | 2.33 | 7.66  | 2.55 |
| P <sub>3</sub> T <sub>1</sub> | 2.00        | 5.00 | 5.00 | 12.00 | 4.00 |
| P <sub>4</sub> T <sub>1</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>5</sub> T <sub>1</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>1</sub> T <sub>2</sub> | 2.00        | 3.33 | 1.67 | 7.00  | 2.33 |
| P <sub>2</sub> T <sub>2</sub> | 1.00        | 5.00 | 1.67 | 7.67  | 2.56 |
| P <sub>3</sub> T <sub>2</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>4</sub> T <sub>2</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>5</sub> T <sub>2</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>1</sub> T <sub>3</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>2</sub> T <sub>3</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>3</sub> T <sub>3</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>4</sub> T <sub>3</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>5</sub> T <sub>3</sub> | 5.00        | 5.00 | 1.67 | 11.67 | 3.89 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 6.405          | 3.203       | 3.14ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 19.233         | 4.808       | 4.71**     | 2.69      | 4.02 |
| AB                  | 8                  | 20.904         | 2.613       | 2.56*      | 2.27      | 3.17 |
| Error               | 30                 | 30.620         | 1.021       |            |           |      |
| Total               | 44                 | 77.162         |             |            |           |      |

ns = Not significant;  
 \*\* = Highly significant

\* = Significant;  
 Coefficient of variation = 23.80%





Appendix Table 10. Leaf quality rating (day 3)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 1.33        | 1.00 | 1.00 | 3.33  | 1.11 |
| P <sub>2</sub> T <sub>1</sub> | 1.00        | 1.00 | 2.67 | 4.67  | 1.56 |
| P <sub>3</sub> T <sub>1</sub> | 1.00        | 2.33 | 2.33 | 5.66  | 1.89 |
| P <sub>4</sub> T <sub>1</sub> | 2.33        | 2.00 | 1.00 | 5.33  | 1.78 |
| P <sub>5</sub> T <sub>1</sub> | 1.00        | 1.33 | 1.00 | 3.33  | 1.11 |
| P <sub>1</sub> T <sub>2</sub> | 2.00        | 1.00 | 1.00 | 4.00  | 1.33 |
| P <sub>2</sub> T <sub>2</sub> | 1.00        | 2.33 | 2.67 | 6.00  | 2.00 |
| P <sub>3</sub> T <sub>2</sub> | 1.33        | 3.00 | 4.00 | 8.33  | 2.78 |
| P <sub>4</sub> T <sub>2</sub> | 1.00        | 1.67 | 2.67 | 5.34  | 1.78 |
| P <sub>5</sub> T <sub>2</sub> | 1.33        | 2.33 | 2.00 | 5.66  | 1.89 |
| P <sub>1</sub> T <sub>3</sub> | 1.00        | 2.00 | 1.00 | 4.00  | 1.33 |
| P <sub>2</sub> T <sub>3</sub> | 1.00        | 2.00 | 1.67 | 4.67  | 1.56 |
| P <sub>3</sub> T <sub>3</sub> | 3.33        | 1.67 | 2.33 | 7.33  | 2.44 |
| P <sub>4</sub> T <sub>3</sub> | 1.33        | 1.00 | 2.67 | 5.00  | 1.67 |
| P <sub>5</sub> T <sub>3</sub> | 1.33        | 1.67 | 1.00 | 4.00  | 1.33 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 1.668          | 0.834       | 1.53ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 6.386          | 1.596       | 2.94*      | 2.69      | 4.02 |
| AB                  | 8                  | 1.022          | 0.128       | 0.23ns     | 2.27      | 3.17 |
| Error               | 30                 | 16.311         | 0.544       |            |           |      |
| Total               | 44                 | 25.386         |             |            |           |      |

ns = Not significant; \* = Significant

43.29%

Coefficient of variation =



Appendix Table 11. Leaf quality rating (day 4)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 1.67        | 1.67 | 1.00 | 4.34  | 1.45 |
| P <sub>2</sub> T <sub>1</sub> | 2.33        | 2.33 | 3.67 | 8.33  | 2.78 |
| P <sub>3</sub> T <sub>1</sub> | 1.00        | 1.00 | 1.00 | 3.00  | 1.00 |
| P <sub>4</sub> T <sub>1</sub> | 1.50        | 2.33 | 1.00 | 4.83  | 1.61 |
| P <sub>5</sub> T <sub>1</sub> | 1.00        | 2.67 | 2.33 | 6.00  | 2.00 |
| P <sub>1</sub> T <sub>2</sub> | 2.33        | 3.67 | 2.33 | 8.33  | 2.78 |
| P <sub>2</sub> T <sub>2</sub> | 2.33        | 1.50 | 3.00 | 6.83  | 2.28 |
| P <sub>3</sub> T <sub>2</sub> | 1.67        | 3.00 | 4.00 | 8.67  | 2.89 |
| P <sub>4</sub> T <sub>2</sub> | 2.00        | 2.67 | 1.33 | 6.00  | 2.00 |
| P <sub>5</sub> T <sub>2</sub> | 2.00        | 3.33 | 2.33 | 7.66  | 2.55 |
| P <sub>1</sub> T <sub>3</sub> | 1.33        | 2.67 | 1.00 | 5.00  | 1.67 |
| P <sub>2</sub> T <sub>3</sub> | 2.67        | 4.33 | 2.33 | 9.33  | 3.11 |
| P <sub>3</sub> T <sub>3</sub> | 2.33        | 2.00 | 1.50 | 5.83  | 1.94 |
| P <sub>4</sub> T <sub>3</sub> | 1.67        | 1.67 | 1.00 | 4.34  | 1.45 |
| P <sub>5</sub> T <sub>3</sub> | 1.33        | 2.33 | 1.00 | 4.66  | 1.55 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 4.383          | 2.192       | 4.02*      | 3.32      | 5.39 |
| Factor B            | 4                  | 5.401          | 1.350       | 2.48ns     | 2.69      | 4.02 |
| AB                  | 8                  | 7.071          | 0.884       | 1.62ns     | 2.27      | 3.17 |
| Error               | 30                 | 16.335         | 0.545       |            |           |      |
| Total               | 44                 | 33.190         |             |            |           |      |

ns = Not significant; \* = Significant

Coefficient of variation = 35.65%



Appendix Table 12. Leaf quality rating (day 6)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 2.33        | 2.33 | 1.67 | 6.33  | 2.11 |
| P <sub>2</sub> T <sub>1</sub> | 2.00        | 1.50 | 1.33 | 4.83  | 1.61 |
| P <sub>3</sub> T <sub>1</sub> | 3.00        | 1.67 | 2.67 | 7.34  | 2.45 |
| P <sub>4</sub> T <sub>1</sub> | 1.00        | 2.00 | 2.67 | 5.67  | 1.89 |
| P <sub>5</sub> T <sub>1</sub> | 4.00        | 2.67 | 3.33 | 10.00 | 3.33 |
| P <sub>1</sub> T <sub>2</sub> | 3.67        | 1.33 | 1.50 | 6.50  | 2.17 |
| P <sub>2</sub> T <sub>2</sub> | 2.33        | 3.33 | 1.67 | 7.33  | 2.44 |
| P <sub>3</sub> T <sub>2</sub> | 2.00        | 2.00 | 5.00 | 9.00  | 3.00 |
| P <sub>4</sub> T <sub>2</sub> | 3.67        | 2.33 | 3.00 | 9.00  | 3.00 |
| P <sub>5</sub> T <sub>2</sub> | 3.33        | 4.33 | 1.50 | 9.16  | 3.05 |
| P <sub>1</sub> T <sub>3</sub> | 3.33        | 1.00 | 1.33 | 5.66  | 1.89 |
| P <sub>2</sub> T <sub>3</sub> | 1.00        | 5.00 | 2.00 | 8.00  | 2.67 |
| P <sub>3</sub> T <sub>3</sub> | 1.00        | 2.67 | 1.50 | 5.17  | 1.72 |
| P <sub>4</sub> T <sub>3</sub> | 1.67        | 2.67 | 1.50 | 5.84  | 1.95 |
| P <sub>5</sub> T <sub>3</sub> | 3.00        | 3.33 | 1.67 | 8.00  | 2.67 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 2.622          | 1.311       | 1.12ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 4.872          | 1.218       | 1.04ns     | 2.69      | 4.02 |
| AB                  | 8                  | 4.847          | 0.606       | 0.55ns     | 2.27      | 3.17 |
| Error               | 30                 | 35.267         | 1.176       |            |           |      |
| Total               | 44                 | 47.608         |             |            |           |      |

ns = Not significant

variation = 45.25%

Coefficient of



Appendix Table 13. Leaf quality rating (day 8)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 1.33        | 2.67 | 3.00 | 7.00  | 2.33 |
| P <sub>2</sub> T <sub>1</sub> | 3.00        | 2.67 | 1.67 | 7.34  | 2.45 |
| P <sub>3</sub> T <sub>1</sub> | 2.00        | 3.33 | 1.33 | 6.66  | 2.22 |
| P <sub>4</sub> T <sub>1</sub> | 2.33        | 1.50 | 3.00 | 6.83  | 2.28 |
| P <sub>5</sub> T <sub>1</sub> | 1.67        | 3.33 | 5.00 | 10.00 | 3.33 |
| P <sub>1</sub> T <sub>2</sub> | 1.33        | 5.00 | 1.50 | 7.83  | 2.61 |
| P <sub>2</sub> T <sub>2</sub> | 1.67        | 5.00 | 2.33 | 9.00  | 3.00 |
| P <sub>3</sub> T <sub>2</sub> | 2.33        | 3.00 | 5.00 | 10.33 | 3.44 |
| P <sub>4</sub> T <sub>2</sub> | 2.67        | 2.67 | 1.33 | 6.67  | 2.22 |
| P <sub>5</sub> T <sub>2</sub> | 4.33        | 3.00 | 1.33 | 8.66  | 2.89 |
| P <sub>1</sub> T <sub>3</sub> | 2.33        | 1.67 | 2.00 | 6.00  | 2.00 |
| P <sub>2</sub> T <sub>3</sub> | 1.00        | 5.00 | 1.50 | 7.50  | 2.50 |
| P <sub>3</sub> T <sub>3</sub> | 1.67        | 2.67 | 1.50 | 5.84  | 1.95 |
| P <sub>4</sub> T <sub>3</sub> | 3.67        | 3.00 | 1.33 | 8.00  | 2.67 |
| P <sub>5</sub> T <sub>3</sub> | 3.00        | 5.00 | 2.33 | 10.33 | 3.44 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 0.999          | 0.500       | 0.28ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 4.643          | 1.161       | 0.66ns     | 2.69      | 4.02 |
| AB                  | 8                  | 4.804          | 0.600       | 0.34ns     | 2.27      | 3.17 |
| Error               | 30                 | 52.927         | 1.764       |            |           |      |
| Total               | 44                 | 63.373         |             |            |           |      |

ns = Not significant

variation = 50.66%

Coefficient of



Appendix Table 14. Leaf quality rating (day 10)

| TREATMENT                     | REPLICATION |      |      | TOTAL | MEAN |
|-------------------------------|-------------|------|------|-------|------|
|                               | I           | II   | III  |       |      |
| P <sub>1</sub> T <sub>1</sub> | 1.00        | 1.00 | 2.67 | 4.67  | 1.56 |
| P <sub>2</sub> T <sub>1</sub> | 1.50        | 1.67 | 5.00 | 8.17  | 2.72 |
| P <sub>3</sub> T <sub>1</sub> | 3.33        | 5.00 | 2.33 | 10.66 | 3.55 |
| P <sub>4</sub> T <sub>1</sub> | 1.33        | 1.67 | 1.50 | 4.50  | 1.50 |
| P <sub>5</sub> T <sub>1</sub> | 5.00        | 5.00 | 5.00 | 15.00 | 5.00 |
| P <sub>1</sub> T <sub>2</sub> | 1.33        | 5.00 | 1.00 | 7.33  | 2.44 |
| P <sub>2</sub> T <sub>2</sub> | 5.00        | 5.00 | 1.00 | 11.00 | 3.67 |
| P <sub>3</sub> T <sub>2</sub> | 1.00        | 5.00 | 5.00 | 11.00 | 3.67 |
| P <sub>4</sub> T <sub>2</sub> | 1.67        | 1.33 | 1.67 | 4.67  | 1.56 |
| P <sub>5</sub> T <sub>2</sub> | 1.67        | 5.00 | 2.33 | 9.00  | 3.00 |
| P <sub>1</sub> T <sub>3</sub> | 1.33        | 2.33 | 1.50 | 5.16  | 1.72 |
| P <sub>2</sub> T <sub>3</sub> | 1.67        | 5.00 | 1.33 | 8.00  | 2.67 |
| P <sub>3</sub> T <sub>3</sub> | 5.00        | 4.00 | 1.67 | 10.67 | 3.56 |
| P <sub>4</sub> T <sub>3</sub> | 3.33        | 1.67 | 1.67 | 6.67  | 2.22 |
| P <sub>5</sub> T <sub>3</sub> | 3.00        | 5.00 | 2.67 | 10.67 | 3.56 |

## Analysis of Variance

| Source of variation | Degrees of freedom | Sum of squares | Mean square | Computed F | TABULAR F |      |
|---------------------|--------------------|----------------|-------------|------------|-----------|------|
|                     |                    |                |             |            | 0.05      | 0.01 |
| Factor A            | 2                  | 0.149          | 0.074       | 0.03ns     | 3.32      | 5.39 |
| Factor B            | 4                  | 32.931         | 8.233       | 3.50*      | 2.69      | 4.02 |
| AB                  | 8                  | 10.469         | 1.309       | 0.56ns     | 2.27      | 3.17 |
| Error               | 30                 | 70.486         | 2.350       |            |           |      |
| Total               | 44                 | 114.034        |             |            |           |      |

ns = Not significant; \* = Significant

Coefficient of variation = 54.24%

