1	**EFFECT OF EXOGENOUS BENZYL AMINO PURINE AND INDOLE ACETIC ACID ON LATERAL SHOOT INDUCTION OF DECAPITATED *Philodendron erubescens*cv *'Gold'*** M.K.L.S. Amarasena[1], G. D. K. Kumara[1], S.A. Krishnarajah[2] [1]Department of Export Agriculture, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka [2] Royal Botanic Gardens, Peradeniya	**1**
2	**EFFECT OF DIFFERENT POSTHARVEST TREATMENTS ON POSTHARVEST LIFE OF JASMINE (*Jasminum grandiflorum*)** **W. G. I. Lakmali[1], G. D. Kapila Kumara[1], L. N. S. Perera[2]** **[1]Department of Export Agriculture, Faculty of Agricultural Sciences,** **Sabaragamuwa University of Sri Lanka** **[2]Royal Botanic Gardens, Peradeniya**	**2**
3	**MORPHOLOGICAL CHARACTERIZATION OF GERBER (*Gerbera jamesonii*) ACCESSIONS AT REGIONAL AGRICULTURE RESEARCH AND DEVELOPMENT CENTER, BANDARAWELA** N.B.U. Dissanayaka, G.D.G Chathurani, W.M.H.P Chandrasena, A.J.M.A.C Abeykoon, J.A Smanthi Regional Agriculture Research and Development Centre, Bandarawela, Sri Lanka	**3**
4	**STUDY ON THE LOW COST METHODS FOR TISSUE CULTURE APPLICATIONS IN ORCHID** P.U. Kumara[1], H.M.I. Herath[2], D.L.C.KumariFonseka[1], A.G.K.W.S. Atapattu[1] [1]Department of Crop Science, Faculty of Agriculture, University of Ruhuna, Mapalana, Srilanka [2]Royal Botanical Gardens, Peradeniya, Sri Lanka	**4**
5	**PRELIMINARY STUDY ON EFFECT OF ELEPHANT DUNG ON GROWTH AND FLOWER QUALITY OF *ANTHURIUM ANDRAEANUM***	**5**

	1 Department of Agricultural and Plantation Engineering, Faculty of Engineering Technology, The Open University of Sri Lanka *2 Botanic Gardens, Henarathgoda, Gampaha, Sri Lanka*	
19	**BIOFILMED BIOFERTILIZERS (BFBFS) ENHANCES GROWTH AND CONTROL OF DISEASES OF *ANTHURIUM ANDREANUM*** **S.M.A. Samanmali[1*], K.A.C.N. Senevirathne[2], S.M.M.R. Mawalagedera[3], U.G.A.I. Sirisena[1] and G. Senevirathne[4]** *[1]Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura.* *[2]Royal Botanic Garden, Peradeniya.* *[3]No 63B, Hewaheta road, Thalwatta, Kandy.* *[4]Microbial Biotechnology Unit, National Institute of Fundamental Studies, Hantana Road, Kandy.*	**19**
20	**INVESTIGATION OF ROSES MARKET LANDSCAPE IN SRI LANKA** **S.D.Dilrukshi and A. De Silva** Department of Agribusiness Management, Faculty of Agricultural Sciences. Sabaragamuwa University of Sri Lanka, Belihuloya. Sri Lanka	**20**
21	**CONFIRMATION OF PHYTOPLASMA ASSOCIATED WITH SHOOT PROLIFERATION IN BEGONIA PLANT SPECIES** A.A.I.M Amarasinghe, T. M. N. D. Tennakoon, K. D. Nandasena Plant Virus Indexing Centre, Department of Agriculture, Homagama	**21**
22	**ALTERING MORPHOLOGICAL CHARACTERS AND SEED GERMINATION OF COCKSCOMB, *CELOSIA CRISTATA* BY COLCHICINE** N. Dahanayake, A.G.K.M.W.S. Atapattu, P.C.D. Perera, P.U.Kumara Department of Agricultural Biology, Faculty of Agriculture, University of Ruhuna	**22**
23	**FLORICULTURE INDUSTRY FOR DRY ZONE IN SRI LANKA** S. M. P.C. Padmini[a], T. Kodagoda[b],R. Samaratunge[c] and S.A. Krishnarajah[d] [a]Sri Lanka Council for Agricultural Research Policy, Sri Lanka; [b]Department of Management, University of Colombo, Sri Lanka; [c]Department of Management, University of Monash, Australia; [d]Department of National Botanic Gardens, Sri Lanka	**23**

24	**EFFECT OF GROWTH HORMONES AND SUBSEQUENT DETOPPING IN *Cordyline terminals* 'Red edge'** **D.A.M.N. Chamini[1], H. K. L. K. Gunasekera[1] and S. A. Krishnarajah[2]**	**24**

	1 Department of Agricultural and Plantation Engineering, Faculty of Engineering Technology, The Open University of Sri Lanka *2 Department of National Botanic Gardens, Peradeniya, Sri Lanka*	
25	**EFFECT OF AUXIN IN COMBINATION WITH GIBBERELLIC ACID AND LIGHT ON SPIRAL PRODUCTION OF *Dracaena sanderiana* var. White CANES AS VALUE ADDED PRODUCT** **H. P. T. L. Sewwandi[1], H. K. L. K. Gunasekera[1] and S. A. Krishnarajah[2]** *[1]Department of Agricultural and Plantation Engineering, Faculty of Engineering Technology, The Open University of Sri Lanka, [2]Department of National Botanic Gardens, Peradeniya, Sri Lanka*	**25**
26	**EFFECTIVENESS OF MULTI NUTRIENT FERTILIZER GRANULES FOR SOILLESS CULTURE OF GERBERA HYBRIDA** **D.P. Karunananda, W.K. Abeysinghe and U. B. Palipana*** Horticulture Research and Development Institute, Gannoruwa, Peradeniya	**26**
27	**INDUCTION OF AXILLARY BUD OUT GROWTH AND PLANT PRODUCTION FROM OVERDUE GERBERA HYBRIDA RHIZOMES, THROUGH ABIOTIC STRESS TREATMENTS** **D.P. Karunananda, W.K. Abeysinghe and U. B. Palipana*** Horticulture Research and Development Institute, Gannoruwa, Peradeniya *Royal Botanic Gardens, Peradeniya	**27**

Contents

EFFECT OF EXOGENOUS BENZYL AMINO PURINE AND INDOLE ACETIC ACID ON LATERAL SHOOT INDUCTION OF DECAPITATED *Philodendron erubescens*cv 'Gold'

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ABSTRACT

*Philodendron erubescens*cv *'Gold'* is an ornamental foliage plant which belongs to the family Araceae and is popular in local and export markets for its colourful foliage. In commercial cultivation it is important to produce more lateral shoots to obtain good quality compacted plants, high number of cuttings and quality planting materials. Selected cultural practices such as decapitation can be used to induce branching. Furthermore it is also possible to use plant growth regulators to increase efficiency of shoot induction and quality. The aim of this study was to investigate and compare the impact of selected plant growth regulator combinations on lateral shoot initiation and quality. In this experiment a cytokinine- Benzyl Amino Purine (BAP) (250 ppm, 500 ppm) and an Auxin- Indole Acetic Acid (IAA) (125 ppm, 250 ppm, 375 ppm, 500 ppm) were used in combinations of different concentrations. Experimental design used was Complete Randomized Design. Stem cuttings of *Philodendron erubescens*cv *'Gold'* were planted and decapitated after 4 weeks. The decapitated plants were treated twice at one week interval with eight different concentration and combinations of growth regulators. The combined effect of BAP and IAA was observed weekly on number of lateral shoots per plant, length of each lateral shoot, number of new leaves developed from each shoot per plant and length of new leaves. Treatments BAP 250 + IAA 250 ppm and BAP 250 + IAA 125 ppm were significantly different ($p<0.05$) from all other treatments with respect to the number of new leaves formed with the highest mean value for BAP 250 + IAA 250 ppm. There was no significant difference among all treatments with respect to the length of new shoots and leaves. The highest mean number of lateral shoot were observed in BAP 250 + IAA 250 ppm and BAP 250 + IAA 125 ppm hormone combinations and they were not significantly different from the control. Thus, BAP 250+ IAA 250 ppm and BAP 250 + IAA 125 ppm hormone combinations are the most effective hormone combinations with highest number of new leaves, compared to other treatments.

Key words: BAP, IAA, decapitation, lateral shoot, *Philodendron erubescens*cv *'Gold'*.

EFFECT OF DIFFERENT POSTHARVEST TREATMENTS ON POSTHARVEST LIFE OF JASMINE (*Jasminum grandiflorum*)

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ABSTRACT

Jasmine (*Jasminum grandiflorum*) has a considerable value in religious activities in Sri Lanka. Under normal conditions, harvested jasmine flower buds open within 12 hours and flowers cannot be retained for more than a day; they show signs of browning on the second day with an abrupt loss in fragrance. At present, there are no effective techniques to reduce postharvest losses of jasmine. In order to extend the postharvest life, three experiments were carried out using Complete Randomized Design. Four pre-cooling temperatures (4, 7, 10 and 13 °C) were tested as the first experiment. Four preservatives (4% boric acid, 15% coconut water, 250 ppm citric acid and 4% sodium chloride) in combination with pre-cooling at 10 °C and 13 °C separately (selected best treatments from the first experiment) were tested as the second experiment. In the third experiment, different packaging materials (banana leaves, newspapers, 150 and 300 gauged low density poly ethylene bags-LDPE) were tested in combination with the best treatments (10 °C with 4% boric acid and 13 °C with 4% boric acid) found in the first and second experiments and kept under air conditioned (18 °C) and ambient storage conditions. Data were recorded daily on bud opening and weight to estimate bud opening index and physical loss of weight. Colour and appearance were assessed using self-prepared charts as references. Fragrance was checked through an evaluation panel in the third experiment. In all experiments, buds which did not open after 24 hours remained unopened even when checked after 48 hours and 72 hours. In the first experiment, physical loss of weight was not significantly different and flowers pre-cooled at 7, 10 and 13 °C showed significant results as slight browning and slight wilting after 48 hours. In the second experiment, physical loss of weight was not significant and 4% boric acid treated flowers showed significant results as slight browning and slight wilting after 48 hours. In the third experiment, physical loss of weight was significant and minimum values were recorded in gauged 300 LDPE bags followed by 150 gauged LDPE bags, under both air conditioned and ambient storage conditions. Flowers in 300 and 150 gauged LDPE bags showed significant results as slight browning and slight wilting after 48 hours, under ambient storage. But, under air conditioned storage, flowers packed in gauged 300 and 150 LDPE bags showed significant results as white colour and fresh appearance up to four days. Fragrance was significant among the treatments. These results suggest that, jasmine buds pre-cooled at 10 °C or 13 °C dipped in 4% boric acid solution followed by packaging in 150 or 300 gauged

LDPE bags preserve white colour and fresh appearance up to four days, while maintaining minimum weight loss under air conditioned storage condition.

Key words: *Jasminum grandiflorum*, Packaging, Postharvest life, Pre-cooling, Preservatives

MORPHOLOGICAL CHARACTERIZATION OF GERBER (*Gerbera jamesonii*) ACCESSIONS AT REGIONAL AGRICULTURE RESEARCH AND DEVELOPMENT CENTER, BANDARAWELA

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ABSTRACT

Gerbera (*Gerbera jamesonii*) is one of the major commercial floricultural crops in Sri Lanka. Since, the demand for novelties in the market, the high planting material cost and susceptibility to pest and diseases of imported varieties, it is essential to bread local varieties. This study was intended to morphologically characterize the gerbera accessions available at RARDC Bandarawela as it is the initial step in identification and selection of accessions and assess the variability of them based on morphological traits. Seven morphological characters including four qualitative and three quantitative were studied and analyzed to identify the dissimilarity of accessions. Cluster analysis and MANOVA using qualitative and quantitative traits generated significantly different six groups at a normalized distance of 1.06. Closest accessions were 22 and 39 whereas most distant accession was 37. As the present study reveals the difference in characters among accessions give an idea about the genetic divergence. This can be used as a simple and quick method to select parents and design crosses. There was significant differences among groups of 39 gerbera accessions for characters studied and these variations can be used in crosses for hybridization programmes in improvement of gerbera cultivars to develop novelties.

Key wards: Gerbera accessions, morphological characters, hybridization, cluster analysis, variability

INTRODUCTION

Floriculture is one of the dynamic, fast growing industries which achieved significant growth rate during past few decades. The floriculture industry in Sri Lanka has been initiated in 1970's and now at the top rank of foreign exchange generating ventures.

Gerbera is one of the major commercial floricultural crops in Sri Lanka. The demand for new varieties is always in the market. In the absence of suitable indigenous varieties, growers have to entirely depend on exotic genotypes which are extremely expensive. A single plant of imported variety costs around 180 - 200 rupees. However, if produced locally, it costs only 70-80 rupees. Imported varieties are highly susceptible to pests and diseases, as they bred to suit for temperate climate. In Sri Lanka, breeding and producing new varieties of Gerbera is limited. Farmers do hand pollination to produce seeds resulting new flower colors and other traits. However, as they are not with standard procedures, it is hard to get value. Hybridization and selection from a breeding programme are important steps in obtaining gerbera novelties (Maria and Chis, 2006). Accordingly, a solid breeding programme to develop local Gerbera varieties is vital for the prosperity of the floriculture industry in Sri Lanka. Considering the circumstances, Regional Agriculture Research and Development Center (RARDC) Bandarawela has taken the first step to create new local gerbera varieties via a conventional breeding programme. The research center has a collection of commercial gerbera varieties which were gathered from farmers and vendors around the area by scientists now and then but, the information about the varieties are not available.

Genetic variability analysis in genera is a preliminary step for breeding programmes because it generates information to visualize genetic relationships existing among the genotypes. This can be done on the basis of molecular procedures and morphological methods as well. Morphological and phenotypic approach is relatively simple to perform. Using molecular markers is best suitable but very expensive and need sophisticated equipments to perform.

Since it is important to find out the identity and divergence of these accessions before using them as parents in hybridization programmes, this study is intended to characterize gerbera accessions available in RARDC Bandarawela morphologically as one of the initial steps in identification and selection of accessions and assess the variability of gerbera accessions base on morphological traits.

MATERIAL AND METHODS

The experiment was conducted at RARDC, Bandarawela. 39 accessions of *Gerbera jamesonii* collected and available at the research center were used for the preliminary study. The experimental design was Complete Randomize Block Design with 39 replicates (accessions) and five repetitions from each accession. The plants were grown in soil: cow dung: sand: paddy charcoal media (2:2:1:1 ratio). As fertilizer practice, Albert mixture solution (2g/l) was applied once in two weeks and $CaNO_3$ once a month. Fungicides and insecticides were applied when necessary and the crop is maintained under polytunnel conditions, with silver mesh as the shade. Data collection was started after the plant reach to its full bloom.

Morphological characterization is done with three quantitative and three qualitative traits. As quantitative traits: flower diameter, disk diameter and stalk length were recorded while quantitative traits were recorded as flower color, number of petal layers and flower type on visual basis.

Since the aim of this study is to differentiate accessions based on different traits, cluster analysis was performed using SAS 9.1.3 software. All qualitative data were transformed to binary data for clustering. Finally, grouping was done to determine the significance among clusters.

RESULTS AND DISCUSSION

The average values of flower diameter, disk diameter and stalk length are represented in Table1. The results elaborate that the accession 18 has highest flower diameter (11.7 cm) where as lowest diameter (7.6cm) was recorded in accession 24. The highest disk diameter of 2.6 cm was from accession 8 and accession 10 showed the least (1.0cm). Maximum and minimum stalk lengths were observed from accession 33(54.1cm) and accession 37(28.9cm) respectively. Highest coefficient of variation is observed for disk diameter (21.4%) According to Kumari *et al.*, (2011), flower diameter has less effect on environment for the character due to close correspondence between genotypic coefficient of variation and phenotypic coefficient of variation while stalk length and flower diameter showed high estimates of heritability (Senapati *et al.*, 2013). Therefore these traits are important in selection programme.

Flower colour gives important clues to understand the history of genetics in Gerbera. Keneth *et al.*,(1993) relieved that gerbera flower colour is a complex trait including polygenic variation and effect of major loci. Therefore, variation of colour in a population can be used

to breed novel flower colours. Though the visual matching to a reference standard is used generally to determine colour variation it does not provide exact colour variation. Instead procedures like Munsell colour system, reflectance spectroscopy can be used.

Table 1. Morphological characteritics of *Gerbera jamesonii accessions.*

Accession No.	*flower diameter (cm)*	*Disk diameter (cm)*	*stalk length (cm)*	*Flower Colour*	*Number of Petal Layers*	*Flower type*	*Petal Shape*
1	8.0	1.26	46.5	White6	D	st	ov
2	9.9	1.28	41.0	White 1	D	st	ob
3	9.5	1.40	40.0	Yellow7	D	st	ob
4	8.1	1.96	43.6	Pink13	D	st	ob
6	8.5	2.48	43.6	Red 1	S	st	ov
7	8.8	2.00	46.4	Red 2	S	st	ob
8	8.6	2.60	40.0	Yellow 3	D	st	ob
9	10.0	1.66	39.5	Pink 15	D	st	ob
10	9.3	1.73	43.5	Orange 10	D	st	ob
11	10.0	2.43	50.2	Orange 2	S	st	ob
12	9.8	1.30	29.0	Pink 1	D	st	ob
13	9.4	1.52	37.1	Orange 8	D	st	ob
14	11.6	2.15	39.1	Orange 5	D	st	ob
15	10.5	1.90	34.1	Orange 1	S	st	ov
16	10.4	1.82	39.5	Pink 15	S	st	ob
17	7.9	1.72	43.7	Red 5	S	st	ob
18	11.7	1.20	45.2	Yellow 5	D	st	ob
19	10.8	1.58	43.4	Orange 7	D	st	ob
20	10.2	1.60	30.0	Yellow 3	D	st	ob
22	10.5	2.22	42.7	Red 7	D	st	ob
23	8.5	1.54	49.0	Red 9	D	st	ob
24	7.6	1.60	35.0	Red 4	S	st	ov
25	9.3	1.76	34.2	Red 4	S	st	ov
26	9.9	2.15	36.9	Red 9	S	st	ob
27	10.7	1.76	41.9	Pink 7	D	st	ob
28	10.3	2.37	53.8	Orange 2	S	st	ob
29	9.8	2.00	32.7	Red 5	D	st	ob
30	10.3	1.50	45.8	Red 4	M	st	ob
31	10.0	1.65	31.9	Pink 14	S	st	ob
32	9.6	1.00	40.9	Pink 6	M	st	Ob
33	8.8	2.06	54.1	Red 10	D	st	Ob
34	9.0	1.98	51.7	Red 7	D	st	Ov
35	10.4	1.82	51.5	Orange 9	S	st	Ob
37	10.7	2.24	28.9	Orange 11	D	mi	Ov
38	11.1	2.06	50.9	Red 4	D	st	Ob
39	10.2	2.15	41.8	Red 7	D	st	Ob
40	8.9	2.50	39.2	Red 1	S	st	Ov
44	8.3	1.60	41.2	Red5	D	st	Ob
46	8.5	1.78	36.3	Orange12	S	st	Ob
Mean	9.6	1.8	41.4				
Max	11.7	2.6	54.1				
Min	7.6	1.0	28.9				
SD	1.0	0.4	6.7				
CV %	10.64	21.24	16.15				

Note: Petal Layers: S, Single;D,Double;M,Multiple: Flower Type:st,standard;mi,mini: Petal Shape:ob,Oblong; Ov, Ovate.

Cluster analysis and MANOVA using qualitative and quantitative traits could generate significantly different six groups at a normalized distance of 1.06(Fig. 1). Group 1 included accessions 1,23,18,30,2,3 and 32 with monomorphic traits of standard flower type. The second group including accessions number 4,17,7,9,16,10,27,19 and 44 were monomorphic for standard flower type and oblong petal shape. In this group, except accessions 17, 7 and 16 others shared common character of double petal layers. Accessions 6,8,40,22,39,14 and 26 were clustered in to group 3 showing standard petal type. But it differed from group 1 because of the variation in flower colour and number of petal layers. Group 4 comprised of accessions 11,28,33,34,38 and 35 which was monomorphic for standard flower type. Excluding accession 34, all others were monomorphic for oblong petal shape. Group 5 made up of accession 12, 20,31,13,24,46,15,25 and 29 showing standard flower type as common traits. Group 6 contained only the accession 37 which was a mini gerbera, a different type. According to the results of Walks' Lambda statistics all groups are significantly different from each other (P=0.0001). Closest accessions were 22 and 39 with a distance of 0.06 whereas most distant accession was 37 with a distance of 2.25.

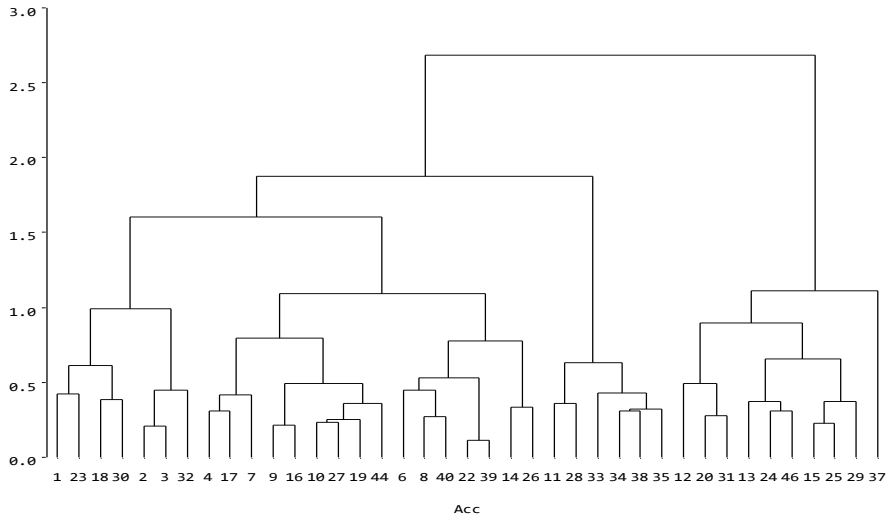

Figure 1. Dendogram drawn by cluster analysis based on the morphological characters of 39 gerbera accessions. AD, Average dissimilarity

CONCLUSION

Based on the results, it can be concluded that there was significant differences among groups of 39 gerbera accessions for characters studied and these variations can be used in crosses for hybridization programmes in improvement of gerbera cultivars to develop novelties. Because this study reveals the difference in characters among accessions give an idea about the genetic divergence and can be used as a simple and quick method for selecting parents and designing crosses.

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STUDY ON THE LAW COST METHODS FOR TISSUE CULTURE APPLICATIONS IN ORCHID

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ABSTRACT

Orchid is one of the most important cut flowers, grown in Sri Lanka for export and local market. One of the major constrains in expanding the orchid cultivation is limited supply of quality planting materials. Micropropagation techniques can be successfully applied for mass propagation of orchids. But microprpagation is and expensive thus increase the cost of production. Therefore this research was undertaken for replacement of expensive agar for *in vitro* subculturing of *Cattaleya* seedlings. Two month old *Cattleya* seedlings were sub cultured on Murashge and Skoog media (MS) and Knudson C media (KNC) as basal media. As gelling agents sago, semolina, corn flour, semolina + agar, corn flour + agar were used. Control treatment was carried out with agar. As alternative water source rain water and tap water were used. Control treatment was carried out with distilled water. Cultures were maintained inside the culture room. Number of leaves, Number of roots, Leaf length, leaf width and percentage of contaminations were recorded at four week intervals. Sago and semolina + agar showed higher performance and low contamination percentage as alternative gelling agent in the MS media. Sago, corn flour, sago + agar, semolina + agar and corn flour + agar showed higher performances and low contamination percentage in KNC media. Rain water was showed in higher performances and low contaminations percentage in KNC media. The results of this study propose that sago, semolina and corn flour can be used as an alternative gelling agents in MS and KNC media for sub culture practices of orchids. Rain water and tap water can use as an alternative water source in KNC media for subculture practices in orchid.

Key words: Alternative gelling agent, Alternative water source, Orchid subculture

PRELIMINARY STUDY ON EFFECT OF ELEPHANT DUNG ON GROWTH AND FLOWER QUALITY OF *ANTHURIUM ANDRAEANUM* CV 'NANO RED'

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Abstract

Anthurum andraeanum growth and flower quality mainly depend on fertilizer, growing media and health of the seedling. Coir fiber mixed with sand and green manure is the commonly used medium in commercial potting substrate. Replacing common medium with animal litters such as elephant dung has been already worked out in many countries for vegetable production. This study was aimed to study the efficacy of elephant dung (which is highly available) on growth and productivity of Anthurium. Eight month old *A. andraeanum* cv 'Nano Red' were used for the trial and plants were grown in ten different media combinations with elephant dung, leaf mould, cattle manure, coir dust and sand. Growth and yield parameters such as plant height, number of leaves, leaf area, petiole length, number of flowers, spathe area, stem length, time taken for flowering were evaluated with two weeks intervals starting at one month after transplanting for the subsequent nine months; root length and number of roots were recorded at the last observation. Experiment was arranged in a completely randomized design with five replicates and data were statistically analyzed using Minitab 17 statistical package at 5% significance level.

Results showed significant differences among treatments ($p<0.05$) and number of leaves, leaf area, plant height, number of roots and root length was highest in the growing media prepared with elephant dung : sand (1:1 and 1:2), elephant dung, leaf mould and sand (1:1:2), elephant dung, leaf mould, coir dust and sand (1:1:1:2) and cattle manure, leaf mould, coir dust and sand (1:1:1:2) compared to other media. The medium containing elephant dung, leaf mould, coir dust and sand (1:1:1:1 and 1:1:1:2) and cattle manure, leaf mould, coir dust and sand (1:1:1:1) gave the best yield with respect to highest number of flowers and spathe area and minimum time taken for flowering. In case of *A. anraeanum,* even though maximum results were recorded by the mixture of cattle manure and leaf mould, elephant dung was equally effective when considering plant growth and yield parameters. The use of elephant dung as a replacement of cattle manure and coir dust is an alternative due to the added advantage of recycling of lignocellulosic wastes which can accumulate in the environment.

Key words: *Anthurum andraeanum*, elephant dung, growth parameters, yield

PERFECTING MICROPROPAGATION PROTOCOL FOR NEW ANTHURIUM HYBRIDS DEVELOPED BY THE DEPARTMENT OF NATIONAL BOTANIC GARDENS

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Abstract

New *Anthurium andraeanum*hybrids introduced by Department of National Botanic Gardens have been very popular among the farmers, contributing substantially to the floricultural trade. Conventional methods of vegetative propagation are time consuming and cannot keep the pace with increasing demand and propagation through seeds is not desired because of cross pollination and the progenies are heterogeneous. Micropropagation is the only tool which helps in producing high quality planting material in large quantities and various techniques being followed in different parts of the world. Culture media influence the propagation efficiency and each plant species has its own nutrient and hormone requirements. Therefore, its medium composition should be improved for better results. Another major challenge in anthurium tissue culture is microbial contamination which cause severe losses to micropropagated plants at each stage of growth. Thus, this study aimed to perfect micropropagation protocol for new anthurium hybrid 'Ayana'. For this purpose, the effect of six different sterilization techniques, six modified MS (Murashige and Skoog) media supplemented with different concentration of nutrients (NH_4NO_3) and hormones (BAP; Benzylaminopurine and 2,4-D; 2,4-dichlorophenoxyacetic acid) on callus induction and shoot regeneration were studied. Experiment was conducted in tissue culture laboratory of Botanic Gardens, Gampaha in completely randomized design with ten replicates. Separate experiment was conducted in order to observe the effective sterilization method and remaining number of cultured bottles with live explants were counted. Effectiveness of the culture media was evaluated on the basis of callus diameter and wet and dry weight of callus was and number of shoots per explant was counted at regeneration stage.

Results revealed that best surface sterilization procedure was 70% (v/v) ethanol for 30 seconds, 3% sodium hypochlorite containing two drops of 0.01% Tween-20 for 10 minutes followed by three rinses with sterile distilled water. Leaves sterilized with concentrated solutions were subjected to browning and necrosis of explants could be observed. Callus with highest fresh weight and dry weight under dark condition was observed in half strength MS medium supplemented with 0.1 mg/L 2,4-D, 1.5 mg/L BAP and NH_4NO_3lowered to250mg/L and it was significantly higher than other treatments. Most efficient shoot regeneration which showed 25 shoots per explant was observed in half strength MS medium containing 0.1 mg/L 2,4-D, 1 mg/L BAP, 720mg/L $NH_4NO_3$with 16 hours' photoperiod. Further researches should be done to identify suitable micropropagation protocol for each new hybrid.

Key words:*Anthurium andraeanum* cv 'Ayana', micropropagation, sterilization, BAP, 2,4-D

THE COMPARATIVE STUDY OF EFFECT ORGANIC FERTILIZER AND INORGANIC FERTILIZER ON THE GROWTH RATE OF *ANTHURIUM ANDRAEANUM* CV 'ANGEL'

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Abstract

Organic farming has gained importance due to pressure of the "energy crisis" and issues of "environmental protection". Most organic fertilizers have been proved to be effective in sustainable productivity in the floriculture sector. In order to evaluate replacement of inorganic fertilizer with organic fertilizer in *Anthurium andraeanum*, an experiment was conducted in Botanic Gardens, Gampaha using four-month old tissue cultured Anthurium plants of cultivar "Angel". Fertilizer treatments were carried out consisting of two chemical fertilizers (Albert's solution and NPK 30:10:10 and 20:20:20 alternatively) and four organic fertilizers including partially decomposed leaf mould, cattle manure, vermiwash and organic liquid fertilizer (Crop master). Water was considered the control and treatments were applied once a week. The effect of the various fertilizer on *A. andraeanum* cv. 'Angel' were evaluated based on plant height, number of leaves, leaf length and width and petiole length during nine months experimental period. Data were subjected to analysis of variance using (ANOVA) with mean separation by Tukey's test at 5% levels of significance using Minitab 17 statistical package.

Results revealed that there was a significant difference ($p<0.05$) among treatments compared to the control in several parameters. Leaf length, width and petiole length was higher with inorganic fertilizers and plants fertilized with inorganic fertilizer, organic liquid fertilizer, vermiwash and cattle manure was equally effective with respect to all the other growth indices during the experimental period. Plants treated with leaf mould showed lowest results while number of leaves did not show any significance difference among treatments. However it is recommended that organic liquid fertilizer and vermiwash and cattle manure can be used to in absence of inorganic fertilizer considering the cost and associated environmental effect on the later. Further research is desired to investigate growth performance, maximum productivity and quality of flowers by using organic fertilizer compared to inorganic fertilizers

Key words: *Anthurium andraeanum,* organic fertilizer, inorganic fertilizer

Effect of vermywash organic liquid fertilizer on the vegitative growth and flowering of Gerbera jamesonii COMPARED TO chemical fertilizer

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ABSTRACT

Gerbera jamesonii belongs to family Asteraceae and is a floricultural crop, native to South Africa, which is mostly used as cut flowers and pot plants for ornamental purposes. In Sri Lanka most of the growers use only chemical fertilizers to fulfill the nutrient requirement to achieve high yield of quality gerbera flowers. This study was carried out to find out the effect of vermywash organic liquid fertilizer on the growth and flowering of *Gerbera jamasonii cv. great smoky mountain* compared (a pot gerbera variety) to chemical fertilizer. Effect of three fertilizer programs, namely, fertilizer programme one (vermywash organic liquid fertilizer – 100 ml /plant; once a week, Osmocote -N:P:K-20:20:20- 2.5g/plant; once in three month, N:P:K-6:30:30+TE, 0.2g/plant, once a week,), fertilizer programme two (Albert solution – 0.2 g/plant; once a week, Osmocote -N:P:K-20:20:20- 2.5g/plant; once in three month, N:P:K-6:30:30+TE, 0.2g/plant, once a week,) fertilizer programme three (N:P:K-20:20:20+TE – 0.2 g/plant; once a week, Osmocote -N:P:K-20:20:20- 2.5g/plant; once in three month, N:P:K-6:30:30+TE, 0.2g/plant, once a week,) were arranged in a CRD design. Measurements made were number of leaves per plant, average leaf length (cm), number of shoots per plant, time taken to flowering, diameter of flower (cm) and total number of flowers. Data were analyzed statistically using Minitab.

All three fertilizer programme had no significant effect on vegetative growth as measured by number of leaves per plant and average leaf length. However fertilizer programme two resulted in significantly highest number of shoots per plant. Furthermore early flowering and highest total number of flowers were observed in plants treated with fertilizer programme two and no significant difference for diameter of flower was observed among all fertilizer programmes. Therefore it is concluded that vermywash organic liquid fertilizer can be used as a substitute for chemical fertilizers for *Gerbera jamesonii* during the vegetative phase.

Key words : *Gerbera jamesonii cv. great smoky mountain*, vermywash organic liquid fertilizer, vegetative growth, flowering

BIO-EFFICACY OF BOTANICAL EXTRACTS AGAINST APHID POPULATION IN ROSES AND CHRYSANTHEMUM

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ABSTRACT

Roses (*Rosa* spp.) and chrysanthemum (*Chrysanthemum morifolium*) are major flower crops grown in upcountry intermediate zone as cut flowers and pot plants. Aphid (*Myzus persicae, Aphis gossypii and Macrosiphum* spp.) is a major insect pest of these crops which reduces both yield and quality of flowers. Farmers respond to this threat by applying insecticides on calendar basis. This is costly, highly hazardous to workers and disruptive to the natural ecosystems. Bio efficacy of Neem (*Azadiracta indica*) seed extract 40g/l, Anona (*Anona* spp.) leaves extract 250g/l, Marigold (*Tagetes patula)* leaf and root extract 50ml/l were evaluated with recommended insecticides, Imidacloprid 200 g/l SL 1ml/l, Thiamethoxam 25% WG 5g/10l for managing aphids in roses and chrysanthemum under natural infestation of aphids in open field at RARDC, Bandarawela. Spraying was commenced after making a record on initial pest counts and recommended insecticides and organic extracts were sprayed in 14 and 7 days intervals respectively. Insect population counts, plant growth parameters in weekly interval and phytotoxic symptoms after spraying were recorded. Neem seed extract and marigold plant extract in roses and neem seed extract in chrysanthemum were effectively controlled aphid populations similar to recommended insecticides. The highest total number of flowers per plant and longest flower bunch in chrysanthemum were observed in plants treated with neem seed extract in chrysanthemum. Chrysanthemum plants treated with Anona leaves extract showed phytotoxicity effect in leaves and flowers whereas in Roses phytotoxicity was not observed with any of the tested chemicals.

Key words: Roses, Chrysanthemum, Aphids, organic extracts, insecticides

AN INVESTIGATION OF VIRAL DISEASES IN MARIGOLD

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ABSTRACT

Marigold (*Tagetes erects* L.), belongs to family Asteraceae, is one of the widely grown, popular flowering plant. It is used extensively on religious and social functions. It attracts the attention of growers due attractive range of colors, strong free flowering, short duration to produce marketable flowers, wide spectrum of attractive color, size and shape and good keeping quality. The plant is grown in home gardens, fields in front of community and social institutions for aesthetic purpose. Deformed, curling and narrowing of leaves, shoestring symptoms along with clustering of leaves and stunted growth was observed in marigold plants. According to the literature, marigold plant act as an alternative host for few viruses. Therefore, leaves, live seeds and petals, dry seeds of those symptomatic plants were tested for Chilli veinal mottle virus (ChiVMV) by Enzyme Linked Immunorsorbant Assay (ELISA). Sap of those ELISA positive marigold plants were mechanically rub inoculated to the *Capsicum annaum, Chenopodium amaranticolor* and *Nicotiana tobaccum* plants. Shoots of ChiVMV infected marigold plants were grafted to the above plants. The inoculated plants were maintained inside the insect proof cages to observe the appearance of symptoms. Tested live plant parts showed positive reaction to the ELISA test. Further, virus concentration was high in live seeds and dry seeds showed negative reaction to the ELISA test. ChiVMV sap inoculated and grafted *Capsicum annum* plants showed typical ChiVMV symptoms while *Chenopodium amaranticolor* and *Nicotiana tobaccum* plants showed characteristic local lesions. Further, those inoculated symptomatic plants showed ELISA positive results. The results of this study revealed that the virus disease like symptoms manifested in marigold had infection of ChiVMV. This is the first record of virus infection of marigold in Sri Lanka. Further, this is the first record of ChiVMV infection of marigold in the world.

Key worlds: ChiVMV, Marigold, inoculation, symptoms

MANAGEMENT OF LEAF YELLOWING AND BROWNING PROBLEM IN AQUATIC PLANT *ECHINODORUS BLEHERI*

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Abstract

Echinodorus bleheri, which belongs to the family Alismataceae, commonly known as Amazon sword plant, is one of the popular aquatic plants for their attractive form and general hardiness. *E. bleheri* is cultivated for and used in ponds and artificial aquatic habitats. Cultivating of this plant is very easy, mainly because of almost zero disease problems. However, very recently browning and yellowing of leaves were recorded in *E. bleheri* mother plant cultivations in Sri Lanka. There were around 15 fungal strains have been isolated from this infected leaves. Some of the fungus spp have been identified belonging to the phylum ascomyta, namely *Colletotrichum* sp., *Nigrospora* sp., *Botryodiploidia* sp., and *Pestalotia* sp. Three systemic fungicides namely Carbendazim, Propiconozole, Cu oxichloride, and one contact fungicide, Thiophenate has effectively controlled those fungus under in vitro condition. But efficacy of those fungicides not evaluated at field level. Therefore, this study was done to evaluate the effectiveness of above fungicides at pot trial as well as at field level. Pot trial was conducted at the laboratory premises under protected house and field trial was conducted at the mother plant cultivation located at Padukka under natural condition. All fungicides were sprayed at two weeks intervals according to the manufactures recommendations for both trial simultaneously. After three months, disease incidence was recorded as no of infected leaves per plant. and leaf samples of each treatment in both trial was cultured. In pot trial all fungicides reduced the disease incidence significantly while at field trail only Propiconozole was reduced the disease incidence significantly. But in field trial no of fungus isolated has reduced compared to control. This results revealed that, it is difficult to control fungal infection under natural condition completely. Therefore, it is recommended grow these plants under protected house.

Key Words: Aquatic plant, fungus,

DETERMINATION OF GENETIC VARIATION AMONG ANTHURIAM (*A. ANDRANEANUM*) VARIETIES USING RAPD AND SSR PRIMERS

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ABSTRACT

Anthuriam andraneanum is one of the most economically important floral crops and potted flowers marketed worldwide. To compete with the world market, it is important to develop our own new varieties. While developing new varieties, phenotypic characterization only will not be sufficient. Genotypic variations have to be considered. Therefore, the objective of this study is to identify the genetic relationship among local Anthuriam varieties. Six cultivars of Anthuriam, five local promising lines including "lanka kumari " and "lanka beauty" and an exotic variety "Tropical" received from Regional Agricultural Research and Development Center, Makandura were used for the study. DNA was extracted from young leaves and subjected to PCR with seven RAPD markers and five SSR markers. PCR products were electrophorized in 1.4% agaorose and data was coded in binary (1, 0) form and cluster analysis was performed by using unweighted pair group method with Arithmetic averages (UPGMA) based on wei's genetic distance. According to the RAPD characterization, "lanka beauty" and "Tropical" are genetically close whereas SSR characterization showed that "lanka kumari" and "lanka beauty" are genetically close but exhibited a distant relationship with "Tropical". Therefore, it is clear that although the phenotypic characters are different (due to environmental influence), they can be genetically similar. Therefore, when releasing a new variety, it is important to consider genotypic characters as well as phenotypic characters.

Keywords: Anthuriam, genotypic characterization

EFFECT OF GRADED SHADE LEVELS ON BIOMASS PARTITIONING OF POLYSCIAS BALFOURIANA L. VAR. 'MARGINATA' IN THE BATTICALOA DISTRICT

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ABSTRACT

An experiment was carried out to evaluate the effects of graded shade levels on the biomass partitioning of *Polycias baulfouriana* L. var. 'Marginata' in Batticaloa district of Sri Lanka. Graded shade levels were defined as treatments viz. 0% (T1), 50% (T2), 60% (T3), 70% (T4), and 80% (T5). The experiment was arranged in a completely randomized design. Experimental location was crop farm, Eastern University, Sri Lanka. Recommended agronomic practices were followed uniformly for all treatments. Plant biomass was measured at monthly interval. Analysis of Variance was performed to determine significant difference among treatments ($p < 0.05$). Plants belong to 0 and 80% shade levels produced significantly ($p<0.05$) lowest biomass while plants grown at 50 % shade level reached highest root, shoot and leaf biomass irrespective of growth stages. Biomass allocation for root was highest in 0% shade level. It showed that water was a limiting factor in open field condition. Allocation of biomass for leaves and shoot were highest in 70% and 80% shade levels respectively. It revealed that plants grown at 70% and 80% shade levels were subjected to low light stress. Approximately equal percentage of biomass allocation for root (30%), shoot (39%) and leaves (31%) was observed in plants grown at 50% shade level. Therefore, it could be concluded that, 50% shade level is optimum for growing *Polycias baulfouria* var. 'Marginata' in the Batticaloa district of Sri Lanka as the growth of plants were higher.

Key words: Biomass, Light stress, Shade level

Introduction

Polycias baulfouriana L. var. 'Marginata' (PBM) is a popular foliage plant and it has high demand in the export markets. It is commercially produced in export oriented large scale plantations in Sri Lanka. When expanding floriculture as an industry in Sri Lanka, it is essential to identify new niches for cultivation. Introduction of floricultural crops in the dry zone could be an important intervention in this regard. Climatic requirements of PBM is compatible to the climatic conditions in the Batticaloa district. Therefore this crop could be act as a foreign income earner to this area. However, there is no information available regarding the optimal light intensity for PBM in the Batticaloa district. An important ecological factor to be considered to any cultivated species is the best irradiance level (Mattana, *et al.*, 2006). Shade levels influence the growth and quality of ornamentals plants and provision of shade is recommended for the cultivation of foliage plants in Sri Lanka. There is a relationship between shade levels and biomass partitioning (Dias-Filho, 2000). The biomass partitioning between roots, shoots and leaves influences the photosynthetic capacity and nutrient uptake of a plant, consequently affecting its relative growth rate (van der Werf, 1996). Hence, objectives of this experiment were to determine the effects of graded shade levels on biomass partitioning of PBM and to select optimum shade level for the cultivation of PBM in Batticaloa district of Sri Lanka.

Materials and methods

This experiment was performed from October 2015 to March 2016 at the Crop Farm, Eastern University, Vantharumoolai, Batticaloa (agro-ecological zone DL_2), Sri Lanka. Graded shade levels were defined as treatments viz. 0% (T1), 50% (T2), 60% (T3), 70% (T4), and 80% (T5). The experiment was arranged in a completely randomized design. Each treatment contained thirty plants and an experimental unit consisted of one plant. Uniform, rooted and one month old cuttings were obtained from Tropical Abundance (Pvt) Ltd, Giriulla. Before planting the cuttings were treated with fungicide (Captan®) to avoid infections. The cuttings were planted in polybags (30cm diameter and 30cm height) filled with a potting medium consisting of loamy soil, compost, cattle manure, and sand in a ratio of 4: 2: 1: 1 (volume basis). Plants were arranged at a spacing of 30 plants per m^2. Experimental plants were watered according to the shade levels (high frequency for low shade level and vice versa) and other management practices were followed uniformly according to the recommendation. Plants were destructively sampled monthly in all treatments during the experiment. The measurements made were root biomass (g), shoot biomass (g) and leaf biomass (g) at

monthly interval. (g). Analysis of Variance was carried out to determine significant differences between treatments ($p<0.05$).

Results and discussion

Different shade levels significantly ($p<0.05$) influenced the biomass partitioning of PBM plants at 3 months after transplanting (MAT) (Table 1).

Table 1. Biomass partitioning of the *Polyscias balfouriana* var. "Marginata" under different shade levels at 3 months after transplanting

	Biomass Partitioning(g)		
Shade level	**Root**	**Shoot**	**Leaves**
0% (T1)	7.5233^{b} (45%)	4.6933^{d} (28%)	4.4333^{c} (27%)
50% (T2)	12.9367^{a} (30%)	16.7233^{a} (39%)	13.2333^{a} (31%)
60% (T3)	1.9867^{c} (9%)	15.8667^{b} (56%)	10.21^{b} (35%)
70% (T4)	1.8833^{c} (7%)	14.0333^{b} (57%)	9.1733^{b} (36%)
80% (T5)	0.88^{c} (6%)	10.1267^{c} (71%)	3.1333^{c} (23%)

Means followed by same letter in each column are not significantly different with the Tukey test at 5% level of probability. (n=3)

PBM plants belong to 0 and 80% shade levels produced significantly ($p<0.05$) lowest biomass while plants grown at 50 % shade level reached highest root, shoot and leaf biomass irrespective of growth stages. Optimum partitioning theory (OPT) suggested that, plants shift biomass to capture limiting resources (Forster and Bonser, 2009). Biomass allocation for root was highest in control (T1) as 45% of total biomass of plant. In open field condition, there was a limitation of water in root zone because of higher solar irradiation. Therefore plants allocated more biomass for roots to receive more water. It showed that water was a limiting factor in open field condition. In high light, the radiation load increases and the plants invest more biomass in root to facilitate water uptake (Poorter, 1999). Allocation of biomass for leaves and shoot were highest in 70% and 80% shade levels respectively. It revealed that plants grown at 70% and 80% shade levels were subjected to low light stress. Sustani *et al*., (2014) reported that at low light levels more biomass is allocated proportionally to leaves and the stems but, accordingly, less to roots. Biomass partitioning for root, shoot and leaf were significantly higher in 50% of shade level. Plants grown at this shade level would have received optimum amount of irradiation. There was no limitation of resources for all plants

parts as the allocation of resources were higher and almost equal. Based on the optimal partitioning theory, in 50 % shade level competition for light and water was lower. It may be the reason for the highest biomass produced by plants grown at 50 % shade level.

Conclusion

PBM plants grown at 0% shade level were under water stress due to increased radiation. Plants grown at 70% and 80% shade levels were subjected to low light stress. Approximately equal percentage of biomass allocation for root (30%), shoot (39%) and leaves (31%) was observed in plants grown at 50% shade level. Therefore, it could be concluded that, 50% shade level is optimum for growing PBM plants in the Batticaloa district as the growth of plants were higher.

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EFFECT OF PHOTOPERIOD ON THE VEGETATIVE GROWTH OF *Anthurium AND REANUM VARIETY "RED"*

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Photoperiod could be an important environmental factor determining the morphology of plants. Identification of morphological response to photoperiod in *Anthurium andreanum* could be useful as it a major floricultural crop in Sri Lankan export market. The objective of this study was to determine the effect of photoperiod on vegetative growth morphology of *Anthurium andreanum* variety "Red" in a growth chamber. Three photoperiods of Short Day (SD),Day Neutral (DN) and Long Day(LD) were tested in cycles of 8hours of light/16hours of dark,12hours of light/12hours dark and 16hours of light/8hours of dark respectively. Three replicates were maintained for each photoperiod in a Complete Randomized Design (CRD). Plant height (PH),Total number of leaves (NL) and Number of suckers (NS)were recorded at the beginning of the experiment in 6 month old vegetatively propagated plants. Above data were recorded after one and half month after the photoperiod experiment and analyzed using SAS (9.1 version, USA). New suckers were not produced during the experimental period. The highest increase in PH was recorded from plants of DN (6.7±0.88cm) and SD (6.32±0.35cm).Under LD, significantly lowest increase in PH (3.66±1.76cm) was recorded. The significantly highest NL gain of 3±0.33 was under DN while under LD, the lowest height gain was recorded. Above results indicate that DN could be favorable for vegetative growth of *Anthurium andreanum*. Further exposure of plants to 3 photoperiods may provide information on effect of photoperiod on flowering initiation as well.

Key Words: *Anthurium andreanum*, Photoperiod, Vegetative Growth

Gypsophila paniculata: A POTENTIAL FLORICULTURAL CROP FOR LOW COUNTRY WET ZONE

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Baby's breath (*Gypsophila paniculata* L.*)* is a herbaceous perennial plant, often grown commercially as an annual crop. It is valued as a cut flower in floriculture industry and added as filler to flower bouquets and several other floral arrangements. Although there is a high demand for this cut flower in the market throughout the country, cultivation is mainly confined to the upcountry areas. A study was carried out to explore the suitability of *G. paniculata* for Low Country Wet Zone (LCWZ) conditions through evaluation of growth and yield potential under protected cultivation. First experiment was conducted to identify the effect of Gibberellic acid (GA_3) on growth and yield of two commercial varieties; Million stars and New love. Results revealed that plant height was not influenced by the application of GA_3.

In the 2nd experiment variety Million stars was subjected to pinching, with and without application of GA_3. Results revealed that GA_3 and pinching individually affected the no. of days to bloom. Mean no. of days to bloom was extended with pinching by more than 2 weeks and application of GA_3 also delayed flowering by 7 days when compared to untreated plants. Pinching reduced the plant height, but increased the no. of branches and flower yield significantly.

The study revealed that both the varieties of Gypsophila can be successfully grown in LCWZ under protected house conditions.

Key words: GA_3, growth, *Gypsophila paniculata*, pinching and yield

Introduction

Out of many Gypsophila species *G. paniculata* (family Caryophillaceae) is the major one used in commercial cut flower production. The species is valued as a cut flower in floristry and widely used as a filler to fill the gaps with larger blooms especially with roses and carnations. In addition, it is also used as a dried flower. Gypsophila is popularly known as baby's breath due its soft odor.

It has a seasonal demand in Sri Lanka and catches high price during wedding seasons. The crop is mainly grown in up country areas under rain shelters. Growing crops under protected houses are becoming popular in other parts of the island with various national programmes implemented to uplift the rural livelihood. Introduction of potential crops for those houses is a timely needed activity for income generation and to make a greater contribution to economy.

Gypsophila can be grown as a short term crop and planting can be planned to get the blooms in wedding season. However, effort has not been made to popularize Gypsophila cultivation in other areas of the country. Therefore, a study was conducted at Agriculture Research Station, Thelijjawila to look for the possibility of introducing this important cut flower in to the area with following specific objectives. 1. to identity suitable variety for low country wet zone area. 2. to study the effect of GA_3 for growth and yield and 3. to identify the combine effect of pinching and GA_3 application on growth and yield.

Materials and Methods

Rooted cuttings of two Gypsophila varieties; New love and Million stars were kindly provided by Agriculture Research Station (Department of Agriculture) Sita Eliya, Nuwara Eliya.

Two factorial experiments were conducted inside an insect proof polytunnel in Complete Randomized Design at Agriculture Research Station, Thelijjawila during October to February, 2012. Plants were maintained in the polytunnel under the following conditions. The average temperature inside the polytunnel was in the range of 29 – 30 ^{0}C in the morning (9.00 a.m.) and reached the maximum temperature of 35 ^{0}C at 1.15 p.m. The temperature was reduced to 29 - 32 ^{0}C at 4.00 p.m. whereas the average light intensity at plant level by 9.00 a.m., 1.15p.m.and 4.00 p.m. were 17,289, 18, 575 and 12,294 lux respectively. Sand, compost and topsoil at 1:1:2 ratio (v/v) was used as the potting mixture and pH was adjusted to 6.2 with Dolomite. The potting mixture was treated with Thiophenate – methyl 50 % + Thiram 30 % WP 4 days prior to planting. Urea, Triple Super Phosphate and Muriate of Potash were mixed at 20:33:25 ratio w/w and 13 g from the mixture was added as basal fertilizer and top dressing was done with urea and Muriate of Potash at 1:2 ratio at the rate of 2.2g/pot 1 month after planting. Plants were supported with sticks 3 weeks after planting to prevent stem damage due to bending. Pots were arranged in the polytunnel by giving 50 cm between rows and 30 cm between plants.

Experiment 1

In this experiment effect of GA_3 on growth and yield parameters of two varieties; New love and Million stars were tested. Two forms of GA_3 (Pure GA_3 (Duchefa, G0907.0001) and commercial GA_3 containing 10% GA_3+6%Ca and 2%B) along with control were tested in the experiment which was laid as 2 factor factorial design with 5 replicates. Four weeks after planting, the plants were sprayed with each formulation at the rate of 150ppm which has been recommended in cultivation manual by Dan farm, Israel and KF Bioplants Pvt. Ltd, India (www.kfbioplants.com) to ensure uniform elongation of the shoots. Data were recorded

on Height of the plant. (Weekly, commencing from 1 week after planting to harvesting) and No. of flowers/inflorescence.

Experiment 02:

This experiment was conducted with 2 weeks old rooted cuttings of variety; Million stars to study the effect of pinching and GA_3 application on growth and flower production characteristics. There were 4 treatment combinations with 5 nos. of replicates per treatment. GA_3 application and pinching were done in the morning before 9.00 a.m. one month after planting. Application of GA_3 and pinching were practiced only once during the crop growth. Height of the plant (weekly, from one week after spraying to fully formed inflorescence), number of branches/plant (weekly) and weight of the inflorescence were measured.

Results and Discussion

Experiment 1

Data on plant height is illustrated in table 1. It can be observed from the plant height data that the growth of main shoot is very rapid and it may be due to the high temperature prevailed under local conditions. One week after spraying plant height is in the range of 57-68cm indicating that the plants are at bolting stage (rapidly growing main stem). Normally, Gypsophila is grown to a height 120 cm (http://www.gardenershq.com) and in this experiment plants have almost attained their full length 4 weeks after spraying.

Table 1. Effect of different treatment combinations on plant height up to 4 weeks from spraying

Treatment combination	Mean Plant height (cm)			
	1 week after spraying	2 weeks after spraying	3 weeks after spraying	4 weeks after spraying
New love +pure GA_3	63.8	86.0	95.4	106.5
Million stars + pure GA_3	58.72	74.8	90.08	100.7
New love + Nap Gibb	68.44	85.78	97.8	102.64
Million stars + Nap Gibb	61.72	76.8	89.02	98.92
New love + water	57.32	75.78	91.54	104.92
Million stars + water	64.3	82.74	93.5	100.1

CV%	13.39	14.07	7.95	7.47
	ns	ns	ns	ns

Not significant at p = 0.05

However, the difference in the plant height among the treatment combinations was not significant in all 4 sets of data. Though it is known that gibberellins enhance elongation of internodes and plant growth in ornamental crops (in tulip: Rudnicki *et al*., 1976; in dahlia: Khan and Tewari,(2003) by increasing the cell division and enlargement, no pronounced effect was seen in the present study. The reason for not showing any influential effect of GA_3 on growth in the present study may be due to the fact that gibberellins (GAs) produce the effect of substituting the action of warm temperatures which are needed by the plant to respond to the inductive effect of long days (Shillo 1985). Therefore, the supply of GAs may not be required or its effect is hindered during warm months as plants are exposed to higher night temperatures when grown under LCWZ conditions. However, repeated application of GA_3 might lead to different results.

Table 2. Effect of variety on no. of flowers/inflorescence

Variety	Mean no. of flowers/inflorescence
Million stars	2672.5a
New love	1122.7b
CV%	15.85

Different letters along the column shows significant difference at p = 0.05

Table 2 showed the results of the statistical analysis of data on no. of flowers/ inflorescence. No. of flowers of the inflorescence was significant only at variety level indicating that GA_3 has no profound effect on flower number. The significant difference between two varieties is attributed to the genetic variation. Var. Million stars produced greater no. of flowers than var. new love (Product information, Amazon.com). In a review by Vieira *et al*., (2010) they quoted the findings of Henny *et al*., (1999) They found that GA application increased the number of flowers of *Syngonium podophylum* Schott cv. White Butterfly when treated with 80ppm GA_3. However, no information was found on the temperature under which the study has been conducted. Application of gibberellin ensure flowering under cold temperatures (Shlomo *et al*., (1985) specially when the night temperature is below 12ºC. Though GA_3 had no effect on flower number in the present experiment, it might have increased the flower yield in terms of weight which we have not assessed in this experiment.

Experiment 2

Statistical analysis of no. of days to initiate flower bud opening was significant at both GA3 treatment and pinching. GA3 applied plants have extended flower bud opening time by 7 days than untreated plants (Table 3) GA_3 is known to decrease in time to flower in ornamental crops like rhododendron (Chang and Sung ,2000) Aglaonema (Henny, 1983). However, the response of GA_3 can be varied with the concentration. For eg. at low concentrations of GA_3, no changes in growth and flowering of chrysanthemum were observed (Vieira, 2008). But in this experiment GA_3 delayed flowering and it may be attributed to weather conditions.

Pinching involves the removal of the head of the main stem at an early stage by breaking out the head of the cutting by bending leaving, 8 to 10 pairs of leaves (internodes) on the plant. It is performed only once in the plants life cycle. Pinching is an essential operation in cultivation of gypsophila. If left unpinched cutting continues to grow a main stem and result in the suppression of the emergence and elongation of the side shoots due to apical dominance. Therefore, pinching helps to make balance plant architecture with branches. Delay in flowering in pinched plants may be due to stimulated and extended vegetative growth due to removal of apical dominance (Table 4).

Table 3. Effect of GA_3 on no. of days to initiate flower bud opening

Treatment	Mean no. of days
With GA_3	76.2a
Without GA_3	69.7b
CV%	3.00

Different letters along the column shows significant difference at p = 0.05

Table 4. Effect of pinching on no. of days to initiate flower bud opening

Treatment	Mean no. of days
With pinching	80.8a
Without pinching	65.1b
CV%	3.00

Different letters along the column shows significant difference at p = 0.05

Table 5. Effect of pinching on plant height up to 4 weeks from spraying

	Mean height of plant (cm)			
	1 week after spraying	2 weeks after spraying	3weeks after spraying	4weeks after spraying

Without pinching	64.3a	88.6a	100.75a	110.5a
With pinching	42.7b	55.25b	74.7b	92.75b
CV%	16.25	11.92	8.43	5.89

Different letters along the column shows significant difference at p = 0.05

Tables 5 pointed out that GA_3 application had no contribution towards plant height but pinching has significant effect. The difference in plant height in all 4 sets of data was significant and at the beginning the difference between pinched and unpinched plant was 22 cm while at flowering it is about 18cm.

Table 6.Effect of pinching on no.of branches

Treatment	Mean no. of branches
Without pinching	0.1b
With pinching	4.1a
CV%	11.98

Different letters along the column shows significant difference at p = 0.05

Pinching induces formation of branches by removing apical dominance. The auxin inhibits the growth of lateral buds and so its removal enables the lateral buds to grow and the plant becomes fuller and more bushy. Table 6 showed that no. of branches was significantly different between two treatments. Unpinched plants hardly produced branches and the average is 0.1 branches per plant. Pinched plants produced 4.1 no. of branches.

Table 7. Effect of pinching and GA_3 application on weight of the inflorescence cv. Million stars

Treatment combinations	Mean weight of flowers(g)/plant
Pinching + 150 ppm pure GA_3	116.70^b
Pinching + Without GA_3	119.06^a
Without pinching + 150 ppm pure GA_3	115.32^b
Without pinching + Without GA_3 (control)	107.3^c
CV%	4.53

Different letters along the column shows significant difference at p = 0.05

The yield of flowers was measured by weight up to end of February through staggered harvesting. Table 7 showed that the weight of flowers was significantly affected by treatment combinations. The highest yield (119.06g) was observed in pinched plants without GA_3 and the lowest yield (107.3g) was recorded by control plants. GA3 treated plants (with or without pinching) produced statistically similar yields. The no. of panicles that could be harvested

form pinched plants is higher than the unpinched plants due to higher no.of branches. GA_3 has a marginal effect on increasing flower yield as the quantities of flowers were more than the untreated plants (control). Shlomo *et al*. (1985) stated that GA_3 had insignificant promotive influence under fully inductive condition of long day and high temperatures. The results we obtained here are at par with their findings.

Conclusions

The results of our experiments revealed that both varieties of Gypsophila can be cultivated in Low Country Wet Zone under protected house conditions. Though application of GA_3 is not required, pinching can be recommended as it produces more number of branches and thereby increased the flower yield in cultivation of *G. paniculata.*

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PRESERVATION OF *Exacum ritigalensis* (BINARA / GINIHIRIYA) FLOWER USING PARAFFIN WAX

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Abstract

Fresh flowers of *Exacum ritigalensis* are firm and they last within few days. So, it is essential to find some effective way to remain the colour and freshness. Paraffin wax is a white or colourless soft solid mixture of hydrocarbon molecules which is solid at room temperature and begins to melt above approximately 37 °C. From this study evaluate the minimum damage to colour and shape of the flower through changing the melting temperature in dipping and storage. The solid paraffin was put into the double boiler and it was stirred constantly (to melts evenly and to prevent lumps or clots from forming). Then flowers were dipped gently in paraffin wax which was at different temperatures (60°C, 65°C, 70°C, 75°C, 80°C and 85°C). Control experiment was conducted at room temperature without waxing. The excess wax was removed by shaking the flowers and they were subsequently dipped into cool water (14°C). Finally they were stored in a refrigerator at 14°C and room temperature. The appearance of flowers was observed after a week. The colour intensities and shape were ranked using a scale 0, 1, 2, 3, and 4 according to the floral colour fading and shape; not changed, change is less, moderately changed, change is higher and the highest respectively. Two factors factorial Completely Randomized Design (FCRD) with ten replicates for each treatment were used for study. Statistical analysis was performed with Duncan's multiple range test using SAS software (version 9.1.3). It was observed that at 60°C and 65°C, wax was solidified and unable to dip the flowers. At 80°C and 85°C, experiment was not successful due to shrink of petals and discoloration. Results showed that there is no significantly different in shape of the flower at 70°C and 75°C. However at 75°C, colour of flower was faded compare to 70°C. After one week, colours of flowers were faded at room temperature and there were no colour change of flowers which were stored in refrigerator. The flowers, waxing under 70°C and stored in refrigerator were given the best results comparing to other treatments.

Keywords*: colours, Exacum ritigalensis, paraffin wax, preservation,*

Enhancing the post harvest longevity and quality of ornamental flowers for

Introduction

Degradation of the quality and appearance of flowers is a problem found in fresh floral decorations. Petal wilting, petal drop and petal discoloration cause to reduce the economic value of floral decorations. Even though there are such methods to improve the quality and appearance of flowers, sometimes those are time consuming and economically not profitable (1- MCP, Ascorbic acid) (Obadamudalige et al.,2014). There are many commercial florists who are preserving fresh flowers using various chemicals. But at market those flowers are very expensive. So it is important to find a low cost method to preserve flowers for floral decorations.

The objective of this study is to find an effective method to preserve fresh flowers using household wax to extend the vase life and to improve the quality of the ornamental flowers.

Materials and methodology

Fresh flowers of Bougainville species, *Plumaria acuminate*, Rose, Orchid were collected from Matara district.

Pure wax solution was prepared by melting household paraffin wax at 100^0C and maintained the temperature at 70^0C using a water bath. Colored wax solutions were prepared by melting household wax with colour pastels. Food colouring solution (1:1) was prepared to dip *plumariaaccuminata* flowers in order to modify the flower colour.

Selected flowers were submerged into the wax until entire up to the stem is covered. Then the flower was removed from the wax and it was gently shaked to remove the excess wax. Just after dipping in the wax, flowers were dipped into cold water at room tempresture. It helps to push the petals back as original flower and to accelerate the cool down. Then they were kept in cold water for 5 minutes. Wax applied flowers were kept for drain excess water and dry.

Waxed flowers kept in refrigerator in different durations (12hr, 24hr, 48hr and 72hr). After kept in refrigerator they were kept under room condition for different durations (6hr, 12hr, and 24hr). Appearance was recorded according to a scale given below based on flower colour and quality.

Very good - 1
Good - 2
Moderate - 3
Unpleasant - 4

Completely Randomized Design (CRD) with five replicates was used for study. Statistical analysis was performed with Duncan's multiple range test using SAS software (version 9.1.3).

Result and discussion

Appearance just after waxing

Table 1.Appearance just after waxing

	Bougainville	Orchid	*Plumariaaccuminata*	Rose
Waxed	1^a	1^a	1^a	1^a
Natural	3^b	3^b	3^b	3^b

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Result showed that waxed

flowers (Bougainville, Orchid, *Plumariaaccuminata*, Rose) significantly with very good appearance and quality than natural flowers.

Figure 1. Waxing for roses

Figure 2. Waxing for orchids

Figure 3. Waxing for bougainville

Figure 4.Waxing for *Plumariaacculminata*

After 12 hours of cooling time

	Bougainville	Orchid	Plumaria	Rose
Chilled	1^a	1^a	1^a	1^a
Room temperature	3^b	3^b	3^b	3^b

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Result showed that the waxed flowers of Bougainville, Orchid, *Plumaria accuminata* and Rose are significantly with very good appearance when stored in a refrigerator for 12 hours. The waxed flowers which are stored at room temperature were not look attractive when compared with chilled flowers.

Figure 5. Waxing for *Plumariaaccuminata*

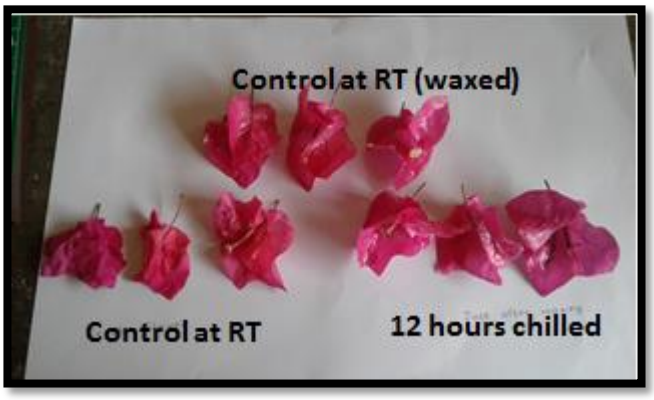

Figure 6. Waxing for bougainville

Figure 7. Waxing for Orchids

Figure 8. Waxing for roses

After 24 hours of cooling time

	Bougainville	Orchid
Chilled	1^{a}	1^{a}
Room temperature	3^{b}	3^{b}

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Result showed that the waxed flowers of Bougainville and Orchid are significantly very good when stored in a refrigerator for 24 hours. The waxed flowers which are stored at room temperature were not look attractive when compared with chilled flowers.

Figure 9. Waxing for Bougainville

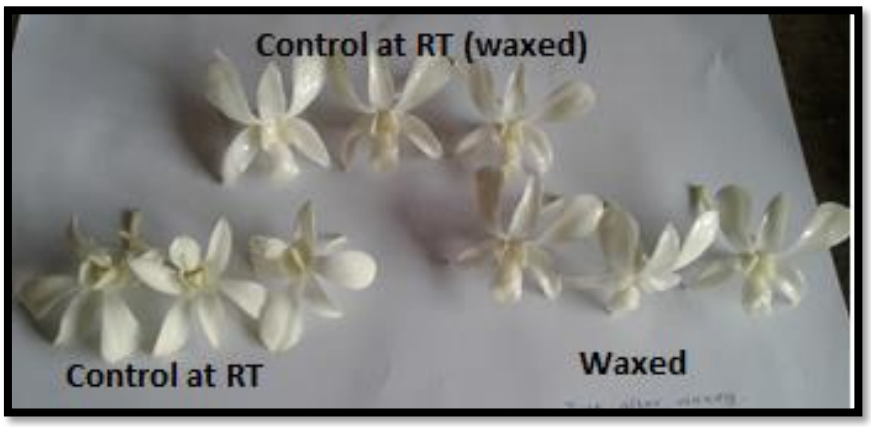

Figure 10. Waxing for orchids

<u>After replacing the 24 hours chilled waxed flowers in to room temperature for 12 hours</u>

	Bougainvill e	Orchid
Waxed	1^a	1^a
Control (waxed but keep in room temperature)	3^b	3^b

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$)

Result showed that the waxed and 24 hours chilled flowers of Bougainville and Orchid are significantly very good even in room temperature for 12 hours. The waxed flowers which are stored at room temperature were not look attractive when compared with chilled flowers.

Figure 11. Waxing for bougainvillea

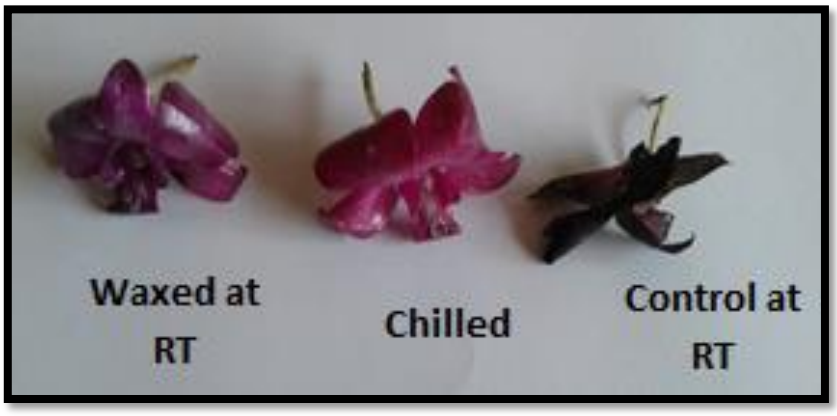

Figure 12. Waxing for orchids

After replacing the 24 hours chilled waxed flowers in to room temperature for 24 hours

	Bougainville	Orchid
Waxed	1^a	1^a
Control (waxed but keep in room temperature)	3^b	3^b

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Result showed that the waxed and 24 hours chilled flowers of Bougainville and Orchid are significantly very good even in room temperature for 24 hours. The waxed flowers which are stored at room temperature were not look attractive when compared with chilled flowers.

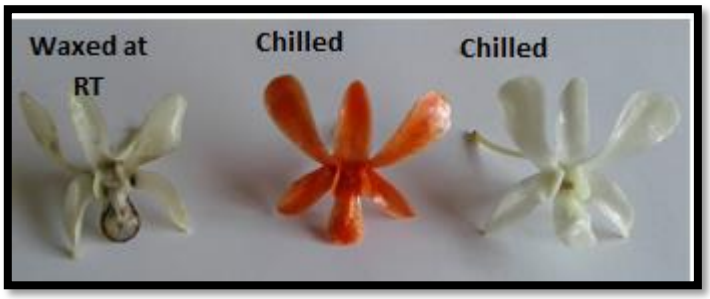

Figure 13. Waxing for orchids

Figure 14. Waxing for bougainvillea

After replacing the 24 hours chilled waxed flowers in to room temperature for 48 hours

	Bougainville	Orchid
Waxed	1^a	1^a

Control (waxed but keep in room temperature)	3^a	3^b

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Result showed that the waxed and 24 hours chilled flowers of Bougainville and Orchid are significantly very good even after replacing in room temperature for 48 hours. The waxed flowers which are stored at room temperature were not look attractive when compared with chilled flowers.

Figure 15. Waxing for bougainvillea

Figure 16. Waxing for orchids

Conclusion

Household wax at 70^{o}C can use as effective method of preserving flowers with good appearance and quality. To enhance the vase life of waxed flowers refrigeration / chilling can use.

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RESPONSE OF *Exacum ritigalensis* (BINARA / GINIHIRIYA) UNDER INDUCED DROUGHT STRESS BY MANNITOL

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Abstract

Exacum ritigalensis (Binara), which seems Kurunegala district, Anuradhapura district, Kandy district and Badulla district, is subjected to a range of abiotic stresses due to unpredicted climatic changes that affect their seed germination and growth. Mannitol is used to induce osmotic stress in plants which is an osmotic adjustment chemical to control osmotic potential in the culture media or nutrient solutions in order to induce water deficit conditions for protein expression or proteomics studies. In this situation, the main objective of this study was to evaluate the resistance of seed germination and seedling growth of *E. ritigalensis* in drought conditions which was induced by Mannitol. Seed pods were sterilized and seeds were introduced to hormone free agar medium (8000 mgL^{-1}) with different concentrations of mannitol (0, 10, 20, 30, 40 and 50 mgL^{-1}). Seedlings heights, length of the root and number of germinated seeds were recorded after two months of culture. Completely Randomized Design (CRD) with five replicates was used for study. Statistical analysis was performed with Duncan's multiple range test using SAS software (version 9.1.3). Results showed that significantly the highest seed germination (98%) from *E. ritigalensis* in control (0 mgL^{-1} mannitol concentrations). In other treatments (10, 20, 30, 40 and 50 mgL^{-1}) seeds were not germinated. Mean height and root length of the four month old *E. ritigalensis* seedlings were 0.52 cm and 0.12 cm respectively. Finally, results were revealed that seeds of *E. ritigalensis* were not resistant to under controlled drought condition from seed germination and growth of seedlings.

Keywords*: Exacum ritigalensis, Drought stress, Mannitol, Seed germination*

EFFECT OF CALCIUM COCENTRATION FOR PRODUCING HIGH QUALITY FLOWERS IN *Gerbera jamesonii*

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ABSTRACT

Gerbera (*Gerbera jamesonii)* is an ornamental cut flower which possesses high demand on commercial scale in Sri Lanka. But bent neck due to low stem thickness is a major issue associated with gerbera in floral decorations. Therefore present study was aimed to find out the best calcium concentration to produce of high quality stem of *Gerbera jamesonii* as a pre-harvest treatment. The Experiment was conducted at the Gerbera plant house located at Botanic Gardens, Henarathgoda, Gampaha by using potted (pot mixture consists of 1:1:1 sand: coir dust and half burned paddy husk) tissue cultured Gerbera plants, i.e. Variety Fredi. The experiment was arranged as a Completely Randomized Design (CRD) with six treatments randomized in three replicates. Treatments were the six different calcium concentrations (g), i.e. 0 (control), 0.25, 0.15, 0.1, 0.2 and 0.3 applied to the plants in every three weeks. All cultural practices were done similar to other plants. Once a week measurements were taken on height of the stem, stem thickness, number of leaves per plant as well as the head diameter. The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at p=0.05.Stem thickness (mm) had significant differences ($p<0.05$) among different calcium concentrations tested. The highest stem thickness was recorded from the highest calcium concentration applied treatment, i.e. 0.3g whiniest the lowest from no calcium applied treatment, i.e. control. Head diameter was not significantly different ($p>0.05$) within calcium levels of 0.15 and 0.2. Furthermore the highest stem height, head diameter as well as number of leaves per plant recorded from the highest calcium concentration applied plants. However, number of leaves per plant was not significant different ($p<0.05$) among high calcium concentrations, i.e. 0.3, 0.2 and 0.1. Overall results showed that the application of 0.3g of calcium was the most effective treatment to produce high quality stem of *Gerbera jamesonii*.

Key words: Gerbera jamesonii, calcium concentrations, stem thickness, quality flowers

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BIOFILMED BIOFERTILIZERS (BFBFS) ENHANCES GROWTH AND CONTROL OF DISEASES OF *ANTHURIUM ANDREANUM*

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Abstract

In Sri Lanka, *Anthurium andreanum* is one of the main cut flowers grown for export and local market. The commercial cultivations of *A. andreanum* are highly susceptible to bacterial and fungal diseases resulting in growth retardation. Mitigation of diseases and thereby optimize growth, development and yield require synthetic agrochemicals. Thus high cost of agrochemicals decreases profits in commercial cultivations. Further, agrochemicals pollute the environment. Biofilmed Biofertilizers (BFBFs) are a cost effective and environmentally friendly option for mitigating diseases and optimizing crop growth. Here, the effects of BFBFs on growth and disease incidences in *A. andreanum* were examined, using five fertilizer treatments ($r=10$); recommended dose of BFBFs, recommended dose of chemical fertilizer, half the recommended dose of chemical fertilizer, recommended dose of BFBFs with half the recommended dose of chemical fertilizer and distilled water (the control). The treatments were applied separately to two groups of plants; infected and healthy. The experimental design was a factorial Complete Randomized Design. Plant growth and disease incidences were evaluated and data were statistically analysed by General Linear Model and Tukeys' post hoc using Minitab ($p<0.05$). The biomass of plants and root lengths were significantly increased by the application of BFBF compared to the control. Half the recommended dose of chemical fertilizer alone and combined with the recommended dose of BFBF decreased incidences of diseases. In conclusion, the BFBFs improved the growth of roots and disease incidences in *A. andreanum*.

***Keywords*:** *Anthurium andreanum*, Biofilmed biofertilizer, diseases, growth

INTRODUCTION

A. andreanum occupies an important position in the cut flower trade. It is grown for its attractive flowers as well as foliage. In number of stems, it is the second highest tropical cut flower traded in the globe. The government of Sri Lanka has identified *A. andreanum* as one of the priority crops for the expansion of cultivated extent and volume exported (Kelegama, 2001). However, exports volume of *A. andreanum* has drastically dropped from year 2004 because cultivations were affected by diseases which caused 20-60% drop in export volumes (Sashanka, 2014).

A. andreanum is highly susceptible to bacterial and fungal diseases that can seriously decrease yield and quality in commercial productions (Norman *et al,* 2012). Bacterial blight caused by *Xanthomonas campestris* pv. *dieffenbachiae* can rapidly kill the plants. Fungicides containing phosphorous acid may prevent infection but is ineffective against systemically infected plants (Norman *et al,* 2006). Root rots caused by *Phytophthora nicotianae* var. *parasitica* and *Pythium splendens* are also common in *A. andreanum*. Plants with root rot will wilt even though the soil moisture is adequate. Severe infections will result in black to brown leaf lesions. Plants with symptoms should be discarded and the rest of the production facility should be treated with a fungicide drench. Fungicide such as mefenoxam, dimethomorph and phosphorous acid may be used to control pathogens causing root rots (Norman *et al.,* 2012).

Biofilmed biofertilizers (BFBF) is a multifunctional fertilizer which can be used to enhance growth of plants and mitigate diseases in *A. andreanum.* A biofilm can consist of microorganisms such as algae, fungi and bacteria plus an extracellular biopolymer known as extracellular polymeric substances (Seneviratne *et al*. 2007). BFBFs can be either a mixture of Fungal-Bacterial Bio-film and/or Fungal-Rhizobial Bio-film which is applied to the growing medium of plants. BFBFs make bio-films on the roots after which the microorganisms in BFBFs and the roots establish an association that is positive on crops' health, growth and yield.

BFBFs enhance the nutrient supply to the plant by fixing and mobilizing nutrients through biological activities that occur between the microorganisms and the root zone soil. BFBFs can compete with and suppress the phytopathogenic microorganisms by competing for the resources in root zone. Therefore, BFBF can decrease the cost spent on synthetic agrochemicals for disease control and nutrient supply. Importantly BFBF is environmentally friendly and multifunctional bio-fertilizer for a sustainable agriculture (Seneviratne and Zavahir, 2008).

BFBFs controlled the diseases and improved growth of commercial scale *Cordyline fruticosa*, *Dracaena sanderiana* and *Hevea brasiliensis* plantations (Hettiarachchi *et al.,* 2014, Udagedara, 2015). Therefore BFBFs may be used for mitigating diseases and improving growth of *A. andreanum* in Sri Lanka for which evidences do not exist. Thus here the effects of BFBF on growth of *A. andreanum* and disease incidences were examined.

MATERIALS AND METHODS

The experiment was conducted at the Research Division, Royal Botanic Garden, Peradeniya (N 80.59º, E 7.27º) from October, 2015 to February, 2016. The temperature variation inside the shade house was between 20-29 ºC.

Nursery stage (both healthy and diseased) 4 weeks old plants of *A. andreanum* Var. "Tropical" were obtained from the tissue culture division of the Royal Botanic Garden, Peradeniya. Plants were established in pots filled with a media of leaf mould: cattle manure: sand (v/v/v, 1:1:0.5). All plants were kept in a shade house during the experiment.

A factorial Complete Randomized Design (CRD) where two factors were, health status and fertilizer regime was used. Fertilizer regime had five treatment levels applied to plants at two health statuses, namely, diseased and healthy plants (*r=10*). The fertilizer treatments were; the recommended dose of BFBF, the recommended dose of chemical fertilizer, half the recommended dose of chemical fertilizer, half the recommended dose of chemical fertilizer combined with recommended dose of BFBF and distilled water (control).

BFBF was prepared by dissolving 3 ml of '*Bio-film- F'* (developed by the National Institute of Fundamental Studies) in 1L of distilled water under sterile conditions and applied 50 ml plant^{-1}. The recommended dose of chemical fertilizer was prepared by dissolving 2.5 g of *Grow More Fertilizer-Nitro Plus* (Unipower Pvt. Ltd.) in 1L of distilled water and applied 50 ml plant^{-1}.Half the recommended dose of chemical fertilizer was prepared by dissolving 1.25 g of *Grow More-Nitro Plus* in 1L of distilled water and applied 50 ml plant^{-1}. Half the recommended dose of chemical fertilizer combined with the recommended dose of BFBF was prepared by dissolving 3 ml of '*Bio-film- F'* and 1.25 g of Grow More-Nitro Plus in 1L of distilled water under sterile conditions and was applied 50 ml plant^{-1}. Distilled water was used as the control and applied 50 ml per plant. Fertilizers were applied at an interval of one week for 14 weeks during the experiment.

Plant height, number of leaves, leaf chlorophyll content, length of roots, fresh weight were measured at the beginning and at the end of the experiment after uprooting plants. The parametric data were scaled by dividing final values by the initial values. Numbers of diseased/ infected leaves were counted weekly during the experiment, and were used to calculate Disease Incidence Index where numbers of infected leaves were divided by the total number of leaves on the plant (Sharma, 2015). Data were statistically analyzed by General Linear Model and Tukeys' post hoc using Minitab (p<0.05).

RESULTS

None of the treatments were significantly different on increment of height, number of new leaves initiated and chlorophyll content in leaves in both healthy and diseased groups (Table 1 – 3). The application of the recommended dose of BFBF increased the root lengths of diseased plants by 76% compared to the control (Table 4; Plate 1). In healthy plants, the

application of the recommended dose of BFBF resulted in the longest roots and shortest roots were found in plants which recommended dose of chemical fertilizer was applied (Table 4).

Table 1 Effect of fertilizer treatments on height increment of healthy and diseased *Anthurium andreanum* plants

Treatment	Height increment[1]	
	Healthy plants	Diseased plants
Recommended dose of BFBF	1.3±0.03[a]	1.3±0.1[a]
Recommended dose of chemical fertilizer	1.1±0.8[a]	1.2±0.1[a]
Half the recommended dose of chemical fertilizer	1.2±0.1[a]	1.4±0.1[a]
Half the recommended dose of chemical fertilizer combined with the recommended dose of BFBF	1.1±0.1[a]	1.3±0.1[a]
Distilled water	1.7±0.4[a]	1.2±0.1[a]

[1] Means ± SE (*n=10*) and values followed by the same letter within each column are not significantly different ($p<0.05$).

Table 2 Effect of fertilizer treatments on number of new leaves initiated in healthy and diseased *Anthurium andreanum* plants

Treatment	Number of new leaves initiated[1]	
	Healthy plants	Diseased plants
Recommended dose of BFBF	1.1± 0.1[a]	1.2± 0.1[a]
Recommended dose of chemical fertilizer	1.2± 0.1[a]	1.1± 0.1[a]
Half the recommended dose of chemical fertilizer	1.2± 0.1[a]	1.1± 0.1[a]
Half the recommended dose of chemical fertilizer combined with the recommended dose of BFBF	1.2± 0.1[a]	1.1± 0.1[a]
Distilled water	1.2± 0.1[a]	1.2± 0.1[a]

[1] Means ± SE (*n=10*) and values followed by the same letter within each column are not significantly different ($p<0.05$).

Table 3 Effect of fertilizer treatments on chlorophyll increment in leaves of healthy and diseased *Anthurium andreanum* plants

Treatment	Chlorophyll increment[1]	
	Healthy plants	Diseased plants
Recommended dose of BFBF	1.0± 0.01[a]	1.0± 0.04[a]
Recommended dose of chemical fertilizer	1.2± 0.03[a]	1.2± 0.03[a]
Half the recommended dose of chemical fertilizer	1.0± 0.02[a]	1.0± 0.03[a]
Half the recommended dose of chemical fertilizer combined with the recommended dose of BFBF	1.1± 0.05[a]	1.1± 0.03[a]

Distilled water	1.0± 0.03[a]	1.0±0.02[a]

[1] Means ± SE (*n=10*) and values followed by the same letter within each column are not significantly different ($p<0.05$).

Table 4 Effect of fertilizer treatments on root length of healthy and diseased *Anthurium andreanum* plants

Treatment	**Root length increment[1]**	
	Healthy plants	**Diseased plants**
Recommended dose of BFBF	1.8±0.2[ab]	2.3±0.2[a]
Recommended dose of chemical fertilizer	1.5±0.2[ab]	1.2±0.1[b]
Half the recommended dose of chemical fertilizer	1.5±0.1[ab]	1.6±0.3[ab]
Half the recommended dose of chemical fertilizer combined with the recommended dose of BFBF	1.7±0.1[ab]	1.7±0.2[ab]
Distilled water	1.5±0.2[ab]	1.3±0.2[b]

[1] Means ± SE (*n=10*) and values followed by the same letter within each column are not significantly different ($p<0.05$).

Plate 1 Roots development of *A. andreanum* exposed to treatments; T1-Recommended dose of BFBF, T2- Recommended dose of chemical fertilizer, T3- Half the recommended dose of chemical fertilizer, T4- Half the recommended dose of chemical fertilizer with recommended dose of BFBF, T5- Distilled water

The maximum biomass of plants were obtained when recommended dose of BFBF were applied to healthy plants. In both healthy and diseased plants the control resulted in the lowest biomass compared to other treatments (Table 5).

In healthy plants the lowest numbers of infected leaves were obtained from half the recommended dose of chemical fertilizer alone and in combination with the recommended dose of BFBF while the highest was from the control (Table 6). In diseased plants highest numbers of infected leaves were from the plants for which recommended dose of BFBF was applied (Table 6).

Table 5 Effect of fertilizer treatments on biomass of healthy and diseased *Anthurium andreanum* plants

Treatment	Biomass increment[1]	
	Healthy plants	Diseased plants
Recommended dose of BFBF	3.2± 0.4[a]	2.6±0.3[ab]
Recommended dose of chemical fertilizer	2.5±0.3[ab]	2.6±0.4[ab]
Half the recommended dose of chemical fertilizer	2.3±0.2[ab]	2.4±0.1[ab]
Half the recommended dose of chemical fertilizer with recommended dose of BFBF	2.6±0.1[ab]	2.0±0.2[ab]
Distilled water	2.3±0.3[ab]	1.8±0.3[b]

[1]Means ± SE (*n=10*) and values followed by the same letter within each column are not significantly different ($p<0.05$).

Table 6 Effect of fertilizer treatments on percentage of infected leaves in healthy and diseased *Anthurium andreanum* plants

Treatment	Percentage (%) of infected leaves[1]	
	Healthy plants	Diseased plants
Recommended dose of BFBF	7.8±3.3[ab]	19.8±4.6[a]
Recommended dose of chemical fertilizer	4.5±2.3[ab]	14.9±4.6[ab]
Half the recommended dose of chemical fertilizer	3.1±2.1[b]	18.0±4.0[ab]
Half the recommended dose of chemical fertilizer with recommended dose of BFBF	3.4±2.0[b]	9.6±3.3[ab]
Distilled water	11.9±4.8[ab]	12.5±2.2[ab]

[1] Means ± SE (*n=10*) and values followed by the same letter within each column are not significantly different ($p<0.05$).

DISCUSSION

The BFBF did not effectively control diseases of *A. andreanum* vegetative plants (Table 6). However, application of lower than recommended levels of chemical fertilizer with BFBF resulted in lower disease development in *A. andreanum* (Table 6) and same trend was seen in *Dracaena sanderiana* and *Cordyline fruticosa* (Udagedara, 2015). It is possible that chemical fertilizers supply nutrients efficiently to the plant thus strengthening the plants against diseases and concurrently BFBF may shift the soil microbial populations towards the beneficial range. Further BFBF may suppress the communities of harmful microbes in the media by breaking the dormancy of microbial seeds, increasing the number and diversity of microbes which are antagonistic on pathogenic microorganisms (Seneviratne, 2014; Buddhika *et al.,* 2013). Also, release of organic acids by BFBF suppresses microbial pathogens (Browning *et al,* 2006).

BFBF increased root lengths of *A. andreanum* plants (Table 4) and similar effects were seen in *Hevea brasiliensis* seedlings where highest root growth was recorded for BFBF treatments (Hettiarachchi, 2014). Positive link between BFBF and root growth may due to the synthesis of indole acetic acid and cytokinins by bacteria of the genera Azotobacter and Azospirillum in BFBF, which promotes the root lengthening and branching (Jagnow *et al.,* 1991, Noel *et al.,* 1996).

The higher biomass of *A. andreanum* plants applied with BFBF (Table 5) may have been due to enhanced root growth (Table 4) leading to increased uptake of nutrients from soil thus promoting plant growth (Jagnow *et al.,* 1991, Noel *et al.,* 1996). Further, BFBF attached to the plant roots of *Oryza sativa*, *Camellia sinenesis* and *Triticum* spp. facilitates cycling of nutrients increasing soil fertility and thus plant growth (Seneviratne, 2003). Also solubilization of mineral nutrients in soil by BFBF could have contributed to the increased plant growth as seen for *Camellia sinenesis* (Hettiarachchi *et al.,* 2014, Seneviratne *et al.,* 2009 and Seneviratne *et al.,* 2011).

The content of chlorophyll in leaves was not improved by BFBF (Table 3) as seen in *Cordyline fruticosa* (Udagedara, 2015). Heavy colonization of fungal-rhizobial biofilms on *Oryza sativa* and *Camellia sinensis,* forms "pseudonodules" on root hairs, which fixed N_2 biologically that lead to increase in chlorophyll contents in leaves (Seneviratne *et al.,* 2010). Thus it is possible the level of colonization was not adequate to for the formation of "pseudonodules" or fixation of N_2 to effectively enhance chlorophyll synthesis in *A. andreanum*.

In conclusion, application of recommended dose of BFBF with half the recommended dose of chemical fertilizer is effective on decreasing incidences of diseases in *A. andreanum* plants. The biomass especially of roots was promoted by applying the recommended dose of BFBFs.

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INVESTIGATION OF ROSES MARKET LANDSCAPE IN SRI LANKA

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The main purpose of this study was to investigate the market landscape of roses, map the market, identify the market issues, trend analysis, and market institutions of roses in Sri Lanka.Roses has high demand in local and also internationally.It has immensely competitive with the presence of other export countries. The study heavily based on secondary data obtained from Sri Lanka Customs, Sri Lanka Export Development Board and private sector organizations related to the industry. Our approach was to investigate the timeline of the roses marketing with special concern on product, price, place and promotion. Sri Lanka has potential to develop the roses market in locally and internationally. There is a comparison between the world trend and the production of roses in Sri Lanka.

Key words: Market landscape, Roses, Sri Lanka

INTRODUCTION

Sri Lanka, presently accounts for less than 0.2% of the global flower trade and has potential to secure large share. Roses production is limited to about 40,000 blossoms per annum. This is mainly due to the highly expert conditions required for cultivation and production. Approximately 2-3 hectares of area have so far been used for cultivation of roses. Roses for the export market are grown under controlled environments in poly tunnels. Consumer

preferences of roses are vary on occasion, color, size and the quality of the flowers. Color preferences varied on demand basis and market demand split into red-50%, Pink-30%, yellow-10% and others 10%. Roses are quite popular in the local market and considered as expensive treat. In general, most of them growers are belongs to the small-medium category(FAO,2016).Country's favorable climatic and other resources better location to establish the rose industry.Kenya is now in the process of developing the export market.Kenya has almost the same climate as Sri lanka.They contribute 1% to the European market.There are huge opportunities and areas to be developed but the proper researches and investigations are not conducting accordingly.This study is aiming on the marketing evolution, timeline and the market landscape of roses which provides a clear piece of information about how the current marketing system has to perform and what are the expected changes to be applied to survive with the bigger competitors locally and internationally in upcoming years.

MATERIALS AND METHODS

The study was heavily based on the secondary data and the collection of data was targeted on government authorities such as Sri Lanka Customs, Sri Lanka Export Development Board, Royal Botanical Garden,Peradeniya. Rose growers in Bandarawela and Hayles PLC facilitated to collect market data and contributed on interviews.Data categories wereauction prices, export values and quantities, import values and quantities and extent of cultivation. Poor data base management and unavailability of time series data hinder the progress of market landscape analysis and we have to consider limited period for analysis. Collected data was analyzed and identified with the special features accordance with the product, price, place, promotion, physical environment, people, and process.Analysis facilitated by the Microsoft Excel software and timer series analysis helped to identify the market trends.

RESULTS AND DISCUSSIONS

Market Landscape development was the key objective of this study. Marketing mix variables were the key parameters where study aimed to identify product, price, place and promotion of roses through the time line. Unavailability of quality secondary data limit the analysis into several years and study recommends proper data base management is essential for future decision marking arena. Figure 1, discuss the four main marketing mix variables and its evolution.

Figure 1: Market landscape of roses

In general,flower consumption of the Sri Lankan consumers can be segment as wedding ceremonies, religious events, interior decoration and the recreational purposes.Flowers play an important role in all special events, i.e. household, religious institutions, offices, etc., as interior decorations.Roses is a most common temperate cut flower market in Sri Lanka.There is a high demand for roses in locally for weddings, ceremonies and social events etc. And also there is a special seasons and days such as Valantine the demand is high for roses.The price fluctuations can be observed according to these seasons.Sri Lanka has favorable climate locations such as Nuwara Eliya, Bandarawela, Balangoda to cultivate the roses in commercial scale. Currently small holders were the main functioning farm group for rose cultivation and their main purpose of the business is producing plantlets. Limited attention had paid to produce cut flower production with good manufacturing practices.

Roses are produced to satisfy the local consumer needs and only the surplus is exported occasionally in small amounts. Global as well as increasing local demand recognize as an important agribusiness venture.Further, industry fetched high demand on value addition and globally floral products market growing rapidly. Rose as cut flower is very competitive and

demand based on quality, variety, freshness and the price. Promotion and distribution elements were poorly recognized and less developed. Informal promotional tools, specially word of mouth, personal relations, social networks dealing in promotional activities locally. Farmers have their own distribution channels to bring flowers to the market places and direct dealing with consumers was more common. Growing demand in cosmetics and Sri Lankan cosmetic manufacturers places high demand for flowers as raw material but local supplies unable to cater the industry demand. There is market for the products produce from natural roses such as roses extracted perfumes, natural dyes and floral designs can build the market for roseproduction to be expand for further more. Figure 2 explain the market trends of roses in Sri Lankan market.

a. b.

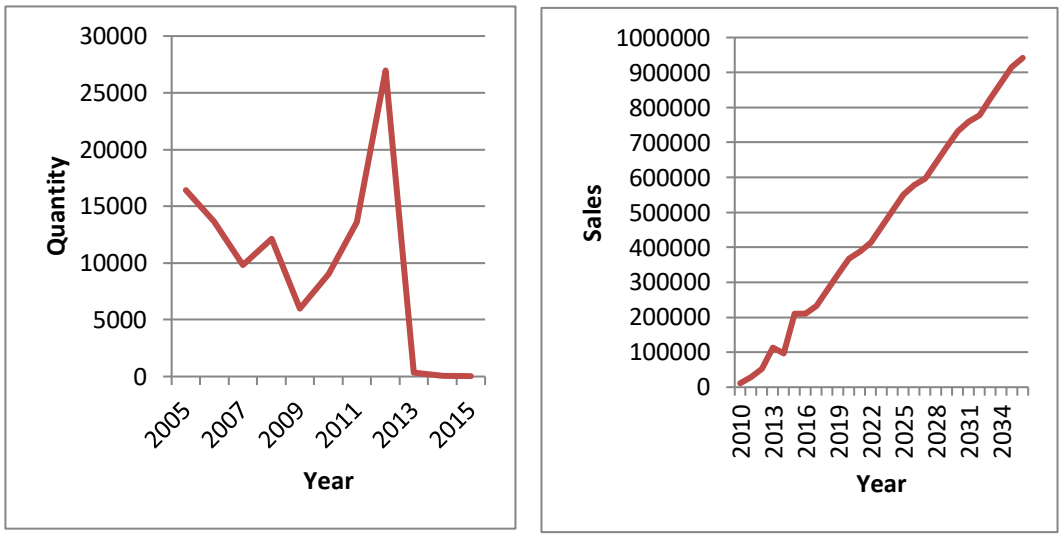

Figure 2: a. Total quantity produced (2005-2015); b. Volume sales and trend analysis

The demand for roses showed declining trend during the period of 2005-2007, due to the economic down turn. In year 2007 there was shift in production of roses by small scale growers and which created positive trend. An increasing trend observed during the period of 2010 to 2012 and in 2012 recorded a massive increase in export.Unfavorable local and global demand in 2013, exports have recorded its lowest and the poor market demand led growers to leave the market. Total sales of local market was increased from 2010 to 2013. Study revealed that 2015 change the industry direction with positive demand, and various macro-economic changes facilitated the demand.

CONCLUSION

Sri Lanka has rich ecological and biodiversity which facilitates to grow 3771 of flowering plants. Yet, we import substantial amount of flowers where roses ranked top in the list. Country has great potential to augment the production and expand the flowers and floral products to enhance the value addition. Recent advent of landscape horticulture and the demand from both individual consumers and institutional customers as well as growth of tourism industry places substantial demand on roses and other flower varieties. The industry is highly competitive and rivalry among global players lead small players out. Quality, variety, freshness and price are paramount importance. Market landscape analysis has created an idea of increasing demand for roses as a cut flower in locally and internationally. Analysis recognize the immense potential for the industry and the existing opportunities. Increasing trend in exports point out the growing demand for roses in international market in the world.Roses can be build a market locally and internationally through the value addition and proper value chain management.Further, clod chain management and logistics for perishables need to upgrade essentially to minimize post-harvest secure quality supplies to the market. Institutional landscape and its stakeholders need to involve collaboratively to recognize industry bottlenecks, challenges and opportunities.

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CONFIRMATION OF PHYTOPLASMA ASSOCIATED WITH SHOOT PROLIFERATION IN BEGONIA PLANT SPECIES

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Begonia (*Begoniaobliqua*L.) is one of the most important ornamental plant species grown in Sri Lanka, appreciated genus of ornamental plants, of economic relevancy, having species of flowers and foliage. In commercial croppings, plants exhibiting characteristic symptoms of phytoplasma infection have been observed, such as shoot proliferation, reduced plant, size small leaves and flowers, and phyllody. Leaves were sampled and total DNA was extracted to be used in nested Polymerase Chain Reaction (PCR), in order to detect and identify an expected phytoplasma. The results confirmed consistently the presence of a phytoplasma associated with symptomatic plants through the amplification of a typical genomic fragment of 1.4 kb by using the universal primers R16mF2/R16Mr1. The use of specific primers R16F2/R16R2 allowed to identify the phytoplasma detected as a representative of the group 16SrIII and the amplified DNA fragments were visualized on 2% agarose gel. Further confirmation was done by using DNA sequencing. This information is very expressive, because different diseases caused by fungus, bacteria, virus and nematodes have been reported for begonia, however, reports have not been found for begonia diseases associated with phytoplasmas.

Key words: Mollicutes, yellows, phytopathogenic prokaryotes

Introduction

The trivial name ‘phytoplasma’ has been adopted to wall-less, non-helical prokaryote that colonized in plant phloem and in insects. Phytoplasma often have reduced genomes (530kb to 2220 kb), having lost important metabolic genes as a result of their host-dependent life cycles. Genomic sequencing of these mycoplasma-like organisms has revealed their survival strategies and adaptations to parasitism. So phytoplasma act as pathogens of plants and insects and cause devastating yield losses in diverse low- and high-value crops worldwide (Oshimaet al., 2013). Begonias are among the most popular of cultivated plants, indoors or outdoors. These plants are grown for both their leaf forms and their blooms, depending on the type of Begonia. Begonia genus of plants includes about 1,500 named species and several thousand hybrids. From a cultivation point of view, begonias have all the ingredients for successful hybridization-they cross readily, they have striking variability in the genus, and their ranks include everything from durable landscape plants to delicate specimens. Begonias are terrestrial understory herbs native to tropical regions around the world, including Central and South America, Asia, and Africa. Today, most begonias in cultivation are hybrids, so they cannot be grown from seeds (Pennsylvania Horticultural Society, 2016) Development of molecular probe, serological based techniques and DNA based techniques were used to detect phytoplasma in different plants. Because those techniques provide easy, rapid, specific and

sensitive results (Almomani and Almuaikel, 2014).There are least number of researches conducted on phytoplasma diseases in Sri Lankan context. It is required rapid, specific and sensitive pathogen identification for effective diseases management practices. Objectives of this research were confirmation of Phytoplasma Associated with Shoot Proliferation in Begonia Plant Species by using DNA based techniques for accurate, rapid and sensitive identification of pathogen.

Materials and Methods

Phytoplasma infection suspected Begonia (Begonia obliqua L.) plants samples were collected from different locations in western province of Sri Lanka. Infected parts of leaf tissues were taken for crude DNA extraction. CTAB phenol chloroform technique (Prince et

al., 1993) was used to extract phytoplasma DNA from different suspected Begonia plant samples. Two hundred fifty milligrams of plant tissue of each samples were used for the extraction of DNA. Plant tissues were ground with 675 µl of DNA extraction buffer. Another 675 µl of lysis buffer was added and facilitate lysis of the cells gently and solubilize the DNA. The suspensions were transferred to the labeled eppendorf tubes. One hundred fifty microliters of 10% sarkosyl was added to each tubes. The eppendorf tubes with suspensions was incubated in a water bath at 55 °C. After one hour eppendorf tubes were transfer in to ice bath for 5 minutes for a heat shock and it provided replacement for the extracellular fluid. The eppendorf tubes were spined at 6000 rpm for five minutes. The 400 µl from each supernatant were pipetted out to new labeled eppendorf tubes and 50 µl of NaCl (0.5 M) and 50 µl of CTAB/NaCl were added gently to each eppendorf tubes with supernatants. Mixtures were vortexed thoroughly and kept in water bath at 65℃ for ten minutes. CTAB cationic surfactant was used to further solubilizes the cells to removed cell wall debris, denatured proteins, polysaccharides complexes with CTAB and leave the DNA in solution.Tubes were taken out from the water bath and 400 µl of Chloroform: Isoamyl Alcohol (24:1) solution was added to each eppendorf tubes inside the fume hood. Then mixtures were vortexed thoroughly and centrifuged at 6000 rpm for five minutes. Then, the 400 µl of each supernatant were transferred into new labeled eppendorf tubes. Three hundred microliter of Phenol: Chloroform: Isoamyl Alcohol (25: 24:1) solution was added for each tubes inside the fume hood. Mixtures were vortexed thoroughly. Then they were centrifuged at 6000 rpm for five minutes. After overnight incubation DNA pellet was precipitated by using ethanol precipitation method. Direct PCR technique was applied by using prepared 10% DNA templates. The amplification was performed in a 25 µl reaction volume containing 2.5 µl 10 x PCR reaction buffer with P1/P2 universal primers. Direct ampilified PCR products was subjected to the nested Polymerase Chain Reaction (PCR), in order to detect and identify an expected phytoplasma. Nested PCR (round 01) was performed for the samples which gave amplified product in direct PCR. The amplification was performed in a 25 µl PCR reaction volume containing 2.5 µl 10 x PCR reaction buffer. Target DNA was amplified by using the

universal nested (round 01) primers R16mF2/R16Mr1 amplify ribosomal RNA operon in 1400 base pair size. Nested PCR (round 02) was performed for the samples which gave amplified product in nested PCR (round 01). The amplification was performed in a 25 µl PCR reaction volumes containing 2.5 µl 10 x PCR reaction. Target DNA was amplified by using the universal nested (round 02) primers R16F2n/R16R2 amplify ribosomal RNA operon in 1200 base pair size .The results confirmed consistently the presence of a phytoplasma associated with symptomatic plants through the amplification of a typical genomic fragments. The amplified DNA fragments were visualized on 2% agarose gel under UV transilluminator. Target DNA sites were sequenced for further confirmation. Sequenced data was analyzed

using NCBI BLAST tool and phylogenetic tree was constructed with phytoplasma genomes available in NCBI database.

Results and Discussion

Plate 1.1: shows the symptoms of phytoplasma infections such as shoot proliferation, reduced plant, size small leaves and flowers, and phyllody.

Fifteen plant species gave positive results producing DNA fragment in 557 bp size from the twenty-five different suspected plant species, detected visually on phytoplasma infection. In (plate 1.1) shows the symptoms of phytoplasma infections such as shoot proliferation, reduced plant, size small leaves and flowers, and phyllody. Presence of phytoplasmas has been demonstrated by the positive results of direct PCR on different phytoplasma genomic sequences with pair of primers P1/P2. The disease suspected plants showed 557 bp band size and all the samples were confirmed as phytoplasma infected samples. Phytoplasma infection is confirmed by the direct PCR in which 557 bp fragment is amplified. Seventy plants gave positive results. But, PCR also meets some difficulties such as unspecific bands and false positives or negatives. Therefore, confirmation of PCR results by using another round of PCR for positive samples that gave sharp clear bands in previous round of PCR with same primer pair combination (P1/P2) and 100 bp ladder.

Plate 1.2: Amplified DNA with universal primer P1/P2 Primer in 2% Agarose Gel from phytoplasma suspected Begonia plants.

Plate 1.3: Amplified DNA with nested PCR in 2% Agarose Gel from phytoplasma suspected Begonia plants

Phytoplasma genome extracted from (Begonia obliqua L.) Plant was subjected to DNA sequencing in order to further confirmation of causal agent. The highest homology was given with 89% query coverage in Candidatus Phytoplasma mali strain A 16S ribosomal RNA, complete sequence. The 3e-66 e value and 73 % identity. According to constructed phylogenetic tree this sequenced DNA closely related to Candidatus Phytoplasma mali strain and underscoring their distinctness from other strains in 16S rRNA group available in NCBI database.

557 bp

Conclusion (Begonia obliqua L.) Which had symptoms such as little leaf, swelling branches and Phyllody. Fifteen plant species gave positive results with producing DNA fragment in 557 bp size from the twenty-five different suspected plant species detected visually on phytoplasma infection. Phytoplasma genome extracted from Begonia obliqua L. was further confrmed and it was given highest homology with 89% query coverage in Candidatus Phytoplasma mali strain A 16S ribosomal RNA, complete sequence. The 3e-66 e value and 73 % identity.

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Plate 1.2: BLAST alignment result of identified phytoplasma

classification with aster yellows, X-disease, and elm yellows MLOs. Phytopathology, 83, (1130-1137) Pennsylvania Horticultural Society. 2016. Begonias. [ONLINE] Available at: http://pennhort.libguides.com/Begonias. [Accessed 22 February 2016].

ALTERING MORPHOLOGICAL CHARACTERS AND SEED GERMINATION OF COCKSCOMB, *CELOSIA CRISTATA* BY COLCHICINE

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ABSTRACT

The study investigated the effect of colchicine on changing the morphological characters and seed germination of cockscomb(*Celosia cristata*). Cockscomb seeds (0.15g)were treated by colchicine at different concentrations (0.0, 30,60 and 90mg/l) and durations (0.0, 6,12, 18, 24 and 48hour). Seed germination percentage at *in vitro* and *in vivo* conditions, shoot length and root length,number of leaves, flowering date, inflorescence length, number of apical inflorescence, plant height, leaf area and number of lateral inflorescencewere recorded. Completely Randomized Design (CRD) with five replicates was used for study. Statistical analysis was performed with Duncan's multiple range test using SAS software (version 9.1.3).

Highest germination percentages were observed in both control treatments under *in vitro* (62%) and *in vivo* (96%) respectively. Germination percentage was significantly different in both colchicine treated seeds under *in vitro* and *in vivo* conditions. In both *in vivo* and *in vitro* conditions none of the seeds were germinated in 60mg/l at 24 hours and 48hours soaking duration, and in 90mg/l concentration of colchicine.Highest values in root length (8.1cm), shoot length (13.5cm), number of leaves (22), inflorescence length (5.5cm), leaf area ($52cm^{2)}$ and plant height (52cm) were observed in control treatment, while colchicine treated plants showed significantly low values. Highest values in number of days to flowering (60 days), number of apical buds of inflorescence (3) and numbers of lateral inflorescence (16) were recorded in colchicine treated plants compare to control. The results revealed that colchicine can be used to generate shorter cockscomb plants with high number of lateral and apical inflorescence.

Keywords: Colchicine, seed germination, plant growth, inflorescence, cockscomb

INTRODUCTION

*Celosia*has become an important plant species in international and local floriculture market. There are two types of *celosia* species in nature. Cockscomb type is known as *Celosia cristata* and plume type is known as *Celosia plumose*. Tight, velvety texture is identical to the cockscomb type while plumose type expresses fluffy, light, airy texture (Gilman and Howe,1999). *Celosia cristata*belongs to family *Amaranthaceae* and it is an annual herbaceous plant (Zuck, 2015). Since this plant has been developed its demand in cut flower industry there are so many commercial varieties in market. Among common commercial varieties 'Chief Series' and the 'Bombay' are popular (Zuck, 2015).

Colchicine has become one of the effective chemical that can be used to polyploidy production. It is an alkaloid extracted from *Colchicum autumnale L.*(Sajjad et al.,2013).Colchicine has the ability to inhibit formation of spindle fibers. The end result of exposing to this chemical is arrest mitosis at the anaphase stage(Sajjad et al.,2013). Colchicine treated plants have shown significant differences in many traits including leaf area, flowering date , flower number ,plant shape, intensify the flower ,fertility, and flower size (Amiri et al., 2010). Even though colchicine is toxic to plants, its extended exposure in low concentration reduces its toxic effects and enhances the production of polyploids (Vajrabhaya, 1983).

Polyploid production has been effectively applied in several ornamental plants such as Rhododendron (Vainola, 2000), Alocasia (Thao et al., 2003), Astragalus (Chen &Gao, 2007) and Scoparia (Escandon et al., 2005) under In vitro conditions. During the last few decades polyploidization has become increasingly successful and polyploids of several ornamental plants have been induced (Roberts et al., 1990). Ploidy manipulation has been found a valuable tool in the genetic improvement of many plants since it is a cost-effective method.

The objectives of study was to develop a protocol to identify the effect of colchicine on plant growth and change the morphology of inflorescence of cockscomb plant to provide new varieties for floriculture industry.

MATERIALS AND METHODS

Experimental material

Seeds of cockscomb, *Celosia cristata*were obtained from a mature flowering plant at faculty of Agriculture, University of Ruhuna.

Seed masses were prepared which is each mass containing 0.15g of seeds. Weights of seeds were measured by using analytical balance. Seeds werewashed under running tap water for 30 minutes. Then seeds were kept in 5% Clorox solution for 20 minutes and then kept in 70% alcohol solution for 2 minutes for the purpose of sterilization.

Seeds were treated with colchicine 0, 30mg/l,60mg/l,90mg/l and each treatment were kept for 6hour,12hour,18hour, 24hour and 48hour. Control experiment was carried out using sterilized distilled water.

For the *in vitro* study Colchicine treated seeds were cultured in ½ MS medium under laminar air flow condition. Culture bottles were kept at 24ºc until germinate. For the *in vivo* studycolchicine treated seeds were planted in small potsseparately.

In*in vitro* study number of germinated seeds was recorded after 2 weeks. In*in vivo* study shoot length and root length,number of leaves, flowering date, inflorescence length, number of apical inflorescence, plant height, leaf area and number of lateral inflorescence were observed.

RESULTS

The data gathered in the study are analyzed and summarized into the following tables.

Table 1. Effect of colchicine on percentage germination *in vitro* study

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	60%[a]	58%[a]	62% [a]	62%[a]	62%[a]
30mg/L	54% [a]	50%[a]	33% [b]	30%[b]	25%[b]
60mg/L	37%[b]	35%[b]	28%[b]	-	-
90mg/L	-	-	-	-	-

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Highest germination percentage (62%) was observed in control at 18hour, 24 hour and 48 hour soaking duration.The germination percentage was varied from 54% to 28% depending on the concentration and the soaking time of colchicine. Seed germination percentages were reducedwhen increasing the concentration of the colchicine and soaking duration. Seedlingswere not developed in60mg/l concentration at 24 hours and 48 hours soaking duration and all durations in 90mg/L concentration of colchicine.

Table 2. Effect of colchicine on germination percentage *in vivo* study

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	80%[a]	80%[a]	82%[a]	96%[a]	80%[a]
30mg/L	68%[b]	52%[b]	43%[b]	40%[b]	32%[b]
60mg/L	42%[c]	38%[c]	30%[b]	-	-
90mg/L	-	-	-	-	-

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Germination percentage after 7 days of planting was recorded in table 2. Highest germination percentage(96%) was observed in control treatment at 24 hours soaking duration while the colchicine treated seeds showed highest of 68% in 30mg/l at 6 hours of soaking duration. Reduced germination percentages were observed with increasing concentration of the colchicine and soaking duration.No seedling growth was observed in60mg/l concentration at 24 hours and 48 hours soaking duration and all durations in 90mg/L concentration of colchicine.

Table 3 effect of colchicine on root length in *in vivo* study

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	7.2cm[a]	7.5cm[a]	7.5cm[a]	8.1cm[a]	8cm[a]
30mg/L	4.2cm[b]	4cm[b]	3cm[b]	2.1cm[b]	2cm[b]
60mg/L	3.8cm[b]	3.2cm[b]	2.8cm[b]	-	-

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Table 4 effect of colchicine on shoot length in *in vivo* study

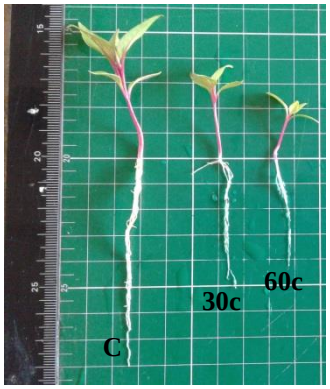
	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	13cm[a]	13cm[a]	13cm[a]	13.5cm[a]	13.2cm[a]
30mg/L	7cm[b]	6.8cm[b]	6.6cm[b]	6.1cm[b]	6.1cm[b]
60mg/L	6.7cm[b]	6cm[b]	5.7cm[b]	-	-

*Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

The longest rootlength (8.1cm) and shoot length (13.5cm) was observed in control experiment with 24 hours of soaking duration. Colchicine treated seedlings were shorter in shoot and root length than control. All the treatmentsof colchicine were significantly different compared to control. (Table 3 and 4)

After 6hrs of soaking time

After 12hrs of soaking time



After 18hrs of soaking time

After 24hrs of soaking time

After 48hrs of soaking time

Table 5effect of colchicine on number of leaves after 35 days

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	20[a]	18[a]	22[a]	22[a]	20[a]
30mg/L	10[b]	10[b]	8[b]	8[b]	8[b]
60mg/L	8[c]	8[c]	6[c]	-	-

Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Table 5 shows data on mean number of leaves, which highest number of leaves observed in control treatment (22) at 18 hours and 24 hours duration of soaking. Lesser number of leaves was identified in colchicine treated plants than control treatment. All the treatments of colchicine were significantly different from control experiment.

Table 6 Number of days to flowering of colchicine treated seeds

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	45^{a}	45^{a}	45^{a}	45^{a}	45^{a}
30mg/L	52^{b}	57^{b}	52^{b}	52^{b}	55^{b}
60mg/L	60^{b}	60^{b}	60^{b}	-	-

Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Control treatment showed lesser number of days to flowering (45 days) while colchicine treated plants showed higher number of days to flowering.The number of days to flowering in colchicine treated plants were significantly different from control treatment.(Table 6)

Table 7 Inflorescence length after 75 days of planting

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	$5cm^{a}$	$5.5cm^{a}$	$5.5cm^{a}$	$5.5cm^{a}$	$5.5cm^{a}$
30mg/L	$2.5cm^{b}$	$2.5cm^{b}$	$2cm^{b}$	$1.5cm^{b}$	$1.5cm^{b}$
60mg/L	$1.5cm^{b}$	$1.2cm^{c}$	$1.2cm^{b}$	-	-

Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Longest inflorescence length was recorded in control experiment (5.5cm) but inflorescence lengths of colchicine treated plants wereless.Inflorescence length was significantly lower in colchicine treated plants compared to control. (Table 7)

Control

30mg/L

60mg/L

After 6hrs of soaking time

Control

30mg/L

60mg/L

After 12hrs of soaking time

Control

30mg/L

60mg/L

After 18hrs of soaking time

Control

30mg/L

After 24hrs of soaking time

Control

30mg/L

After 48hrs of soaking time

Table 8 Number of apical buds of inflorescence after 60 days

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	1^{a}	1^{a}	1^{a}	1^{a}	1^{a}
30mg/L	3^{b}	3^{b}	3^{b}	3^{b}	3^{b}
60mg/L	3^{b}	3^{b}	3^{b}	-	-

Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Even though colchicine treated plants showed significantly higher number of apical buds of inflorescence (3), there was only one inflorescence in control treatment. (Table 8)

Table 9 Plant height after 35 days of planting

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	50cm^{a}	50cm^{a}	52cm^{a}	50cm^{a}	50cm^{a}
30mg/L	30cm^{b}	32cm^{b}	30cm^{b}	28cm^{b}	28cm^{b}
60mg/L	28cm^{b}	27cm^{b}	27cm^{b}	-	-

Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Plant height was significantly higher in control treatment(52 cm) at 18 hours of soaking time while colchicine treated plants were significantly lower in plant height. (Table 9)

Table 10 Leaf area after 35 days of planting

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	52^{a}	50^{a}	48^{a}	50^{a}	50^{a}
30mg/L	20^{b}	18^{b}	18^{b}	18^{b}	16^{b}
60mg/L	18^{b}	18^{b}	15^{c}	-	-

Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

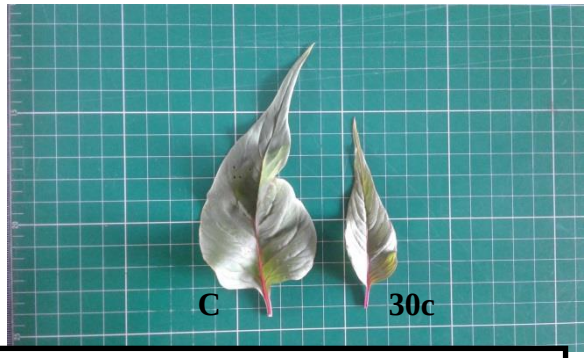
Leaf area was significantly higher in control treatment ($52cm^2$) at 6 hours of soaking duration but colchicine treated seeds were significantly lower in leaf area. (Table 10)

After 6hrs of soaking time

After 6hrs of soaking time

After 6hrs of soaking time

After 6hrs of soaking time



After 6hrs of soaking time

Table 11 Number of lateral inflorescence after 75 days

	6 Hours	12 Hours	18 Hours	24 Hours	48 Hours
Control	8^{a}	8^{a}	8^{a}	8^{a}	8^{a}
30mg/L	12^{b}	14^{b}	14^{b}	14^{b}	14^{b}
60mg/L	15^{c}	16^{c}	16^{c}	-	-

Mean values in each column superscripted by the same letters are not significantly different ($p>0.05$).

Highest number of lateral inflorescence was observed in 60mg/l concentration of colchicine treatment while control treatments werelower significant different. (Table 11)

DISCUSSION

Germination percentage is very important in *in vitro*polyploidy induction while applying colchicine. With increasing concentration of colchicine low germination percentage can be observed in different plants (Sanguthai et al., 1973). Usually chemical mutagens have been reported to have inhibitory effects on seeds leading to low percentage germination (Dhakhanamoorthy et al., 2010; Pande and Khetmalas, 2012). Previous experiments prove that the increasing concentration of colchicine may reduce the germination percentage (Mensah et al., 2005; Mensah and Akomeah, 1997).Treatments 30mg/l,60mg/l,90mg/l in the present study also recorded reduced percentage germination probably due to the high concentration of colchicine as reported by the earlier researchers.

Significant difference in the number of leaves per plant was recorded in Sesame (Mensah et al., 2007) and *Trigonellafoenumfraeum* (Datta and Biswa, 1988) when treated with colchicine. In this experiment also mean number of leaves were significantly differ in all the treatments from control treatment.

Dhakhanamoorthy et al, 2010 states that early flowering and fruit maturity may be due to the physiological changes caused by mutagen. But in this experiment the flowering time in all treatments were longer than control treatment.In the present study colchicine treatments with high concentration of colchicine delayed in flowering suggesting that the chemical may have interfered with plant development. Comparing number of days to flowering all the treatments showed a longer period to flowering while the control had a shorter period.

CONCLUSION

Colchicine is a better source to altering the morphological characters in plants with in short period of time. Colchicine can be used to generate shorter cockscomb plants with high

number of lateral and apical inflorescence. The outcome of this study can be used in floricultural industry to produce plants with smart characters.

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FLORICULTURE INDUSTRY FOR DRY ZONE IN SRI LANKA

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As per the Government policies in floriculture industry mainly concentrated on the wet zone and intermediate zone of Sri Lanka which have more than 1,000 mm annual rainfall. The Government of Sri Lanka planned to establish 1,500 floriculture villages and generate 30,000 job opportunities in sub urban and rural areas of Western, North Western and Central Provinces of Sri Lanka (National Policy Framework, 2010).

Existing literature identifies the importance of floriculture industry especially in terms of national development, whilst support networks through the business development. However, adequate information is not available. This research aims to identify the distribution of floriculture industry in the dry zone of Sri Lanka and social capital development of floriculture growers. Qualitative and quantitative methods are utilised, multistage sampling method was used to conduct survey in Anuradupura, Polonnaruwa, Puttalam and Hambantota districts which are come under low country dry zone 1 (DL 1), DL 3 and DL 5. The sample size was 78 women floriculture growers in those districts. As to this sample, 55% of growers earn Rs. 30,000.00 to 50,000 per month. Their social capital development is high because 73 of them connected to the growers associations and other institutes. 39% of growers take loans to increase capital injection whereas others invest their generated income. Loans were taken, if generated money has been utilised for personal/ family purposes.

These growers enjoy high rates of production utilising small land space, using sustainable technologies and bounded within their own entitlement. Most women are staying at as home mothers; traditions and customs inflict women to care for children. They are gifted with the opportunity to provide the household with more capital, intern influencing the livelihood of the family and reducing female dependence on male for family income. By introducing sustainable technologies such as growing under poly tunnels and as potting media use of coconut husk, coir dust and mulching methods, they use minimum amount of water for successful production. The study revealed that this industry is success in the dry zone of country and can be promoted in all over the country. Findings can be utilised for policy developments and empower women whilst eliminating poverty.

Keywords: floriculture; dry zone of Sri Lanka, women growers, poverty reduction; social capital

EFFECT OF GROWTH HORMONES AND SUBSEQUENT DETOPPING IN *Cordyline terminals* 'Red edge'

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ABSTRACT

Cordylines are excellent pot plants in their juvenile state and commercially propagated by stem cuttings. However scarcity of quality planting material becomes a limiting factor for commercial cultivators. Hence present study was aimed to optimize the auxiliary shoot formation of *Cordyline* in order to make the propagation feasible and economical. The experiment was laid out in a Completely Randomized Design (CRD) with six treatments randomized in three replicates. Treatments were the four different Gibberellic acid (GA_3) concentrations (mgl^{-1}), i.e.25, 50, 75 and 100 applied in combination with constant level of BAP ($75mgl^{-1}$). Hormone was applied (three times) to the cut end of the stem cuttings in ten days interval. Two treatments were maintained as control, i.e. sole application of $75mgl^{-1}$ of BAP and non hormone treatment. Rooting hormone applied stem cuttings were planted in black polythene bags (10cm× 8cm) filled with sand: coir dust (1:1 ratio in weight) medium and rooted cuttings were detopped one month after planting. Once a week measurements were taken on number of new shoots, length of new shoots, number of leaves per plant, length of the new leaves and time taken for new shoots formation. The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at p=0.05. Number of shoots per plant as well as length of the shoots did not show any significant difference ($p>0.05$) in sole application of $75mgl^{-1}$ of BAP and non hormone treatments. However significantly highest number of lengthy shoots was manifested from $75mgl^{-1}$ of BAP applied treatment and lowest from $75mgl^{-1}$ of BAP + $50mgl^{-1}$ and $75mgl^{-1}$of GA_3 applied treatments. Leaf length was significantly different ($p<0.05$) in non hormone treatment and sole application of $75mgl^{-1}$ of BAP whilst number of leaves per plant did not show any significant difference ($p>0.05$) in both treatments tested. On the other hand, $75mgl^{-1}$ of BAP + $100mgl^{-1}$ of GA_3 applied treatment took long time (days) to initiate first shoot whilst sole application of BAP ($75mgl^{-1}$) recorded the lowest time. Furthermore application of different concentrations of GA_3 did not show any significant impact on new shoots initiation and development. Hence $75mgl^{-1}$ BAP and subsequent detopping can be considered as the most effective treatment for auxiliary shoots initiation and development of *Cordyline terminals* in order to make the propagation feasible and economical.

Key words: *Cordyline terminals*, detopping, BAP, Gibberellic acid, shoots initiation

EFFECT OF AUXIN IN COMBINATION WITH GIBBERELLIC ACID AND LIGHT ON SPIRAL PRODUCTION OF *Dracaena sanderiana* var. White CANES AS VALUE ADDED PRODUCT

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ABSTRACT

Dracaena sanderiana var. "white" (Lucky bamboo) is a very popular foliage plant due to value added products made by their spirals. But the problem associated to produce value added plants is more time taken for spiral formation as well as low smoothness of spiral. Therefore present study was aimed to optimize the spiral formation of *Dracaena sanderiana* with improving the smoothness of spirals in order to make value added products more feasible. The experiment was arranged as a Completely Randomized Design (CRD) with six treatments randomized in three replicates. Treatments were the five different concentrations (ppm) of Auxin, i.e. 50, 100, 150, 200, 250 combined with 100ppm of Gibberellic acid (GA3) applied pot plants rotated once a week at the angle of 45 degrees. Application of 100ppm of Gibberellic acid and rotation (45 degrees) of plant stalks in front of the sun light at once a week was considered as the control of the experiment. Pots filled with coir dust: soil: top soil: compost medium (1:1:1:1 ratio in weight) mixed with 3% Indole-3-butyric were placed vertically in a net house. Two stones placed either side of pots to prevent rolling. Black polythene boxes which had 10cm long strip on top were used to cover the pot plants. Once a week measurements were taken on spiral growth, plant height, internodel length, number of new leaves per plant and smoothness of the spiral. After the hormone treatment *Dracaena* spirals were rooted and reduced smoothness of the canes. Hence the roots were removed from the spirals and pots were rotated with the same angle (45 degrees) in two times per week as a second experiment. Once a week same measurements were made without applying hormones. The data obtained were tabulated and analyzed subjected to the Analysis of Variance (ANOVA) procedure of Statistical Analysis System (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at $p=0.05$. Plant height and internodel length did not show any significant differences ($p>0.05$) in different treatments tested. However the highest plant heights and long internodes were manifested from GA3 (100ppm) + 45 degrees rotated plants and the lowest from GA3 (100ppm) + Auxin (250ppm) + 45 degrees rotated treatments. When correlation analysis performed for a overall data set, there was a significant ($p<0.01$) positive correlation between internodel length and the smoothness of spiral. However, application of 100ppm of GA3 + 50ppm Auxin with 45 degrees rotated plant stalks in front of the light at two times per week showed a positive impact on spiral growth as well as the smoothness of *Dracaena* canes.

Key words: *Dracaena sanderiana*, Auxin, Gibberellic acid, spiral production, value added products

EFFECTIVENESS OF MULTI NUTRIENT FERTILIZER GRANULES FOR SOILLESS CULTURE OF GERBERA HYBRIDA

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Abstract

Application of liquid fertilizers through advanced fertigration system is the recommended fertigation practice for gerbera cultivation, which add considerable cost for the gerbera production. Although gerbera shows positive response to granular fertilizer application, information on this practice is rare. Current study was conducted to ascertain the potential of **multi nutrient fertilizer granules** usage in Gerbera hybrida soilless culture. **Osmocote + hydrocomplex , hydro complex alone and Osmocote alone** were tested against single nutrient fertilizer mixtures (urea+MOP+TSP) (T3). All the treatments were designed to provide 1.8 g of N, 1.4g of P and 1. 5g of K and 2 g of granular micro nutrient mixture per month for a pot filled with 6.5 liter of medium. At the end of the experiment (20^{th} week) **leaf number (15.4 and 15.7), average leaf area (236 cm^2 and 282cm^2) flower number (3.4 and 3.3) and root length (64 and 73) were significantly high in the Osmocote + hydrocomplex and Osmocote alone treated gerbera pots.** However, only in the T4, pH and Ec of the medium were in the acceptable range as 5.6 and 0.09 respectively through-out the experiment and this would revealed that application of osmocote to provide1.8 g of N, 1.4g of P and 1. 5g of K (13.5gof granules) and 2g of micro nutrient mixture can be used for gerbera soilless culture.

INDUCTION OF AXILLARY BUD OUT GROWTH AND PLANT PRODUCTION FROM OVERDUE GERBERA HYBRIDA RHIZOMES, THROUGH ABIOTIC STRESS TREATMENTS

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Abstract

Vegetative multiplication rate of Gerbera hybrids is very low due to strong dormancy of axillary buds at rhizome. This study was conducted to induce outgrowth of axillary buds to produce shoots and develop them as new plants. Three years old gerbera bushes which were remained and removed top growing bud were separately subjected to mild abiotic stresses ie. 7 days drought and 4 days water logging conditions as treatments. Regular watering and fertigation were practiced for control plants. Treated plants also were provided with same watering and fertigation during post stressed period and number of outgrown axillary buds in each pot was recorded. Newly initiated shoots in drought stressed plants were isolated from the rhizomes and rooting ability was evaluated in coir dust + sand and coir dust+biochar media as the second part of the experiment. Higher shoot initiation was observed in both drought-stressed and waterlogged plants with removed growing buds during first two weeks as averages of 3.25 and 3.75 per plant respectively. There were significant main effects ($f=68.8$, $p= 0.0001$ for stress and $f=4.0$ and $p=0.06$ for bud removal) as well as their interaction ($f=5.69$, $p=0.012$) of stress and bud removal treatments on new shoot outgrowth from stem at the end of the experiment. Waterlogged, bud removed plants were not survived after 3rd week of post stressed period. New shoot initiation was continued in drought-stressed plants and from them growing bud removed plants showed significantly high (5.75) mean shoot outgrowth per plant at the end of the experiment. In the second experiment root initiation between two treatments was not significantly different; all the shoots produced healthy root systems with average of 6.325 (coir dust+sand) and 5.875 (coir dust +biochar) within 3 weeks. Growing bud removal followed by drought stress treatment is effective in shoot induction from overdue gerbera rhizomes and these initiated shoots rooted successfully in coir dust+sand or coir dust +biochar medium.

Key Words: Axillary buds, drought stress, water logging, shoot induction