A Comparison of Growth Media for Cyclamens in a Controlled Environment©

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INTRODUCTION

Cyclamens are considered an important crop for winter to supplement the income of enterprises during the cold season. Container grown cyclamens are considered an expensive commercial horticultural crop where growth media is seen as a factor which contributes significantly to the production costs. The economic landscape in South Africa dictates that production costs are kept as low as possible without compromising on quality. Determining the most suitable growth media and maintaining quality would be beneficial for the cyclamen growers. It would not only enhance plant growth, decrease disease, and pest management but allow for competitive prices at the market. The focus of this study was on the comparison of seven growth media in order to determine the most suitable growth media for the South African environment. Existing scholarly and trade literature together with the existing growth media commercially available determined the selection of growth media for the study. The selected growth media included: (1) Cyclamen mix — a commercially imported mixture consisting of coir and perlite, (2) Cyclamen mix - 45 Mix, (3) 49 Mix — a mixture of pine bark and coir, (4) 45 Mix — a mixture of pine bark and coir, (5) 7 Mix — pine bark, (6) course coir, and (7) Klasmann peat substrate 4 — a commercially imported medium consisting of peat. The study involved subjecting container cyclamens to a visual observation measuring instrument which was created from using existing measuring instruments used to compare the growth media of cyclamens in literature. The measuring instrument criteria included the following measurements and observations: Total plant height, plant diameter, fresh plant mass, number of leaves, leave width, foliage fresh weight, number of flowers, diameter of corm, and root mass. Based on the results of the measuring instrument, the most suitable growth media for container cyclamens for South African circumstances will be identified. Recommendations will be made as to the most suitable growth media based on the results of the study.

Research Background

I am currently registered for my M.Sc. in Ornamental Horticulture at University of South Africa (Unisa). The research topic of the comparison of growth media on cyclamen was identified while under the employ of Tuberflora™, a wholesale nursery in Gauteng, as a grower. I started becoming interested in the propagation and production after the realization that the quality and market timing of commercial container cyclamens determines the competitive edge on the market. Where are their ways of speeding up the growing season of the cyclamens in order to provide the market with quality cyclamens ahead of the competitors? This newly found interest lead to an investigation which forms part of my M.Sc. in Ornamental Horticulture.

The motivation for the research project involves identifying a growth medium most suitable in the commercial production of container cyclamen for the South African environment. The commercial growers of cyclamens would benefit from the study as this would allow a commercial nursery to make informed management decisions on the cultivation of a preferred crop for winter/cold season income supplementation. It would assist the commercial growers of cyclamens in determining whether there are any South African growth media alternatives for cyclamens. On an environmental level, it would help determine whether the carbon footprint of the growing medium can be reduced by using the most suitable and cost-effective growth medium for container cyclamens.

Literature Review

Cyclamen in general as an ornamental horticulture crop have acquired the international reputation of being difficult to cultivate. According to Beytes (2003) and Onofrey (2000), in order to successfully cultivate for commercial purposes, *Cyclamen* require advanced growing skills and competencies. This includes specialized growth specifications, dedicated production space, specialized growth medium, disease and pest management programme, and a specialized fertilization programme.

The present economic situation dictates that commercial nurseries economize and focus on more cost effective production strategies. These production strategies involve the cost-effective utilization of available greenhouse production space, and the utilization of the best quality growth medium for propagation at competitive prices.

RESEARCH DESIGN

Research Problem Statement

How do the selected growth media for cyclamens compare in terms of quality in the production of commercially grown container cyclamen in a South African context in a controlled environment?

Research Sub-Problems

- Determining the most suitable growth medium for the cultivation of container cyclamens grown in a controlled environment.
- Identifying the criteria that can be used to create a visual measuring instrument for the comparison of the cyclamen growth media.
- Determining how the commercial cyclamen grower would benefit by using the most suitable growth medium in the production of container cyclamens.

Research Methodology

A comparative study was conducted. The trials were conducted using selected growth media presently being used by commercial growers in the production of cyclamens in South Africa during 2012 and 2013.

The evaluation criteria for growth media were determined to develop a visual measuring instrument for the comparison of the cyclamen growth media. The experiments were conducted with consent of Tuberflora™ management according to the Unisa Ethics requirements.

Experimental Design

Trials were conducted in a greenhouse on the premises of Tuberflora™, a commercial wholesale nursery, located on a plot in Muldersdrift in the province Gauteng, South Africa. The greenhouse a pad and fan structure with double-layered clear plastic (polyethylene - 200 micron ×2) had an area of 3,072 m^2 (48×64 m). Climate control included a mechanized 40% filter screen and plastics to allow for manipulation of light intensity (ideal range between 250-650 lux). Temperature was a critical factor. It was essential to have a “cold house” during production phase. This meant that cyclamen plantlets were transplanted at a cooler temperature during the warm December summers of Gauteng (temperature max 39°C). The trials were arranged in a randomized complete block design with seven pre-selected growth media treatments as suggested by Whitcomb (2003), Nelson et al. (2010), and Widmer (1971). There were five plants per block with 4 blocks and 2 replications (seasonal commercial growth cycles) in a closed environment. The study therefore included a total of 105 plants per replicate and a total of 210 plants over the entire project.

A randomized complete block design (suggested by Whitcomb, 2003; Nelson et al., 2010; Widmer, 1971) used during the study.

Plant Population
There were 210 plants in the trial. The focus would be on only one cultivar of cyclamen for a homogenous plant population. It was decided to focus on *Cyclamen persicum* F_1 standard, cultivar Grandola deep rose seeds from the supplier, Hemgenetics™. Each trial container cyclamen would be clearly marked with a sticker indicating the plant as part of trial and not to be sold commercially.

Growth Media
The growth media used for the study is listed in Table 1.

Table 1. List of growth media.

Growth media name	Growth media
1. Cyclamen mix	Cyclamen mix consists of course coir and perlite (9:1, v/v), growth medium supplied by MEEGAA™
2. Mix 2	Cyclamen mix and 45 Mix (1:1, v/v), this mixture consists of a mixture of two exciting mixtures
3. 49 Mix	The 49 Mix consists of pine bark and coir (4:1, v/v)
4. 45 Mix	The 45 Mix consists of pine bark and coir (3:2, v/v)
5. 7 Mix	This mix consists of 100% pine bark
6. Coir	This mixture consists of 100% course coir
7. Klasmann peat substrate 4	This imported medium is 100% peat from the Netherlands

Data Collection
The following guidelines were adhered to:
- The temperature and humidity were recorded with data logger on hourly basis.
- The light intensity was measured and recorded hourly using a Lux data logger.
- The growth media analysis was conducted by Eco Analytica (North West University). The growth media nutrients were recorded on regular intervals using an EC meter and administered with Dosatron® system.
- A pest and disease management programme was designed specifically for the cyclamen production, AVONROD Plant protection® and used by Tuberflora.
- The measuring instrument developed as evaluation tool would be used for the visual observation and measurements of the cyclamens.
- The visual observations and measurements were recorded in three sessions over two seasons.

Measuring Instrument
The measuring instrument criteria included the following measurements and observations: Total plant height, plant diameter, fresh plant mass, number of leaves, leave width, foliage fresh weight, number of flowers, diameter of corm and root mass.

The following information will be captured on the data capturing spread sheet (Table 2).

Table 2. Measuring instrument.

	Parameters/ criteria	Sub parameters	Source
1)	Total plant	Plant height (canopy height)	Widmer (1971), Van der Gaag et al. (2007), Nelson et al. (2010), Cativello et al. (1997) and Mao et al. (2006)
		Plant diameter	Widmer (1971), Cativello et al. (1997), Van der Gaag et al. (2007), Trelka and Szczepaniak (2009) and Nelson et al. (2010)
		Fresh plant mass/ weight (with corm/ tuber)	Cativello et al. (1997), Van der Gaag et al. (2007), Trelka and Szczepaniak (2009) and Nelson et al. (2010)
2)	Leaves	Number of leaves	Mao et al. (2006), Trelka and Szczepaniak (2009) and Nelson et al. (2010)
		Leaf width	Mao et al. (2006)
		Foliage fresh weight	Cativello et al. (1997)
3)	Flowers	Number of flowers	Cativello et al. (1997), Van der Gaag et al. (2007) and Nelson et al. (2010)
4)	Corms/tubers	Diameter of corm/ tuber	Mao et al. (2006) and Trelka and Szczepaniak (2009)
5)	Roots	Root mass/weight	Cativello et al. (1997)

RESULTS AND DISCUSSION

The results would include the visual observations and measurements recorded during the data collection of three separate sessions during two growing seasons.

Table 3. Mean values for season 1 and 2 combined. Growth media mix comparison.

Measuring schedule per production week	Mix 1: cyclamen Mix	Mix 2: cyclamen mix and 45 Mix	Mix 3: 49 Mix	Mix 4: 45 Mix	Mix 5: pine bark	Mix 6: 100% coir mix	Mix 7: Klasmann peat mix
First measurement							
Plant height	6.2	5.1	4.4	4	4	4	4.9
Plant diameter	17	17	15	13	16	14	20
Plant mass	12.6	12.1	11	10.5	10.5	10.6	12.4
Number of leaves	35	31	24	25	26	36	53
Leaf width	5.9	9.4	5	5	4.8	5.5	5.8
Folaige fresh weight	18.9	10.9	10.6	10.9	11.9	12	19.4
Number of flowers	*	*	*	*	*	*	*
Diameter of tuber	1.5	1.7	1.6	1.5	1.7	1.7	1.6
Roots fresh weight	11	11	9	9	9	20	29
Second measurement							
Plant height	12	9.4	7.4	7.9	7.2	9	9.8
Plant diameter	29	33	21	25	25	29	28
Plant mass	23.4	20.6	16.2	17.7	15.5	19.5	20
Number of leaves	134	115	59	78	58	122	200
Leaf width	8.5	8.2	7.5	7.9	6.9	8.4	8.2
Folaige fresh weight	75.9	69.8	33.8	41.3	31.5	47.8	57.8
Number of flowers	18	16	12	14	13	14	17
Diameter of tuber	1.9	2.1	2	1.9	1.9	1.9	1.9
Roots fresh weight	36	27	17	26	19	52	123

Table 3. Continued.

Measuring schedule per production week	Mix 1: cyclamen Mix	Mix 2: cyclamen mix and 45 Mix	Mix 3: 49 Mix	Mix 4: 45 Mix	Mix 5: pine bark	Mix 6: 100% coir mix	Mix 7: Klasmann peat mix
			Third measurement				
Plant height	15	14.3	10.7	11.4	9.5	11	12.4
Plant diameter	28.1	23.1	20.3	21	17	20.8	24.5
Plant mass	373.8	263.8	158.8	203.4	101.5	161	391.4
Number of leaves	50.3	46.5	33.2	45.3	26.3	30.5	50.5
Leaf width	9.75	8.7	8.3	8	7.4	8.6	8.7
Folaige fresh weight	153	115.6	64.7	88.1	52.8	85.8	98
Number of flowers	28.5	26.8	21.1	23.7	14.4	17.7	27.3
Diameter of tuber	1.9	2.5	2.2	2.3	2	2.1	1.8
Roots fresh weight	135.5	87.1	35.1	68.6	29.1	41	244.5

*No flowers present.

Statistical Comparisons for Season 1 and 2

This section contains the statistical comparisons conducted. Parametric and as well as non-parametric methods were used to compare Mix means and were followed up with post-hoc analysis to identify which Mix differed significantly. The assumptions of normality, constant variance and independence were tested in considering the appropriate method: Parametric and non-parametric data.

1. Parametric Data. For the parametric data namely plant height; diameter of tuber; number of leaves and leaf width, was used for group comparisons and Tukey HSD for the post-hoc analysis.

2. Non-Parametric Data. The non-parametric data namely plant diameter; plant mass; number of flowers; root fresh weight and foliage fresh weight were tested using Kruskall Wallis for a comparison between Mix means followed by Mann-Whitney U test for the post-hoc analysis. In order to accommodate the objective of the research, the post hoc tests were conducted with a top-down approach. The mean values were ranked and the highest Mix mean was compared with the second highest value until a significant difference was obtained.

Table 4. Measuring instrument parameters.

Measuring instrument parameters	Sub parameters	Year 2012			Year 2013		
Total plant	1. Plant height	ANOVA p=0.00232	Mix 1 & 2	Tukey HSD p=0.03	ANOVA p=0.014	Mix 1 & 3	Tukey HSD p=0.014
	2. Plant diameter	Kruskal Wallis p=0.056	Mix 1 & 5	Mann-Whitney p=0.01	Kruskal Wallis p=0.005	Mix 1 & 7	Mann-Whitney p=0.039
	3. Fresh plant mass	Kruskal Wallis p=0.026	Mix 7 & 6	Mann-Whitney p=0.024	Kruskal Wallis p=0.007	Mix 7 & 4	Mann-Whitney p=0.01
Leaves	4. Number of leaves	ANOVA p=0.07			ANOVA p=0.107		
	5. Leaf width	ANOVA p=0.0003020244	Mix 2 & 3	Tukey HSD p=0.041	ANOVA p=0.011	Mix 6 & 3	Tukey HSD p=0.051

Table 4. Continued.

Measuring instrument parameters	Sub parameters	Year 2012			Year 2013		
Leaves	6. Foliage fresh weight	Kruskal Wallis p=0.032	Mix 1 & 2	Mann-Whitney p=0.126	Kruskal Wallis p=0.118		
Flowers	7. Number of flowers	Kruskal Wallis p=0.293			Kruskal Wallis p=0.651		
Tubers	8. Diameter of tuber	ANOVA p=0.005	Mix 2 & 5		ANOVA p=0.015	Mix 2 & 5	Tukey HSD p=0.059
Root	9. Weight	Kruskal Wallis p=0.005	Mix 1 & 7	Mann-Whitney p=0.05	Kruskal Wallis p=0	Mix 7 & 6	Mann-Whitney p=0.018

This Section Contains the Explanation of the Statistical Comparisons Conducted (Year 2012 and Year 2013 Hereafter Referred to as 2012 and 2013)

1. Plant Height. 2012 ANOVA compare p=0.00232 Mix 1 (Cyclamen Mix) and Mix 2 (Cyclamen Mix and 45 Mix Tukey HSD p=0.03).

2013 ANOVA compare p=0.014 Mix 1 and 3 (49 Mix) Tukey HSD p=0.014

In both 2012 and 2013, the plant height differed significantly between the mix means. In 2012 plant height was significantly larger in Mix 1 compared to Mix 2. The means of Mix 1 were less than that of Mix 2. In 2013, plant height was also significantly larger for Mix 1 compared to Mix 3 with the means of Mix 1 less than that of Mix 3.

2. Plant Diameter. 2012 Kruskal Wallis compare p=0.056 Mix 1 and Mix 5 (7 Mix) Mann-Whitney p=0.01.

2013 Kruskal Wallis comparer p=0.005 Mix 1 and Mix 7 (Klasmann peat Substrate 4) Mann-Whitney p=0.039.

In both 2012 and 2013, the plant diameter differed significantly between the Mix means. In 2012 plant diameter was significantly larger in Mix 1 compared to Mix 5. The means of Mix 1 were less than that of Mix 5. In 2013, plant diameter was also significantly larger for Mix 1 compared to Mix 7 with the means of Mix 1 less than that of Mix 7.

3. Fresh Plant Mass. 2012 Kruskal Wallis compare p=0.026 Mix 7 and Mix 6 Mann-Whitney p=0.024.

2013 Kruskal Wallis compare p=0.007 Mix 7 and Mix 4 (45 Mix) Mann-Whitney p=0.01.

In both 2012 and 2013, the fresh plant mass differed significantly between the Mix means. In 2012 fresh plant mass was significantly larger in Mix 7 compared to Mix 6. The means of Mix 7 were less than that of Mix 6. In 2013, fresh plant mass was also significantly larger for Mix 7 compared to Mix 4 with the means of Mix 7 less than that of Mix 4.

4. Number of Leaves. 2012 ANOVA p=0.07. 2013 ANOVA p=0.107.

No significant difference for number of leaves between treatments in both 2012 and 2013 when using an alpha value of 0.05. However, using an alpha value of 0.1 a significant difference is observed. It is therefore further mentioned that the three highest mean values for the Year 2012 (treatment 7, 2, 1) and the Year 2013 (treatment 1, 7, 2) are the same.

5. Leaf Width. 2012 ANOVA compare p=0.00030244 Mix 2 and Mix 3 Tukey HSD p=0.041.

2013 ANOVA compare p=0.011 Mix 6 (Coir) and Mix 3 Tukey HSD p=0.051.

In both 2012 and 2013, the leaf width differed significantly between the Mix means. In

2012 leaf width was significantly larger in Mix 2 compared to Mix 3. The means of Mix 2 were less than that of Mix 3. In 2013, leaf width was also significantly larger for Mix 6 compared to Mix 3 with the means of Mix 6 less than that of Mix 3.

6. Folaige Fresh Weight. 2012 Kruskal Wallis compare p=0.032 Mix 1 and Mix 2 Mann-Whitney p=0.126.

2013 Kruskal Wallis compare p=0.118 Mix 1 and Mix 2.

In both 2012 and 2013, the foliage fresh weight differed significantly between the mix means. In 2012 foliage fresh weight was significantly larger in Mix 1 compared to Mix 2. The means of Mix 1 were less than that of Mix 2. In 2013, foliage fresh weight was also significantly larger for Mix 1 compared to Mix 2 with the means of Mix 1 less than that of Mix 2.

7. Number of Flowers. 2012 Kruskal Wallis compare p=0.293.

2013 Kruskal Wallis compare p=0.651.

No Significant difference for number of flowers between treatments in both 2012 and 2013.

The results of the comparison of mean number of flowers, indicated Mix 1 performed best and the largest mean number of flowers being recorded with Mix 1.

8. Diameter of Tuber. 2012 ANOVA compare p=0.005 Mix 1 significantly smaller than Mix 2 and Mix 5.

2013 ANOVA compare p=0.015 Mix 2 and Mix 5 Tukey HSD p= 0.059.

In both 2012 and 2013, the diameter of tuber differed significantly between the mix means. In 2012 diameter of tuber was significantly smaller in Mix 1 compared to Mix 2 and Mix 5. The means of Mix 1 were larger than that of Mix 2 and Mix 5. In 2013, diameter of tuber was also significantly larger for Mix 2 compared to Mix 5 with the means of Mix 2 less than that of Mix 5.

9. Root Fresh Weight. 2012 Kruskal Wallis compare p=0.005 Mix 1 and Mix 7 Mann-Whitney p=0.05.

2013 Kruskal Wallis compare p=0 Mix 7 and Mix 6 Mann-Whitney p=0.018.

In both 2012 and 2013, the root fresh weight differed significantly between the Mix means. In 2012 root fresh weight was significantly larger in Mix 1 compared to Mix 7. The means of Mix 1 were less than that of Mix 7. In 2013, root fresh weight was also significantly larger for Mix 7 compared to Mix 6 with the means of Mix 7 less than that of Mix 6.

CONCLUSION

The results for the comparison of the growth media on cyclamen growth in a controlled environment indicate that Mix 1 (Cyclamen Mix) and Mix 7 (Klasmann peat Substrate 4) are the best performing growth media. Based on the analysis of the results of the comparison of the combined Season 1 (2012) and Season 2 (2013) obtained during the study, it was found that the most suitable growth media for container cyclamens for South African circumstances would include peat or a mixture of peat. Therefore commercial growers using growth media with peat and peat mixtures, would not only have a better quality product for market but would have the minimum number of flowers, deemed necessary for market ready, present and therefore ready for market sooner than when using growth media without peat. The study was therefore able to determine suitable growth media for container cyclamens in a controlled greenhouse structure. The study also highlighted the benefits to the commercial grower such as faster production cycle and earlier market ready container cyclamen delivery to the market.

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