Westhoff Vertriebsges. mbH

Combi-Pots: Colourful Bedding Plant Combinations

Evaluating the combination ability and alternative culture methods of bedding plants in mixed container plantings

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Abstract

It all began with ¨Celebration® Karneval®¨ from Westhoff, a *Calibrachoa* mix consisting of three different colours. The result in red, yellow and blue was so convincing that it became the trend-setter for what nowadays is marketed under the name ¨combi-pots¨. These are colourful combinations, either contrasting or tone-on-tone, in the form of mixed plantings whereby three young plants of either the same or different genera are rooted separately or together in a single pot. For the cultivation of mixed young plants it is important that all varieties have similar demands in relation to light, water, temperature, plant growth regulators, flowering time and growth habit. However, many combinations seem in relation to alternative culture methods not fully developed. For this reason, it was decided to re-evaluate existing and partly develop new potential bedding plant combinations of three different genera using Westhoff Westflowers® varieties to satisfy production requirements.

Most commonly used in plant mixes are *Calibrachoa*, *Lobelia*, *Petunia* and *Verbena* because they show similar growth and flowering characteristics. Other possible combination partners were *Bacopa*, *Bidens*, *Sanvitalia* and *Scaevola*. Suitable varieties were selected according to growth vigour, growth habit and flowering time. Every combination was given a mix number and tested under alternative culture methods. Cuttings were rooted separately or together in plugs of different sizes. After three weeks the young plants were potted in 12 cm pots. Two applications with Caramba/Regalis, Caramba/Cycocel/Regalis, Alar and Topflor were applied to observe the effect on the combination ability of different varieties. After 11 weeks of culture the varieties were evaluated according to specific criteria: flowering time, number of flowers, growth vigour, growth habit, sales maturity and an overall impression.

The combinations consisting of three separately rooted young plants showed to be more uniform in growth and flowering time than rooting them together in a single plug. The use of Caramba/Regalis or Caramba/Cycocel/Regalis was necessary to maintain the uniformity in relation to growth and development of different partners in the mix. It was observed that a broader assortment of plants can be treated with a single treatment consisting of various chemicals.

Potential combinations have been recommended to the company that will be taken into production in 2012. The outcomes of this research show that there are various ways of producing a good combination. On this basis, the company can decide whether or not to enter the mix segment of genera combinations.

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Abbreviations

CCC	Cycocel
CW	Calendar Week
HT	Heating Temperature
PGR	Plant Growth Regulator
RH	Relative Humidity
URC	Unrooted Cuttings

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1 Introduction

1.1 Westhoff Company Profile

Westhoff was founded three generations ago in 1969 by Josef Westhoff, who began growing vegetables in a small greenhouse (Annex 1). At that time, Josef Westhoff sold his vegetables directly to the end consumer. Nowadays, the company has become a major producer growing an extensive assortment of pot plants on over 130.000 square meters (Figure 1) for Germany and Europe (Annex 2). Millions of plants are hereby traded until they reach our gardens. What has stayed the same over the years is the companies' passion for flowers.

In 1995, Westhoff began their own breeding program to meet the requirements and expectations of the market and consumers. Under the trade name Westflowers®, the company continuously offers new varieties which are well received by producers and consumers. The Westflowers® advantage: strict production requirements have to be met before new varieties are released into the market (Westhoff, 2011).

Figure 1 Aerial photograph of company Westhoff (Westhoff, 2009)

1.1.1 Westhoff Culture Program

In the winter months from November to February, the company Westhoff produces young plants such as *Pelargonium*, New Guinea *Impatiens* and diverse bedding plants. Their own selection of Westflowers® is cultivated for the most part, which consists of own varieties such as *Calibrachoa*, *Lobelia*, *Petunia*, *Scaevola* and *Verbena*. Bedding plants are produced in pots ranging from 8 cm to 13 cm for sales in spring. Additionally, there is a diverse assortment of hanging baskets with a total of approximately 26.500.

After the high production season, from mid till end of May, the first *Cyclamen persicum* in 12 cm pots are potted. Only the varieties Halios, Latinia and Metis from the company Morel in France are cultivated and sold. In total 480.000 plants are cultivated per year, which is produced in four batches of 120.000 each.

In mid July the first Christmas stars (*Euphorbia pulcherrima*) arrive as unrooted cuttings (URC) that originate from the company Danwitz in Tönisforst. They are also cultivated in four batches, whereby not all batches are of the same size. The batches are divided in 1 x 30.000, 2 x 50.000 and 1 x 40.000 plants. The 170.000 Christmas stars are solely cultivated in 13 cm pots and sold from mid November onwards (Böing, 2006).

In the past years, colourful combi-pots arising from mixed container plantings of the same or different genera have found their way into the bedding plant market and are now in trend. Westhoff markets colourful *Calibrachoa* mixes under the name ¨Celebration® Karneval®¨, which the company produces to the most part as half finished plants. The assortment is big, but do they live up to what they promise?

1.2 Combi-Pots: Colourful Bedding Plant Combinations

It all began with ¨Celebration® Karneval®¨ from Westhoff (Figure 2). Wilhelm Westhoff, head production manager at the company, had the initial idea of taking left-over young plants in different colours and to simply plant them together in a pot. The result in red, yellow and blue was so convincing that they decided to invest more time in breeding and selection.

Figure 2 Celebration® Karneval® from Westhoff (Westhoff, 2011)

What began as an almost ridiculed niche product can nowadays be found in the assortment of many well-known breeding and young plant companies under the name ¨combi-pots¨. These are colourful combinations in the form of mixed plantings whereby three unrooted cuttings of either the same or different genera are rooted separately or together in a single pot.

Particularly strong in the mix segment is the company Dümmen with their ¨Confetti Garden¨ combi-pot series, which in the meantime is already five years on the market. The origin of the idea lies in the breeding and introduction of the *Petunia* series ¨Potunia¨ (Figure 3).

Figure 3 *Petunia* series ¨Potunia¨ from Dümmen (Dümmen, 2010)

As a result of the compact growth of the new *Petunia*, for the first time three cuttings of different genera could be planted and cultivated in a single pot. ¨Confetti Garden¨ exists in 24 combinations, whereby the colourful ¨Hawaiian Luau¨ is the strongest mix at Dümmen with 50 % share of combi-sales (Figure 4).

Figure 4 Hawaiian Luau from Dümmen (Dümmen, 2011)

However, tone-on-tone[1] genera combinations have also made their way through, where ¨Hot Pink Jazz¨ has the strongest foothold (Figure 5). Genera combinations are at Dümmen fully in trend according to Sonja Dümmen, company co-owner and marketing manager (Valenta, 2011).

Figure 5 Hot Pink Jazz from Dümmen (Dümmen, 2011)

[1] tone-on-tone: a colour in different shades

1.2.1 Dümmen Company Profile

Dümmen was founded over 40 years ago. The company began greenhouse production back in the sixties with cut flowers during the winter months. Nowadays, they are a leading producer of young plants, with operations worldwide.

Since the nineties, Dümmen is well known for their own varieties of *Pelargonium* and *Poinsettia*. For more than 15 years, the company markets all their own varieties under the trademark RED FOX, which has become a brand for experts and horticulturists both in and outside Germany. In the past ten years, the RED FOX assortment has strongly developed in the field of *Petunia*, *Verbena* and *Calibrachoa*.

In 2008 Dümmen launched the Confetti Liner (Figure 6). The concept of this exceptional idea: three cuttings of different genera rooted together in a single plug. Confetti Garden already exists in 24 combinations, of which 11 are inter-specific[2] and the rest are plain[3] genera mixes. According to the company they all provide matched timing, growth and colours (Dümmen, 2011).

Figure 6 Confetti Liners from Dümmen (Dümmen, 2011)

[2] inter-specific: three cuttings of different genera rooted together in a single plug
[3] plain: three cuttings of the same genera rooted together in a single plug

1.3 Problem Definition

For the cultivation of mixed young plants it is important that all varieties in one combination have similar demands in relation to light, water, temperature and plant growth regulators to achieve uniform growth. However, in the mix segment of the bedding plant market, many combinations seem in relation to alternative culture methods not fully developed. A successful concept must take these components into account and this is where there is still margin for improvements (Mehring-Lemper, 2011).

With regards to alternative culture methods, there are many factors that influence the combination ability of different varieties during cultivation. It all begins with the propagation of the young plants, so what fits together during the young plant culture? There are various factors that need to be considered: rooting method, rooting time, growth vigour, application of growth regulators and space requirements.

If this was not enough, a successful concept must also take into account buyer preferences. Of most importance are the colour combinations in the mixed plantings, so what colours harmonise best together? This is a very difficult question simply because colour preferences are different. Generally, most people prefer flowers to be colourful as they are used to it being that way. On the other hand, more recently there has been a movement to tone-on-tone colour combinations. With *Calibrachoa* combinations the ¨colourful ones¨ continue to be the most popular, originating from the Westhoff ¨Celebration® Karneval®¨ with three *Calibrachoa* planted together in red, blue and yellow (Dümmen, 2011).

There are many components that have to be taken into account for a succesful concept, making it very difficult to combine all of these elements in a single product and especially when dealing with different genera cultivated together in a single pot. To highlight the difficulties of such concepts, various bedding plant mixes are presented on the next page with short reviews and experiences.

Figure 7: Matching colour combination and growth habit, but uniformity is not ideal.

Figure 7 Hot Pink Jazz from Dümmen (TASPO, 2009)

Figure 8: Growth habit not matching, *Petunia* is very dominant and *Verbena* is suppressed.

Figure 8 Purple Cleopatra from Dümmen (Parks, 2009)

Figure 9: Common problem with genera mixes; some need more PGR applications than others.

Figure 9 Trio Rock from Sentier (TASPO, 2010)

Figure 10: Here the end consumer would be happy. The individual varieties show harmonious growth, appealing colour combination, uniform flowering time and growth habit.

Figure 10 Celebration Orient from Westhoff (Westhoff, 2010)

Here the end consumer would be disappointed. The *Petunia* is very dominant, the *Calibrachoa* is not really visible and the *Verbena* is almost completely suppressed.

Figure 11 Aloha Confetti Garden Lavender Spring from Dümmen (Dümmen, 2010)

1.4 Research Objective and Research Questions

Research Objective

The objective of this research is to re-evaluate existing and partly develop new potential bedding plant combinations of three different genera in various colour mixes using Westhoff Westflowers® varieties.

The bedding plant market offers an extensive assortment of plant mixes and combinations. Therefore, the first step will be to re-evaluate existing concepts, primarily from market players such as Dümmen. This information will be the starting point to re-develop those bedding plant mixes, in other words, improving and further developing them in the form of combi-plans. Essentially, these combi-plans show which three different genera should be planted together and, most importantly, which varieties and in what colour combinations. There are a limited number of genera that are suited for such mixed plantings and therefore the ones used for the trials will be to a large extent the same, but also other genera will be integrated in the combi-plants for possible ´new´ combinations. The key to further improve and develop plant mixes is the use of different varieties. The use of own varieties is what makes the concepts unique as every company uses their own breeding program for their combinations. Colour mixes will be a matter of colour preferences, but there is certainly a limit to the amount of variations because of the limited number of existing colours per genera. Next to the colours, the compatibility between the varieties is of most importance.

Research Questions

What are the best performing bedding plant combinations of three different genera in various Westhoff Westflowers® colour mixes' to satisfy production requirements?

From the main research question, the following sub-questions can be derived:

1. How will different rooting methods affect the performance during cultivation?

    1.1 Will planting of inter-specific genera cuttings in separate plugs have an effect?

    1.2 Will planting of inter-specific genera cuttings in the same plug have an effect?

2. Which genera and varieties are compatible for inter-specific mixed plantings in terms of growth and habit?

3. How will different plant growth regulator treatments affect the combination ability?

2 Literature Review

The literature review serves the reader and writer with background information in relation to the developments of alternative culture methods. It elaborates on the period, the extent to which and with what consequences individual culture methods influence plant elongation. In this context, it is important to explain the mechanism and influencing factors of plant elongation. In particular, it concerns the chemical influence of plant growth regulators (PGR´s) on the combination ability of mixed plantings, whereby the application and resulting limitations are the main point of focus.

Ornamentals can be shaped into different product forms by influencing plant height and the number of shoots. Especially with pot plants it is often important to have compact growth in order to produce efficiently and have a lower loading height during transport. There is no concrete definition for compact growth, but generally it implies a short distance between the internodes. New varieties show less excessive growth as compared to older varieties, however it is still important to have the know-how about the possibilities there are to influence the plant structure (Bettin, 2011).

2.1 Plant Growth and Branching

Influencing plant growth and branching are a major concern in ornamental plant production. Already at the start of the culture, many pot plants should form as many side shoots as possible to form a more bushy plant. However, lateral shoot growth should be limited to a great extent to maintain the growth habit of the plants more compact. Hereby the quality of the plants is improved, space utilisation is more efficient and the diversity of plant shapes that can be formed is increased (Bettin, 2011).

2.1.1 Influencing Factors on Branching

To encourage the formation of side shoots, it is necessary to inhibit the apical dominance of the shoot tip. Auxin and cytokinin are the most important hormones for side shoot formation (Davies, 1987). Auxin is mostly produced in the younger leaves and inhibits the sprouting of

underlying lateral buds. Cytokinins are produced in the root tips and move from there into the sprout. Possibly, cytokinins are transported where the highest concentration of auxin is present. Applying substances with cytokinin activity on the plant or removing the sprout tip causes the plant to loose the dominance of the shoot tip and the side buds begin to sprout (Figure 12).

Figure 12 Intensive side shoot formation in *Fuchsia* after application of 100 ppm 6-BAP

In the case of *Schlumbergera*, an application of cytokinin during flower induction causes a higher amount of flowers at the phylloclades (Bettin, 2011). On the other hand, an application of auxin on pinched shoot tips inhibits the sprouting of side buds (Figure 13).

Figure 13 Strong flower set on *Schlumbergera* as a result of an application with cytokinin during flower induction

2.1.2 Influencing Sprouting of Side Buds

Mechanical Factors

Generally, side shoots sprout faster after pinching the younger shoot tips situated higher up in the plant. However, during this process only a few side shoots are formed. Mechanical removal of older shoot tips results in much slower sprouting, whereby more side shoots are formed as compared to pinching. This general tendency can be more or less present depending on the apical dominance of individual species and varieties (Bettin, 2011).

Presumably, auxin is not always produced in young but also older leaves depending on the plant species. This can be observed when a plant with a strong apical dominance is pinched and additionally defoliated. Ivy and *Lycianthes rantonnetii*, both with a strong apical dominance, also form side shoots at older buds when defoliated. As soon as a new sprout develops, with *Lycianthes* it takes over the lead and suppresses the underlying side shoots. With Ivy and *Schefflera* it is possible to promote branching by simultaneously defoliating and pinching (Figure 14).

Figure 14 Strong branching of *Schefflera arboricola* after defoliation

With many plants, by means of pruning at the same height, a homogeneous material for cuttings can be obtained. With *Chrysanthemum* this is only possible to a certain extent because pruning lower in the plant results in a stronger plant growth of the new shoots as compared with pinching.

With some plants, for example *Erica*, it is possible to prune by means of a mower for automation purposes (Figure 15). It is essential that all plants are on a flat surface to ensure equal pruning. Partly the pruning is combined with spacing so that the plants are placed on conveyor belts and then pruned. During this pruning procedure also material for cuttings can be obtained.

Figure 15 Pruning of *Erica* by means of a mower on a conveyor belt

In practice, pruning also shows signs of inhibiting root growth. The effect is probably due to the removal of the plants source of auxin. Additionally, the loss of surface that can be used for assimilation is also responsible for this inhibition (Bettin, 2011).

Environmental Factors

After pruning, light and temperature are the main growth factors that influence the rate and number of side buds. Generally, more available light promotes the number of side shoots and a higher temperature results in faster cell division as well as faster sprouting. Less light availability can increase the number of side shoots, maintaining the temperature below the optimum for the corresponding species. As a result of the slower sprouting, the apical dominance is not as strong. An alternative is the use of assimilation light to promote the number of side shoots.

Figure 16 shows four different plants under various light and temperature conditions. Plant A has more available light but a lower temperature; this promotes the number of side shoots. Plant B has more available light and a higher temperature, resulting in faster cell division and sprouting. Plant C has less available light and a lower temperature, reducing the apical dominance. Plant D has less available light but a higher temperature, promoting cell division and reducing the number of side shoots.

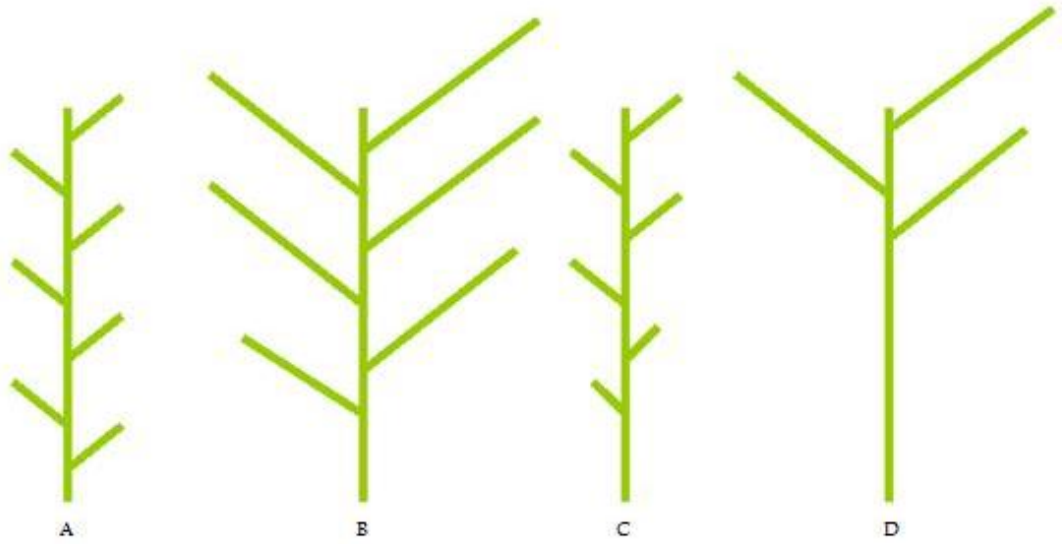

Figure 16 Effect of light and temperature on the number and rate of shoots (Bettin, 1995)

With regards to light quality, plants react with a higher number of side shoots when light with a lower dark red spectrum is used, as is the case with most assimilation lamps. Other growth factors such as the supply of CO_2 are in practice less relevant in relation to the number and rate of shoots.

In specific cases, it is the aim to suppress the sprouting of side buds, an example being the production of big flowered and single stemmed *Chrysanthemum*. In this case it is possible to apply auxin, but it is not widely practiced. In a trial it was possible to suppress the sprouting of side buds, however the inflorescence was also damaged. The application of auxin to promote apical dominance was therefore not further investigated (Bettin, 1995).

2.2 Effects of Plant Growth Regulators

Plant growth regulators act by influencing plant hormone balances which affect the growth of plants. The number of side shoots can be increased by means of substances with auxin-reducing or cytokinin-promoting activity. An auxin-antagonist is ethephon, which in many plants can be converted into ethylene. Substances with cytokinin activity, like 6-Benzylaminopurin (=6-BAP=Benzyladenin=BA), cause in many dicotyledons and some monocotyledons, like for example *Cordyline*, strong branching. If such side shoots are removed for propagation purposes, in most cases the rooting capability is very much limited. 6-BAP is often used *in vitro* culture to promote branching. The substance performs badly in water but is more soluble in alcohol and already has an effect at a low concentration (Basra, 2000).

The Application of Plant Growth Regulators

PGR´s for the reduction of plant growth can either be taken up by the leaf or by the roots. The transport within the plants is then in the direction of the shoot tips that are being treated, where growth will be affected. When applying the chemical it is important that all shoots are in contact with the active substance, otherwise the shoots that are covered by leaves will not or not sufficiently be treated.

For absorption over the leaf it is essential to apply the PGR in liquid form, fogged substances cannot be taken up in this way. It is therefore important to ensure a water film stays on the leaves. Spraying should be undertaken with a low light intensity, preferably in the morning or in the evening. If necessary, the screens can be closed. Depending on the solubility of the medium, the effects of PGR´s can be improved by means of auxiliary substances such as oils. These help to keep the active substances longer in a liquid form to ensure they can be sprayed more equally over the plants. All the following PGR´s mentioned inhibit not only cell elongation, but also cell division. As a result, a delay in the culture time is often observed. The application over the root is due to cost or other reasons not always useful (Basra, 2000).

The Effect of Plant Growth Regulators

Essential for the effect is the quantity of active ingredient that plants have taken up. The commonly used method of spraying ¨dripping wet¨ leads to a significantly lower amount of active substance on the plant as compared to spraying to a lesser extent. The reasoning behind may become clearer when you add drop wise water to a cup fully filled up with water. As long as the tension in the water stays, the amount of water keeps increasing until a certain point where the water film breaks and more water runs out than the last drop that was added. For an application usually per liter of chemical a surface of around 6-10 m² can be sprayed.

All PGR´s generally act more inhibiting on shoot elongation rather than the root. By inhibiting shoot elongation it is possible to slightly promote the transfer of assimilates in the root. Only by giving an overdose of the PGR it is possible to influence root growth. PGR´s also commonly influence the flowering habit.

PGR´s must be approved of before being used on a specific culture. If the manufacturer does not approve its use for ornamentals, then it is necessary to request a special authorization. Due to always changing regulations it is important to first consult relevant websites of authorities before applying any chemical (Evers, 1987).

2.2.1 Cycocel

Cycocel (CCC) is the oldest and most widely used PGR for inhibiting plant growth and producing more compact plants. Besides spraying (commonly used concentrations are 0,1-0,15 %), it can also be applied as a liquid drench (0,5-0,75 %). Hereby the salt content in the substrate increases significantly, together with the chlorine content. With high concentrations the plants react in particular to treatments with chlorosis at the leaf edges (Figure 17).

Figure 17 Chlorosis on leaf edges due to high Cycocel concentration with pot *Azalea*

CCC is rapidly degraded by most plant species and therefore it rarely has a long lasting inhibiting effect (exception: *Pavonia multiflora*). Until the plant shows a reaction a week usually goes by. With some plants the substance is not taken in by the leaf, but instead by the root (for example *Argyranthemum frutescens*). Some ornamentals do not or not sufficiently react to the active ingredient, these are listed below.

- *Fuchsia*
- *Hydrangea*
- *Lycianthes rantonnetii*
- *Petunia*
- *Primula*
- *Rosa* (relevant for pot varieties)
- *Solanum jasminoides*
- *Tagetes*
- *Tulipa* (relevant for pot varieties)
- *Viola*

2.2.2 Triazole

This active ingredient group of systemic fungicides has an effect against real mildew and fungi; however it is mostly applied as a PGR. An overdose can be recognized by the darkening of the leaves, whereby the leaf veins are more affected in their growth than the leaves themselves. Thereafter follow swellings in the leaf (Figure 18). At higher concentrations not only cell elongation, but also cell division is affected. As a result, the regeneration of new plant organs comes to a halt. Plants that have been treated with a too high concentration are often only capable of cell division again after a treatment with gibberillic acid. Triazoles are often very persistent and therefore left over substrates should not be added to the compost.

It can be critical to assess the use of these chemicals as a ¨emergency brake¨ in a higher concentration to inhibit plant growth shortly before sales, in other words, to avoid excessive growth of remaining plants which could lead to completely inhibited plants arriving at the end consumer.

Figure 18 Effect of a Triazol on *Hydrangea*

2.2.3 Prohexadion-Ca

Prohexadion-Ca was developed for fruit growing, although nowadays it is commonly used as a PGR for many pot plants. After application often there are unwanted discolorations in blue and red flowers, however in orange and yellow coloured flowers no disorders could be observed. Prohexadion-Ca also reduces pathogen infection in some plant species (Oostendorp et al., 2001).

2.2.4 Daminozide, Dazide

Daminozide is an effective PGR for most plants. In Germany it is not allowed due to environmental issues, but it is widely used in other countries. It is especially applied to those plants where Cycocel is not effective enough.

2.3 Nutrition and Water Use

Besides the factors already mentioned in the previous sections, nutrition and water use also play an important role in plant growth regulation.

In particular a deficit in nutrition of the elements N and P inhibits plant growth. A deficiency in phosphorous inhibits the elongation of internodes, whereby the shoot is often coloured dark green as a result of this deficit. Fertilizers and standard substrates already have high nutrition levels, but alternatively it is possible to increase the level of phosphorous by adding aluminium oxides to the substrate.

Also by means of a nitrogen deficiency it is possible to inhibit plant growth, as shown in *Poinsettia*. It has been a problem to convince growers that in the past strived to supply their plants optimally, to let their plants suffer under an nitrogen deficiency and to do the first application towards the end of the culture to provide the necessary colour. A nitrogen deficiency is easier to achieve than a phosphorous deficiency.

Water stress can be achieved by either controlling the amount of water the plants receive or by increasing the level of salt in the substrate. This can also result in an inhibiting effect to control plant growth.

During the application of these methods, not only the elongation of the internodes is inhibited, but also the leaves are clearly smaller. Compact growth due to PGR´s inhibits mostly the elongation of the internodes, whilst drought stress as well as a nitrogen and phosphorous deficiency also restrict the growth of leaf surfaces (Bettin, 2011).

3 Materials and Methods

3.1 Selection Criteria for Combinations

3.1.1 Genera and Varieties

The starting point was to select suitable genera combinations. Most commonly used in plant mixes are *Calibrachoa*, *Lobelia*, *Petunia* and *Verbena* because they show similar growth and flowering characteristics. *Bacopa*, *Bidens* and *Sanvitalia* are also used to a smaller extent because they show less compatibility in a mixed planting in relation to their response to growth regulators and growth habit. Nevertheless, these will also be used for the trials. Additionally, *Scaevola* will also be included because it is one of the products the company Westhoff is well known for and is interesting to observe how it will perform as it is not commonly seen in plant mixes. With regards to varieties, the company Westhoff has made it clear that only Westflowers® varieties from their own breeding program should be used, simply to encourage and promote their own products. Currently there are 217 varieties, from which 19 are not included in the general assortment list because they are not available for every customer due to exclusive contracts that ensure specific companies to be the only one producing or distributing those exclusive varieties. The largest product groups in terms of varieties are: *Calibrachoa* 57, *Petunia* 27, *Lobelia* 23 and *Verbena* 19.

The next step was to look even further into suitable varieties from each of the above selected genera. A closer look together with various experts from different departments at Westhoff including breeding, production and sales was necessary to further reduce the assortment. The selection criteria: from which varieties is it possible to obtain starting material, either to be ordered or from own mother stock, and which varieties have the potential to perform best when combined in a mixed planting. This reduced the assortment to 39 varieties from eight different genera. Establishing the assortment made it possible to start developing combination concepts. A limitation was set in relation to the total number of combinations, which was discussed and decided together with Ewald Tubes, general manager at Westhoff, to a maximum of 38 combinations. The reasoning behind being that a complete row of moving benches in a production compartment of the greenhouse has a total of 38 benches, meaning that there was one combination per bench. This surface provided enough space to produce

over 15.000 individual plants in 12 cm pots and allowed for sufficient replications. It is important to mention that not every company can afford such a large scale trial and especially not in the high production season where all the available space is at full capacity.

Overall, there were 19 different genera combinations with 58 variations in relation to varieties and colours. Therefore, together with Daniel Boom from the sales department, the combinations were further reduced from 58 to 38 on the basis of his experience with production and knowledge about customer preferences (Annex 3). In addition to Westhoff combinations, plant mixes from Dümmen were also included as a comparison to observe their performance (Table 1).

Table 1 Plant mixes from Dümmen used for trials

RED FOX Trio Confetti Garden Mix		
RED FOX Hot Pink Jazz	trial	*Calibrachoa x Petunia x Verbena*
RED FOX Lavender Spring	trial	*Calibrachoa x Petunia x Verbena*
RED FOX Patriot	trial	*Calibrachoa x Petunia x Verbena*
RED FOX Water Colours	trial	*Lobelia x Petunia x Verbena*

3.2 Culture Information

3.2.1 Starting Material

The starting material, in the form of unrooted cuttings, was ordered in calendar week (CW) 5. The URC were delivered in two batches, most in CW 6 and the remaining in CW 7 because of different suppliers (Table 2).

Table 2 List of suppliers for ordering URC and their origin

Supplier	Origin
Adler	Israel
Barak	Israel
Cohen	Israel
McGregor	United States
Savanna	Kenya
Westhoff	Germany

3.2.2 Rooting Medium

The URC were planted in either 1,6 cm or 4 cm (jumbo) plugs. In 1,6 cm plugs, different genera are planted individually and rooted in trays of 180 (Figure 19). In jumbo plugs, three different genera are planted together and rooted as one in trays of 60 (Figure 20).

Figure 19 *Calibrachoa* Celebration Snowball planted in 1,6 cm plugs and rooted in trays of 180

Figure 20 Mix 24 with URC planted in 4 cm (jumbo) plugs and rooted in trays of 60

3.2.3 Propagation

The URC were rooted for three weeks until CW 9. Generally it takes two weeks but some species, for example *Scaevola*, take a week longer. An extra week ensured that all cuttings rooted properly, essential for *Scaevola* and the ones that were delivered later in CW 7. The trays were placed on moving benches in the greenhouse and propagated at 21°C heating temperature (HT) and 25°C ventilation temperature (VT) with a relative humidity (RH) of 86 %.

3.2.4 Potting

In CW 10 the young plants were potted in 12 cm, brown plastic pots. Every bench was filled with 250 pots, placed in the center pot to pot to be re-spaced at a later stage during cultivation. In total, 38 benches with 9.500 pots were prepared for planting. Half of the pots (4.750) were planted with three smaller plugs and the other half with one jumbo plug already containing three rooted cuttings.

3.2.5 Substrate

The substrate was a *Petunia* substrate consisting of:

- 90 % white peat
- 10 % perlite
- 50 kg clay/m^3
- 0,75kg/m^3 NPK 14-16-18
- 0,75kg/m^3 osmoform
- 75g/m^3 micro elements
- 100g/m^3 Fe-chelate
- pH 5,5 – 6,0

3.2.6 Temperature

After potting the temperature was set at 18°C for the formation of new roots. After one week, the HT was decreased to 16°C and the VT to 22°C for the remaining culture weeks.

3.2.7 Watering

The plants were kept evenly moist; too wet or too much water from the bottom was avoided to prevent disease problems in the roots. Overhead watering was done by an automatic boom only done before noon so that the plants do not go too wet into the night, otherwise it could result in *Botrytis*.

3.2.8 Fertilizer

The plants were given a balanced fertilizer 15-11-15 during every watering application with a pH of 5,8. Towards the end of the cultivation the fertilizer composition was changed to a NPK ratio of 1:3:3. The fertilizer composition was adjusted during cultivation depending on the growth and development of the plants.

3.2.9 Spacing

The plants were spaced in CW 15 (Figure21), just before the plants started to grow into each other. The final spacing of the pots was 8 x 30 = 240; the remaining 10 pots were used for PGR trials.

Figure 21 Mix 7 after spacing in CW 15

3.2.10 Pinching

The first pinching was done by three people in CW 10 before potting. The second so called ¨repair pinching¨ was done one week after potting by two people to ensure uniformity of all plants. During this procedure, it is important to ensure that all working equipment is disinfected. For this purpose, a 2 % solution of Menno-Florades was used.

3.2.11 Integrated Pest Management

A treatment against *Botrytis* with the chemical Chinoplant was given in the propagation phase to all cuttings, especially *Petunia* which showed a relatively severe infection. The plants recovered after the first application and showed no more infections during cultivation. A second treatment against aphids with the chemical Confidor was given in CW 18 before the plants were ready to be sold.

3.2.12 Plant Growth Regulation

One week after the second pinch (CW 12), the first application with various growth regulators was given. The applications consisted of four treatments and a control. Every treatment consisted of 25 repetitions (pots) per rooting method. This means that every treatment was

given twice, once for 25 pots planted with three smaller plugs and again for 25 pots planted with jumbo plugs. Every following week the development of the plants was monitored depending on the length of the internodes and flower development to decide whether or not to apply another application (Table 3).

Table 3 PGR treatments with different chemicals from CW 12 to CW 16

	Authorised PGR´s		Prohibited PGR´s		
CW	**Treatment 1**	**Treatment 2**	**Treatment 3**	**Treatment 4**	**Control**
12	Caramba 0,05 % + Regalis 0,13 %	Caramba 0,05 % + CCC 720 0,1 % + Regalis 0,13 %	Alar 0,1 %	Topflor 0,07 %	0
13	Caramba 0,05 % + Regalis 0,13 %	Caramba 0,05 % + CCC 720 0,1 % + Regalis 0,13 %	Alar 0,1 %	Topflor 0,07 %	0
14	Caramba 0,05 % + Regalis 0,13 %	Caramba 0,05 % + CCC 720 0,1 % + Regalis 0,13 %	Alar 0,1 %	Topflor 0,07 %	0
15	Caramba 0,1 % (Regalis 0,13 %)	Caramba 0,05 % + CCC 720 0,1 %	Alar 0,2 %	Topflor 0,12 %	0
16	Caramba 0,1 % Tilt 0,15 %	Caramba 0,1 % Tilt 0,15 %	Alar 0,2 %	Topflor 0,15 %	0

Two applications were given over seven weeks after potting, the first in CW 12 and the second in CW 15. It is important to note that treatments 1 and 2 consist of authorised PGR´s and treatments 3 and 4 of prohibited PGR´s that are not authorised in Germany. The reason for this differentiation is due to the fact that some chemicals are authorised in one country but not in another. Westhoff has several customers in the United States where Alar and Topflor are not prohibited and the chemicals are more widely used than Caramba and Regalis. With regards to the prohibited PGR´s used for the trials, Westhoff organised a special license allowing the company to use these chemicals legally.

The active ingredients of the chemicals used for the trials and their effects on plant growth are presented in Table 4.

Table 4 Active ingredients of chemicals used for trials and their effects on plant growth (BVL, 2011)

Commercial Name	Active Ingredient	Effect
Alar	Daminozide	Compact cell growth, short internodes, greener leaves
Caramba	Metconacol	Inhibits plant growth, compact plants
CCC 720	Chlormequat-chlorid	Shortens stem length, improves flower development
Regalis	Prohexadion-Calcium	Inhibits shoot growth
Tilt	Propiconazol	Inhibits plant growth, compact plants
Topflor	Flurprimidol	Inhibits the synthesis of gibberellins, short internodes

3.3 Evaluation of Finished Plants

After 11 weeks of culture, from rooting until finished plants, in CW 17 (end of April) the plants were evaluated. In order to adequately evaluate the 38 different combinations, it was essential to develop a scheme with specific criteria to assess the performance during the trials. For every combination (mix), there were two tables to evaluate the different rooting methods. The first table (Table 5) highlighted in green was used for the pots planted with 1,6 cm plugs, rooted in trays of 180. The second table (Table 6) highlighted in blue was used for the pots planted with jumbo (4 cm) plugs, rooted in trays of 60.

Table 5 Evaluation scheme for pots planted with 1,6 cm plugs, rooted in trays of 180

180	Mix Number	Flowering Time	No. of Flowers	Growth Vigour	Growth Habit	Sales Maturity	Overall Impression
C	Taifun Mega Pink						
C	Cele. Purple Rain						
C	White Star						
T1	Taifun Mega Pink						
T1	Cele. Purple Rain						
T1	White Star						
T2	Taifun Mega Pink						
T2	Cele. Purple Rain						
T2	White Star						
T3	Taifun Mega Pink						
T3	Cele. Purple Rain						
T3	White Star						
T4	Taifun Mega Pink						
T4	Cele. Purple Rain						
T4	White Star						

Table 6 Evaluation scheme for pots planted with jumbo (4 cm) plugs, rooted in trays of 60

Jumbo	Mix Number	Flowering Time	No. of Flowers	Growth Vigour	Growth Habit	Sales Maturity	Overall Impression
C	Taifun Mega Pink						
C	Cele. Purple Rain						
C	White Star						
T1	Taifun Mega Pink						
T1	Cele. Purple Rain						
T1	White Star						
T2	Taifun Mega Pink						
T2	Cele. Purple Rain						
T2	White Star						
T3	Taifun Mega Pink						
T3	Cele. Purple Rain						
T3	White Star						
T4	Taifun Mega Pink						
T4	Cele. Purple Rain						
T4	White Star						

Tables 3 and 4 show the different criteria used for assessing and evaluating individual combinations. There were six different evaluation criteria for evaluating the performance during the trials: flowering time, number of flowers, growth vigour, growth habit, sales maturity and an overall impression. Every criterion was defined and sub-divided into a range of different grades in order to assess individual varieties in the combination.

- **Flowering Time**

Definition: the moment in time a plant begins to flower, taking the propagation phase as the earliest flowering point and the point of evaluation in CW 17 as the latest.

Table 7 Grading scheme for flowering time

Grades	Code	Flowering Time
Very Early	SF	Begins to flower during propagation phase (CW 6-7)
Early	F	Begins to flower after propagation but before potting
Medium	M	Begins to flower after potting (CW 10)
Late	S	Begins to flower 1 week before evaluation
Very Late	SS	Not flowering at point of evaluation (CW 17)

- **Number of Flowers**

Definition: number of flowers at the point of evaluation in CW 17.

Table 8 Grading scheme for number of flowers

Grades	Number of Flowers
1	No flowers (0)
3	Weak flowering (1)
5	Moderate flowering (3)
7	Strong flowering (5)
9	Abundant flowering (>7)

- **Growth Vigour**

Definition: the speed at which a plant develops, either in height or in width, until the point of evaluation in CW 17.

Table 9 Grading scheme for growth vigour

Grades	Code	Growth Vigour
Very Weak	SK	Minimal growth, mostly suppressed
Weak	K	<10 cm of growth above pot (height or width)
Moderate	M	+/- 10 cm of growth above pot (height or width)
Vigorous	W	> 10 cm of growth above pot (height or width)
Very Vigorous	SW	>20 cm of growth above pot (height or width)

- **Growth Habit**

Definition: the form and shape in which a plant grows and develops during cultivation until the point of evaluation in CW 17.

Table 10 Grading scheme for growth habit

Grades	Code	Growth Habit
Upright	A	+/- 90° angle to the pot vertically upwards
Semi-Upright	HA	+/- 45° angle to the pot vertically upwards
Semi-Hanging	HH	+/- 45° angle to the pot horizontally downwards
Hanging	H	>45° angle to the pot horizontally downwards
Compact	K	5 cm of growth above pot (height or width)
Round (Bushy)	KK	Spherical shape

- **Sales Maturity**

Definition: the point where a plant is ready for sales from the production side of the company. The plant needs to be flowering (minimum 1 open flower), it must show the development of new buds; it should be well branched and compact (around 10 cm in height or width).

Table 11 Grading scheme for sales maturity

Grades	Code	Sales Maturity
Never	N	Unsightly plant, no flowers or buds
Not Sellable	NV	Significant defects, no flowers or buds
Sellable	V	Branching very good, compact, many flowers and buds
Overripe	U	Senescing flowers, cleaning necessary

- **Overall Impression**

Definition: the overall impression of the combination taking into account the flowering and growth characteristics of the individual varieties.

Table 12 Grading scheme for overall impression

Grades	Overall Impression
1	Unsightly plant, no flowers
3	Plant with significant defects, little flowers
5	Plant with slight defects, but with flowers
7	Plant structure harmonises, attractive and many flowers
9	Plant has abundant flowering and is very attractive

4 Results and Discussion

4.1 Rooting Method

The first fundamental difference during cultivation was in the young plant production. Here the combinations consisting of three separately rooted young plants showed to be more uniform in growth and flowering time than planting them together in a single plug, however, both methods had their benefits and drawbacks.

Planting the URC in 1,6 cm plugs (trays of 180) with one cutting was twice as fast as compared to planting three cuttings in one 4 cm (jumbo) plug. This was no surprise considering that it logically takes less having to plant only one cutting per plug as well as not having to change between varieties. When it comes to potting, this becomes an important aspect for growers in relation to planting time. Planting one jumbo plug per pot is faster than planting three 1,6 cm plugs per pot. However, it is important to consider the fact that the jumbo plugs required more time for planting and therefore the relation between planting and potting is balanced out between the two rooting methods. For a young plant producer, rooting in jumbo plugs is more space efficient as compared to rooting separate varieties individually.

With regards to rooting, 98 % of all species began rooting after one week, with the exception of two *Scaevola* varieties, Amethyst and Suntastic, which needed a week longer (Figure 22). Differences in rooting time of different genera and varieties between the two rooting methods were not observed. That there would be no difference was already expected due to the fact that all plants had the same climatic conditions during the propagation phase and the level of competition in the jumbo plugs is very low at such an early stage.

Figure 22 Rooting stages of *Scaevola* Suntastic (starting from the left), *Scaevola* Amethyst, 2 *Calibrachoa* varieties, *Verbena* and *Bacopa* after 1 week of propagation

However, the rooting method did show effects on the growth and development of the individual plants once the cuttings were well rooted. Figure 23 shows the uniformity of the young plants rooted in trays of 180 (separated by genera and varieties).

Figure 23 *Calibrachoa* Dream Kisses Orange Sunset rooted in trays of 180 in CW 9 (Endisch, 2011)

The young plants rooted in jumbo plugs, depending on the genera and variety, had more difficulties showing the same uniformity as in the 1,6 cm plugs (Figure 24). *Calibrachoa*, *Lobelia*, *Petunia* and *Verbena* grew more vigorously, therefore suppressing other partners in the mix like *Bacopa*, *Bidens* and *Sanvitalia*.

Figure 24 Mix 19 with *Bidens* Giant Sun, *Petunia* Bingo Blue and *Verbena* Estrella Voodoo Star rooted in jumbo plugs in CW 9 (Endisch, 2011)

Figure 24 shows how *Bidens* is suppressed by the more vigorous *Petunia* and *Verbena*. At the same time the plants develop, the level of competition for water and nutrients inside the plug increases. This level of competition is eliminated by rooting the different partners in separate plugs, as well as being more flexible in the combinations you can make. If you would plant the *Bidens* together with the *Petunia* and *Verbena* at a later stage during potting, it would have more space to grow and develop, thereby increasing the success rate.

It was interesting to observe how the plants rooted in jumbo plugs were more vigorous, forming longer internodes, even though they received the same PGR treatments as the ones rooted in 1,6 cm plugs. A logical reason for this is the fact that the individual plants are much closer together, resulting in higher competition for the same resources, in particular light. Additionally the jumbo plugs are already delivered from the manufacturer with a higher nutrition level and therefore providing the plants with more ´food´ to grow.

4.2 Combination Performance

4.2.1 *Petunia*

A total of 34 Westhoff combinations were tested during the trial phase, of which 14 were planted with *Petunia*. After 11 weeks of culture, from rooting until finished plants, 10 of these mixed plantings were predominantly[4] with *Petunia* (Figure 25) and only 4 combinations showed compatibility between all three partners (Figure 26).

Figure 25 Mix 19 dominant *Petunia* Bingo Blue suppressing other partners (Endisch, 2011)

Figure 26 Mix 24 less dominant *Petunia* combination, all partners harmonise well together

[4] Dominant: combination partner with more vigorous growth, other partners are suppressed

Table 12 highlights the combinations with *Petunia* that showed compatibility[5] with other partners in the mix. Table 14 shows the combinations where other partners in the mix were suppressed by the vigorous growth of *Petunia*.

Table 12 Combination with Petunia that showed compatibility with other partners

Bidens x Calibrachoa x Petunia						
Bidens	**12**	Sunball				
Calibrachoa		Cele. Purple Rain				
Petunia		**Bingo Rose**				
Calibrachoa x Petunia x Verbena						
Calibrachoa	**24**	D. Kiss. Magnolia Imp.	**25**	D. Kiss. Tiger Eye	**28**	Cele. Neon Rose
Petunia		**Bingo Neon Pink**		**Bingo Red**		**Bingo Pink**
Verbena		Estr. Merlot		Carpet White		Carpet Violet

Table 13 Combinations with Petunia where the other partners were suppressed

Bacopa x Petunia x Verbena				
Bacopa	**8**	Super. W. Wedding	**9**	Taifun Mega White
Petunia		**Bingo Purple**		**Bingo Purple**
Verbena		Estr. Voodoo Red		Estr. Merlot
Bidens x Calibrachoa x Petunia				
Bidens	**11**	Sunball	**13**	Giant Sun
Calibrachoa		Cele. Neon Rose		D. Kiss. Tiger Eye
Petunia		**Bingo Purple**		**Bingo White**
Bidens x Petunia x Verbena				
Bidens	**19**	Giant Sun		
Petunia		**Bingo Blue**		
Verbena		Estr. Voodoo Star		
Calibrachoa x Lobelia x Petunia				
Calibrachoa	**20**	Cele. Orange Red		
Lobelia		Hot White		
Petunia		**Bingo Purple**		
Calibrachoa x Petunia x Verbena				
Calibrachoa	**26**	Cele. Orange Red	**27**	D. Kiss. Tiger Eye
Petunia		**Bingo White**		**Bingo Blue**
Verbena		Carpet Violet		Estr. Voodoo Red
Lobelia x Petunia x Verbena				
Lobelia	**32**	Superstar	**33**	Superstar
Petunia		**Bingo White**		**Bingo White**
Verbena		Estr. Voodoo Star		Estr. Merlot

[5] Compatibility: combination partners showing the same growth characteristics

When comparing both tables, it can be observed from the above mixes that there were clear differences in the varieties of *Petunia* (highlighted in bold) being used. Table 15 shows the different varieties and their characteristics in relation to their growth vigour.

Table 14 Growth vigour of different *Petunia* varieties from the Bingo series

Variety	Growth Vigour
Bingo Blue	very vigorous
Bingo Purple	very vigorous
Bingo White	very vigorous
Bingo Neon Pink	vigorous, compact
Bingo Pink	vigorous, compact
Bingo Red	vigorous, compact
Bingo Rose	vigorous, compact

Combinations with Bingo Blue, Bingo Purple and Bingo White showed only or to the most part just *Petunia*. However, combinations using the less vigorous and more compact varieties allowed for the other partners to develop.

All *Petunia* varieties were classified as early in relation to flowering time, as the first flowers were already visible after the first week of potting. *Petunia* have a strong flower set, forming many flowers for a relatively long period of time. This was clearly visible during the trials, where the number of flowers was mostly evaluated as good or very good. This makes *Petunia* a good combination partner as it is mostly in flower and therefore will be mostly in bloom together with other genera. The fact that they produce so many flowers that early also implies that at a certain point there will be many senescing flowers on the plant, having to clean them at the point of sales. When it comes to sales maturity, where all partners should be in bloom, *Petunia* will need cleaning to remove the older flowers, resulting in additional work and therefore costs which a company does not want to have. The overall impression is thereby negatively influenced by all these factors.

4.1.2 *Calibrachoa*

Calibrachoa was the most commonly used plant species, accounting for 23 of all combinations. *Calibrachoa* showed to be compatible in a wide spectrum of combinations with other partners in relation to most characteristics that were evaluated. Table 16 shows the combinations with *Calibrachoa* that were most compatible with other partners.

Table 15 *Calibrachoa* combinations showing compatibility with other partners

Bacopa x Calibrachoa x Lobelia							
Bacopa ***Calibrachoa*** *Lobelia*	**1**	Taifun Mega Pink **Cele. Purple Rain** White Star					
Bacopa x Calibrachoa x Verbena							
Bacopa ***Calibrachoa*** *Verbena*	**4**	Taifun Mega Pink **D. Kiss. Magnolia Imp.** Carpet Violet					
Bidens x Calibrachoa x Petunia							
Bidens ***Calibrachoa*** *Petunia*	**12**	Sunball **Cele. Purple Rain** Bingo Rose					
Calibrachoa x Petunia x Verbena							
Calibrachoa *Petunia* *Verbena*	**24**	**D. Kiss. Magnolia Imp.** Bingo Neon Pink Estr. Merlot	**25**	**D. Kiss. Tiger Eye** Bingo Red Carpet White	**28**	**Cele. Neon Rose** Bingo Pink Carpet Violet	

Sixty percent of all *Calibrachoa* varieties, like the ones highlighted above, were assessed as ¨moderate¨ in relation to growth vigour during the evaluation of the trials. Some varieties were observed to be more vigorous. These are highlighted in Table 17.

Table 16 *Calibrachoa* varieties that are more vigorous in growth

Variety	Growth Vigour
Celebration Blue	vigorous
Celebration Orange Red	vigorous
Celebration Orange Sunset	vigorous
Celebration Velvet Blue	vigorous
Dream Kisses Deep Red Improved	vigorous

The varieties in Table 17 that showed to be more vigorous had to be pinched once more before CW 17 in order to keep the uniformity and avoid the other partners in the combination

to be suppressed. *Calibrachoa* showed to be a good partner for both more and less vigorous plant types, as shown in Figure 27 with *Petunia* (more vigorous) and *Bidens* (less vigorous).

Figure 27 Mix 12 with *Calibrachoa* as a good combination partner together with *Bidens* and *Petunia*

Ninety percent of all Calibrachoa varieties were evaluated as medium in relation to flowering time. This is a good characteristic when it comes to combinations as it guarantees a product that will be in bloom when it comes to the point of sales and the aspect of cleaning like with *Petunia* is eliminated. In relation to the number of flowers, the following varieties were evaluated as moderate to strong flowering:

- Celebration Snowball
- Celebration Purple Rain
- Dream Kisses Magnolia Improved
- Dream Kisses Tiger Eye
- Celebration Neon Rose

The more vigorous types (Table 17), which had to be pinched once more after potting, produced no flowers simply because they were cut back and therefore delaying the generative stage. As a result, the sales maturity was negatively evaluated as not sellable due to having no flowers.

4.1.3 *Verbena*

Verbena was the second most commonly used plant species after *Calibrachoa*, accounting for 23 of all combinations. *Verbena* also showed to be a good combination partner in most mixes. Table 18 shows the *Verbena* combinations that harmonised best with other partners.

Table 17 *Verbena* combinations showing compatibility with other partners

Bacopa x Calibrachoa x Verbena							
Bacopa *Calibrachoa* ***Verbena***	**4**	Taifun Mega Pink D. Kiss. Magnolia Imp. **Carpet Violet**					
Bacopa x Lobelia x Verbena							
Bacopa *Lobelia* ***Verbena***	**7**	Super. W. Wedding Superstar **Estr. Voodoo Star**					
Bidens x Lobelia x Verbena							
Bidens *Lobelia* ***Verbena***	**18**	Sunball Hot Blue **Estr. Voodoo Red**					
Calibrachoa x Petunia x Verbena							
Calibrachoa *Petunia* ***Verbena***	**24**	D. Kiss. Magnolia Imp. Bingo Neon Pink **Estr. Merlot**	**25**	D. Kiss. Tiger Eye Bingo Red **Carpet White**	**28**	Cele. Neon Rose Bingo Pink **Carpet Violet**	
Lobelia x Scaevola x Verbena							
Lobelia *Scaevola* ***Verbena***	**34**	Hot White Suntastic **Estr. Voodoo Red**					

From Table 18 it can be observed that there were two different series of *Verbena* (highlighted in bold) used for the combinations: the Estrella and Carpet series. Table 19 shows the differences in growth vigour between the two *Verbena* series.

Table 18 *Verbena* comparison between Estrella and Carpet varieties

Estrella Varieties	**Growth Vigour**
Estrella Merlot	moderate
Estrella Peach	moderate
Estrella Voodoo Red	moderate
Estrella Voodoo Star	moderate
Carpet Varieties	
Carpet Violet	vigorous
Carpet White	more vigorous

As shown in Table 19, the Estrella series were very similar in relation to their growth vigour, whereby the Carpet series showed differences. Carpet White was slightly more vigorous than Carpet Violet. Both series had their advantages and disadvantages, not only in growth vigour but also in all other characteristics that were evaluated after the trials. The growth habit was, as already expected, very different and therefore interesting to see in combination with other partners. All Estrella varieties were classified as upright or semi-upright, whereas the two Carpet varieties were more semi-hanging. This gave an interesting overall impression depending on the series used in the combination, resulting in different product shapes. Figure 28 shows a combination with Carpet Violet and other partners with the same semi-hanging growth habit as compared to Figure 29 with Estrella Voodoo Red and other partners with a more upright growth habit.

Figure 28 Mix 4: *Bacopa* Taifun Mega Pink, *Calibrachoa* Dream Kisses Magnolia Improved, *Verbena* Carpet Violet showing the same semi-hanging growth habit

Figure 29 Mix 18: *Bidens* Sunball, *Lobelia* Hot Blue, *Verbena* Estrella Voodoo Red showing the same upright growth habit

It was also interesting to observe differences in number of flowers between the two Verbena series. Within the Estrella varieties there were no major differences, these were classified as moderate. More interesting was the difference between the Carpet varieties. Carpet White was observed to have double as many flowers as Carpet Violet but also all other Estrella varieties. However, no combination with Carpet White was selected as a potential candidate simply because it was too vigorous, even the ones that were treated with various PGR treatments.

4.1.4 *Lobelia*

Lobelia accounted for 11 of all combinations, showing similar characteristics as *Verbena* in relation to growth vigour. Two different groups were used: Hot and Star. The differences of both series are shown in Table 20.

Table 19 *Lobelia* comparison between Star and Hot varieties

Star Varieties	**Growth Vigour**
Blue Star	medium
Superstar	medium
White Star	vigorous
Hot Varieties	
Hot Blue	vigorous
Hot White	vigorous

The Hot varieties used were clearly more vigorous than the Star varieties, making it more difficult for other combination partners to develop. However, this was only a problem with genera that were either weak or very weak in relation to growth vigour such as *Bidens* or *Bacopa*. With more vigorous partners like *Calibrachoa* or *Verbena* this was not a problem. Flowering time was very dependent on the rooting method. The ones rooted in jumbo plugs were classified as late or very late, whereas the ones rooted in 1,6 cm plugs were evaluated as medium. Differences in the number of flowers were also observed, where over 90 % of the plants rooted in jumbo plugs had no or just one flower. As a result, the sales maturity and overall impression of the combinations with *Lobelia* in jumbo plugs were not sellable due to the fact that they mostly consisted of leaves and no flowers.

4.1.5 *Bidens*

Bidens showed strong differences as a partner in different combinations. *Bidens* was mostly classified as ¨weak¨ in relation to growth vigour. *Bidens* was mostly suppressed by the more vigorous types like *Petunia*, but also by moderate types like *Calibrachoa*. The only cases in which *Bidens* was capable of staying present without being overgrown by the other partners were in the controls without PGR treatments. A good example of this was mix 12 (Figure 30).

Figure 30 Mix 12 with *Bidens* as a possible combination partner (Endisch, 2011)

For the trials, two different *Bidens* varieties were used: Giant Sun and Sunball. With regards to growth vigour, Sunball showed to be slightly more vigorous and therefore was more compatible than in the combinations with Giant Sun. Sunball was used in 6 combinations, from which two were selected that have potential and Giant Sun was only used in 4 combinations, whereby none were considered to be interesting. It is important to highlight that the varieties used have potential, especially Sunball, but it does not mean they performed as well as other genera. *Bidens* is simply too weak in relation to growth vigour, making it a critical candidate for such genera combinations. Nevertheless, it has some other positive characteristics which do make it an interesting candidate: very early flowering and abundant flowers. Through more breeding, stronger and more vigorous varieties can be selected that may become potential candidates for future combinations.

4.1.5 Critical Genera Candidates

Bacopa, *Sanvitalia* and *Scaevola* were critical candidates that did not prove to be suitable for such genera combinations. The root of the problem is that they are all very weak in relation to growth vigour and they also react heavily when treated with various PGR´s. In all combinations all three genera were mostly suppressed by the other partners, except for the ones that were not treated with PGR´s (controls). However, since PGR applications are necessary for all other genera this has no practical use. Additionally, various other difficulties were observed during the trials using these genera.

Bacopa was very early in relation to flowering time, already in bloom during the propagation phase. As a result, the flowers were overripe at the point of sales and therefore they posed the same problem as *Petunia*.

Sanvitalia has the advantage of producing many flowers, similar to *Bidens*, but it strongly reacts to any PGR treatment and was therefore only present in the controls.

Scaevola not only grows slowly, but also flowers later and has fewer flowers as compared to all other genera. Westhoff is well known for their *Scaevola* varieties and have a strong foothold in the market, making it an interesting product for such new combinations. For the trials, two varieties were used: Amethyst and Suntastic. It was surprising to see how Suntastic showed uniform growth with some other partners (Figure 31).

Figure 31 Mix 34: *Lobelia* Hot White, *Scaevola* Suntastic, *Verbena* Estrella Voodoo Red (control)

4.3 PGR Treatments

All combinations during the trials were treated with various PGR applications (Section 3.2.1). One week after pinching, in CW 12, the first application was given to promote branching. A week later already the first differences were observed. Treatments 1 and 2 consisting of more than one PGR resulted in more compact and bushier plants (Figure 32). The following weeks all plants were monitored on the development of new shoots and the length of the internodes, which mainly depended on the response to the PGR treatment as well as the weather conditions. In CW 15 a second application was given for the more vigorous types like *Petunia*, *Lobelia* and *Verbena*. In some cases, it was not always easy deciding whether or not to spray depending on the individual partners in a mix. Partners like *Bacopa* or *Bidens* would have completely stopped growing after a second application as they are already genetically less vigorous. However, it was still interesting to see how only two PGR treatments were sufficient to keep the plants short, compact and bushy even though five applications were scheduled during the planning stage before beginning with the trials. It was observed that this year's spring had more light and sunny days as compared to other years, naturally keeping the plants shorter (Westhoff, 2011). This is one important reason why the trials with the best performing combinations have to be repeated coming season to see whether the same results can be achieved with maybe different climatic conditions but the same number of PGR applications. It is the dream of every grower to produce such short and compact plants with only two treatments, but usually one treatment is given every week over a period of four to five weeks. PGR´s are also very expensive and therefore the fewer applications the lower the production costs.

Figure 32 Mix 7 sprayed in CW 12: control (left), treatment 1 (center) and treatment 2 (right)

Figure 32 shows clear differences between treatment 1 (center) and treatment 2 (right). Treatment 2 consisted of Caramba/Regalis and the addition of CCC, therefore increasing the inhibiting effect. A critical aspect was observed with Regalis, which caused some discolouration in the flowers. Especially the colour red, which turned into pink, was affected by treatments with Regalis. Figure 32 clearly shows this phenomenon in comparison with the treatments without Regalis and the control (left).

The other treatments also had an effect on plant growth and development (Figure 33). Treatments 1 and 2 (red stick) were by far the most inhibiting, followed by treatment 4 (black stick) and then treatment 3 (green stick). From the authorised chemicals, treatment 2 was the most inhibiting and from the prohibited chemicals, treatment 4 was the most effective. Treatment 3 showed very similar results to the control.

Figure 33 Mix 7: control (first left), treatment 1 (2nd left), treatment 3 (3rd left), treatment 4 (4th left) sprayed in CW 12

5 Conclusions and Recommendations

From a total of 38 combinations, five have been selected as potential candidates for the company. All mixes have been tested under alternative culture methods in order to identify these best performing combinations. Based on my research questions, recommendations are given in the form of a culture guide which highlights the most important factors to satisfy production requirements.

5.1 Recommended Culture Guide

Begin of Culture

The culture should ideally begin when there is sufficient natural light available for the plants. It is possible to already start in the winter months, whereby additional assimilation light is needed.

Rooting and Potting

Cuttings should be rooted separately in 1,6 cm plugs (trays of 180) and then be planted together during potting in 12 cm pots. Although 12 cm pots are standard, bigger pot sizes provide the plants with even more space for all partners to equally develop in the mix and therefore reducing the risk of weaker growth partners to be suppressed. In this way a more uniform end product can be produced.

Pinching

The first pinch should be done one week after potting to promote branching. A second pinch will be necessary depending on the weather conditions and varieties used. If necessary, a third ¨repair pinch¨ can be done to ensure uniformity when using more vigorous types for the combinations.

Plant Growth Regulation

Application with growth regulators is necessary. It is especially important with high outside temperatures. Treatment 2 with a combination of Caramba/CCC/Regalis showed the best inhibiting results during the first week (CW 12) of the trials. An alternative would be to only use Caramba/Regalis which showed very similar results but without CCC, which implies lower costs for spraying. However, precautions must be taken with Caramba and Regalis. A high concentration with Caramba can lead to damage; here it is recommended to stay below a concentration of 0,1 %. Regalis should also be used carefully, it is important to stop any further applications four weeks before flowering to prevent any discolorations in flower colour. Additional applications may be necessary depending on the climatic conditions and the development of the plants, therefore close monitoring is essential.

5.2 Best Performing Combi-Pots

The five best performing combinations are highlighted on the following pages. Under best performing it is important to distinguish the fact that these are potential candidates that will be taken into production again in 2012 to perform a second set of trials to give the definite ´green light´ before they can be taken into the assortment. Recommendations in relation to genera and varieties are given where there is still margin for improvements in order to make the combinations even better. The outcomes of this research show that there are various ways of producing a good combination. On this basis, the company can decide whether or not to enter the mix segment of genera combinations.

Mix 1

***Bacopa* Taifun Mega Pink, *Calibrachoa* Celebration Purple Rain, *Lobelia* White Star**

Mix 1 showed an attractive colour combination in purple and white. *Calibrachoa* and *Lobelia* harmonize well in relation to growth habit and vigour. Flowering time was also matching, resulting in a good overall impression between these two partners. *Bacopa* Taifun Mega Pink is too weak and is therefore mostly suppressed.

Recommendation: substitute *Bacopa* with *Verbena,* possibly Estrella Peach to keep the same colour combination. Other varieties are equally suitable depending on colour preferences.

Table 20 Evaluation results for Mix 1 in CW 17, plants rooted in 1,6 cm plugs (trays of 180)

180	Mix 1	Flowering Time	No. of Flowers	Growth Vigour	Growth Habit	Sales Maturity	Overall Impression
C	Taifun Mega Pink	SF	6	K	HA	V	3
C	Cele. Purple Rain	F	2	M	HA	NV	3
C	White Star	M	8	SW	A	V	3
T1	Taifun Mega Pink	SF	2	SK	HA	N	2
T1	Cele. Purple Rain	M	3	M	HA	V	2
T1	White Star	S	2	M	KK	NV	2
T2	Taifun Mega Pink	SF	1	SK	HA	N	1
T2	Cele. Purple Rain	M	3	M	HA	V	1
T2	White Star	S	2	M	KK	NV	1
T3	Taifun Mega Pink	SF	2	SK	HA	NV	1
T3	Cele. Purple Rain	S	2	M	HA	NV	1
T3	White Star	M	7	SW	A	V	1
T4	Taifun Mega Pink	SF	2	SK	HA	NV	1
T4	Cele. Purple Rain	S	2	M	HA	NV	1
T4	White Star	M	6	SW	A	V	1

Mix 4

***Bacopa* Taifun Mega Pink, *Calibrachoa* Dream Kisses Magnolia Improved, *Verbena* Carpet Violet**

Mix 4 showed an interesting shape as compared to most other combinations, something different to the typical compact and bushy plants. Nevertheless, all partners had the same semi-hanging growth habit and therefore gave a good overall impression. The colour combination was also attractive. *Bacopa* Taifun Mega Pink has a similar growth habit but is relatively weak in relation to the *Calibrachoa* and *Verbena*. In the long term it will probably be suppressed in combination with two more vigorous partners.

Recommendation: there are no genera alternatives to *Bacopa* that have the same semi-hanging growth habit. New varieties may arise through breeding that are more vigorous.

Table 21 Evaluation results for Mix 4 in CW 17, rooted in 1,6 cm plugs (trays of 180)

180	Mix 4	Flowering Time	No. of Flowers	Growth Vigour	Growth Habit	Sales Maturity	Overall Impression
C	Taifun Mega Pink	SF	4	K	HA	U	3
C	D. Kiss. Magnolia Imp.	M	4	M	HA	V	3
C	Carpet Violet	S	3	W	HH	V	3
T1	Taifun Mega Pink	SF	2	SK	HA	U	1
T1	D. Kiss. Magnolia Imp.	M	4	M	HA	V	1
T1	Carpet Violet	S	2	K	HH	NV	1
T2	Taifun Mega Pink	SF	2	SK	HA	U	1
T2	D. Kiss. Magnolia Imp.	M	4	M	HA	V	1
T2	Carpet Violet	S	2	M	HH	NV	1
T3	Taifun Mega Pink	SF	3	K	HA	U	2
T3	D. Kiss. Magnolia Imp.	M	4	M	HA	V	2
T3	Carpet Violet	S	3	M	HH	V	2
T4	Taifun Mega Pink	SF	3	K	HA	U	2
T4	D. Kiss. Magnolia Imp.	M	4	M	HA	V	2
T4	Carpet Violet	S	2	M	HH	V	2

Mix 7

Supercopa White Wedding, *Lobelia* Superstar, *Verbena* Estrella Voodoo Star

Mix 7 showed a very attractive colour combination between the two double flowered *Lobelia* Superstar and *Verbena* Estrella Voodoo Star. Both varieties harmonized well together in relation to growth habit, growth vigour, flowering time and therefore giving a good overall impression. Here again, *Bacopa* relatively weak in comparison to the two other partners.

Recommendation: Supercopa White Wedding is the most vigorous variety and therefore it would be interesting to observe how it performs after the point of sales. A *Calibrachoa* variety, for example Celebration Snowball, could be a good alternative due to having the same growth and flowering characteristics.

Table 22 Evaluation results for Mix 7 in CW 17, rooted in 1,6 cm plugs (trays of 180)

180	Mix 7	Flowering Time	No. of Flowers	Growth Vigour	Growth Habit	Sales Maturity	Overall Impression
C	Super. W. Wedding	SF	7	M	HA	U	5
C	Superstar	M	8	M	A	V	5
C	Estr. Voodoo Star	M	5	M	A	V	5
T1	Super. W. Wedding	SF	6	K	HA	U	4
T1	Superstar	M	7	K	A	V	4
T1	Estr. Voodoo Star	M	4	K	A	V	4
T2	Super. W. Wedding	SF	6	K	HA	U	2
T2	Superstar	S	5	K	A	NV	2
T2	Estr. Voodoo Star	M	3	K	A	V	2
T3	Super. W. Wedding	SF	7	M	HA	U	3
T3	Superstar	M	7	M	A	V	3
T3	Estr. Voodoo Star	M	5	M	A	V	3
T4	Super. W. Wedding	SF	6	K	HA	U	2
T4	Superstar	M	8	M	A	V	2
T4	Estr. Voodoo Star	M	3	M	A	V	2

Mix 24

***Calibrachoa* Dream Kisses Magnolia Improved, *Petunia* Neon Pink, *Verbena* Estrella Merlot**

Mix 24 performed very well throughout the trials. The colour combination was very attractive and the growth characteristics of all three partners harmonized very well together. All plants were very uniform in size and stayed compact. *Verbena* Estrella Merlot has a very nice colour that harmonizes well tone-on-tone with the other partners but the flowering time is later than other Estrella varieties.

Recommendation: substitute Estrella Merlot with Voodoo Red.

Table 23 Evaluation results for Mix 24 in CW 17, rooted in 1,6 cm plugs (trays of 180)

180	Mix 24	Flowering Time	No. of Flowers	Growth Vigour	Growth Habit	Sales Maturity	Overall Impression
C	D. Kiss. Magnolia Imp.	M	6	M	HA	V	7
C	Bingo Neon Pink	F	8	M	A	U	7
C	Estr. Merlot	S	2	M	A	V	7
T1	D. Kiss. Magnolia Imp.	M	5	M	HA	V	6
T1	Bingo Neon Pink	F	7	M	A	U	6
T1	Estr. Merlot	S	2	M	A	V	6
T2	D. Kiss. Magnolia Imp.	M	6	M	HA	V	8
T2	Bingo Neon Pink	F	8	M	A	U	8
T2	Estr. Merlot	S	2	K	A	V	8
T3	D. Kiss. Magnolia Imp.	M	4	M	HA	V	5
T3	Bingo Neon Pink	F	6	M	A	U	5
T3	Estr. Merlot	S	2	M	A	V	5
T4	D. Kiss. Magnolia Imp.	M	5	M	HA	V	5
T4	Bingo Neon Pink	F	5	M	A	U	5
T4	Estr. Merlot	S	2	M	A	V	5

Mix 28

***Calibrachoa* Celebration Neon Rose, *Petunia* Bingo Pink, *Verbena* Carpet Violet**

Mix 28 also harmonised very well in relation to growth vigour and flowering time. It was one of the very few tone-on-tone combinations. Interesting were the differences in growth habit, creating different levels. Whilst the *Calibrachoa* and *Petunia* grew upwards, the *Verbena* covered the lower part of the pot.

Recommendation: the combination of these three partners is good, but it should be tested again to ensure that the end product looks the same.

Table 24 Evaluation results for Mix 28 in CW 17, rooted in 1,6 cm plugs (trays of 180)

180	Mix 28	Flowering Time	No. of Flowers	Growth Vigour	Growth Habit	Sales Maturity	Overall Impression
C	Cele. Neon Rose	M	6	M	HA	V	4
C	Bingo Pink	F	8	M	A	U	4
C	Carpet Violet	S	3	W	HH	V	4
T1	Cele. Neon Rose	M	5	M	HA	V	6
T1	Bingo Pink	F	6	M	A	U	6
T1	Carpet Violet	S	2	M	HH	V	6
T2	Cele. Neon Rose	M	5	M	HA	V	7
T2	Bingo Pink	F	8	M	A	U	7
T2	Carpet Violet	S	2	M	HH	V	7
T3	Cele. Neon Rose	M	4	M	HA	V	5
T3	Bingo Pink	F	6	M	A	U	5
T3	Carpet Violet	S	2	W	HH	V	5
T4	Cele. Neon Rose	S	2	M	HA	V	3
T4	Bingo Pink	F	7	M	A	U	3
T4	Carpet Violet	S	2	W	HH	V	3

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Annex

Annex 1 Westhoff Company History

1958	A small greenhouse of 30 m² is the precondition to start growing vegetables locally.
1960	The first greenhouse of 400 m² is built. At that time the cultures were radish, kohlrabi, *Viola* and *Bellis*.
1964	The next greenhouse with a surface of 1.400 m² is built. In autumn big flowered *Chrysanthemum* were cultivated and in spring Geraniums.
1968-1974	More greenhouses with a total surface of 8.100 m² are built.
1976	After buying new land, 8.000 m² of new greenhouses are built with the first mobile benches in Germany.
1989	Expansion through 6.000 m² of Venlo-block greenhouses.
1993	The first vegetative propagated *Lobelia* Azuro is registered for plant breeder's rights.
1996	Further expansion of greenhouse surface by 7.000 m², together with a loading ramp and a two storey shipping hall of 1.400 m². The second floor is equipped with mobile benches.
1998	Through successful breeding complete series of *Petunia*, *Lobelia*, *Calibrachoa* and *Scaevola* are launched on the market.
1999	Further expansion through another 8.000 m², equipped with the latest greenhouse technology and equipment.
2002	The first trademark ¨Westflowers¨ is introduced, under which own varieties are traded.
2003	Expansion of greenhouse surface by another 5.000 m².
2005	Completion of state of the art greenhouses with a total production surface of 12.000 m².

Annex 2 Operational Facts

Company size total:	80.000 m^2
Production surface:	75.000 m^2 of glasshouse
	50.000 m^2 Venlo-block greenhouses
	25.000 m^2 German standard greenhouses (12 m wide)
	17.000 m^2 rented space from February to May
Open field surface:	2.000 m^2 for presentation purposes
Heating systems:	3 x 1.750 KW gas boilers
	1 x 2.500 KW gas boiler
	1 x 5.000 KW oil boiler
	2 x 2.500 KW coal boilers
Workforce:	3 production managers
	9 supportive staff
	2 technicians
	5 trainees
	15 temporary staff, full day
	7 temporary staff, half day
	10 seasonal workers from October to December
	40 seasonal workers from January to June
Distribution:	Big mail order company Ahrends & Siebertz
	Grower Pötschke
	Big mail order company Baldur
	Big mail order company Starkl (Austria)
	Landgard
	Diverse garden centers and retailers inside and outside Germany

Annex 3 Combi-Plans

The mix numbers highlighted in red are contrasting colour combinations and the ones in blue are tone-on-tone colour combinations.

Bacopa x Calibrachoa x Lobelia		
Bacopa	**1**	Taifun Mega Pink
Calibrachoa		Cele. Purple Rain
Lobelia		White Star

Bacopa x Calibrachoa x Sanvitalia		
Bacopa	**2**	Super. W. Wedding
Calibrachoa		D. Kiss. Deep Red Imp.
Sanvitalia		Tequilla Imp.

Bacopa x Calibrachoa x Scaevola		
Bacopa	**3**	Super. W. Wedding
Calibrachoa		Cele. Orange Red
Scaevola		Amethyst

Bacopa x Calibrachoa x Verbena						
Bacopa	**4**	Taifun Mega Pink	**5**	Taifun Mega White	**6**	Taifun Mega Blue
Calibrachoa		D. Kiss. Magnolia Imp.		D. Kiss. Deep Red Imp.		Cele. Snowball
Verbena		Carpet Violet		Carpet Violet		Estr. Voodoo Red

Bacopa x Lobelia x Verbena		
Bacopa	**7**	Super. W. Wedding
Lobelia		Superstar
Verbena		Estr. Voodoo Star

Bacopa x Petunia x Verbena				
Bacopa	**8**	Super. W. Wedding	**9**	Taifun Mega White
Petunia		Bingo Purple		Bingo Purple
Verbena		Estr. Voodoo Red		Estr. Merlot

Bidens x Calibrachoa x Lobelia		
Bidens	**10**	Sunball
Calibrachoa		Cele. Orange Sunset
Lobelia		Blue Star

Bidens x Calibrachoa x Petunia							
Bidens	**11**	Sunball	**12**	Sunball	**13**	Giant Sun	
Calibrachoa		Cele. Neon Rose		Cele. Purple Rain		D. Kiss. Tiger Eye	
Petunia		Bingo Purple		Bingo Rose		Bingo White	

Bidens x Calibrachoa x Verbena								
Bidens	**14**	Giant Sun	**15**	Giant Sun	**16**	Sunball	**17**	Sunball
Calibrachoa		Cele. Velvet Blue		Cele. Blue		Cele. Indigo		Cele. Velvet Blue
Verbena		Estr. Merlot		Estr. Voodoo Red		Estr. Merlot		Estr. Voodoo Red

Bidens x Lobelia x Verbena		
Bidens	**18**	Sunball
Lobelia		Hot Blue
Verbena		Estr. Voodoo Red

Bidens x Petunia x Verbena		
Bidens	**19**	Giant Sun
Petunia		Bingo Blue
Verbena		Estr. Voodoo Star

Calibrachoa x Lobelia x Petunia		
Calibrachoa	**20**	Cele. Orange Red
Lobelia		Hot White
Petunia		Bingo Purple

Calibrachoa x Lobelia x Sanvitalia		
Calibrachoa	**21**	Cele. Snowball
Lobelia		Blue Star

Sanvitalia		Tequilla Imp.									
Calibrachoa x Lobelia x Verbena											
Calibrachoa	**22**	Cele. Banana	**23**	Cele. Banana							
Lobelia		Hot White		Hot White							
Verbena		Estr. Merlot		Estr. Voodoo Red							
Calibrachoa x Petunia x Verbena											
Calibrachoa	**24**	D. Kiss. Magnolia Imp.	**25**	D. Kiss. Tiger Eye	**26**	Cele. Orange Red	**27**	D. Kiss. Tiger Eye	**28**	Cele. Neon Rose	
Petunia		Bingo Neon Pink		Bingo Red		Bingo White		Bingo Blue		Bingo Pink	
Verbena		Estr. Merlot		Carpet White		Carpet Violet		Estr. Voodoo Red		Carpet Violet	
Calibrachoa x Sanvitalia x Verbena											
Calibrachoa	**29**	Cele. Snowball									
Sanvitalia		Tequilla Imp.									
Verbena		Estr. Voodoo Star									
Calibrachoa x Scaevola x Verbena											
Calibrachoa	**30**	D. Kiss. Magnolia Imp.	**31**	Cele. Snowball							
Scaevola		Amethyst		Suntastic							
Verbena		Estr. Peach		Estr. Merlot							
Lobelia x Petunia x Verbena											
Lobelia	**32**	Superstar	**33**	Superstar							
Petunia		Bingo White		Bingo White							
Verbena		Estr. Voodoo Star		Estr. Merlot							
Lobelia x Scaevola x Verbena											
Lobelia	**34**	Hot White									
Scaevola		Suntastic									
Verbena		Estr. Voodoo Red									