PN ABN-949

PROEXAG II

82046

EXPORT INDUSTRY TECHNOLOGY SUPPORT PROJECT (AGRICULTURAL COMPONENT)

TECHNICAL INFORMATION ON ZANTEDESCHIA AND SANDERSONIA

Assignment Number: ST-150

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(Contract AID No. 596-0165-C-00-1296-00)

UNDER THE AUSPICES OF:

United States Agency for International Development (USAID)
Regional Office for Central American Programs (ROCAP)
Guatemala City, Guatemala

March 1993

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A DEVELOPMENT PROJECT SPONSORED BY USAID/ROCAP AND IMPLEMENTED BY CHEMONICS INTERNATIONAL

TECHNICAL INFORMATION ON ZANTEDESCHIA AND SANDERSONIA
(Gathered During Barrie McKenzie's Visit in Central America)

Background

Barrie McKenzie is a producer/broker of colored callas (Zantedeschias) from New Zealand. He has the franchise to multiply by seed, bulb division or tissue culture and produce bulbs of different sizes (PST or Pea Size Tuber, MST or Marble Size Tuber, FST or Flowering Size Tuber and LFST or Large Flowering Size Tuber) of certain cultivars for the world market. He came to Central America with one of his specialist on tissue culture to assist a Guatemalan entrepreneur in the establishment and initial operations of a tissue culture laboratory for multiplication of Barrie's cultivars. PROEXAG II took advantage of Barrie's presence in the region and requested him to monitor PROEXAG's trial plantings of callas in Guatemala, El Salvador and Costa Rica. He was also requested to give a seminar in El Salvador and Costa Rica on "Opportunities in Central America for the production and export of cut flowers and bulbs of Zantedeschia, Sandersonia and others" New Zealand, because of its high labor costs and freight costs of large tubers to the market, can only produce callas and Sandersonias profitably for the high priced specialized market of Japan, leaving the markets in the Americas and Europe for Central American entrepreneurs. Central Americans can tissue culture, grow the FSTs and LFSTs and market them in North America.

Barrie provided PROEXAG the latest literature (copy attached) on propagation, production and post harvest handling of Zantedeschia and Sandersonia. Included below are technical notes picked up during the seminars given by Barrie as well as pertinent advice and comments given during the field visits.

Notes On Zantedeschia

Initial varieties brought to Central America by Barrie through Eddie Welsh were Pink Persuasion and Black Magic, followed later by Majestic Red, Pixie and Hazel Marie. Lately, Starlight, Fandango, Pacific Pink and Chianti came in. Other cultivars of Barrie include Childsiana (dwarf white) and Green Goddess. There are other cultivars form other nurseries in New Zealand that were brought in by local entrepreneurs.

Effective control of Erwinia, the number one problem in calla culture, involve very well drained soils, raised beds and appropriate soil moisture control. Agrimycin treatment on the bulbs prove effective. Barrie recommends the use of a thin layered sawdust (rice hull or pumice) on top of the soil, followed by a 70% saran netting layer on top of this, the bulb placed on top of the saran and then covered with sawdust mulch on the top to 2 cm deep. The bulb, in this case, does not get in contact with the soil and the sawdust maintains a humid but aerated condition (Erwinia is an anaerobic bacteria). The contractile roots could pull the bulb

deeper into the soil sideways if planted too shallow but the saran prevents further bulb movement down to the soil level. Bulb harvest and cleaning is also much easier with the saran-sawdust system.

Growth phases from initial tissue culture (TC) material follows:

TC-I: 4 weeks for the multiplication phase.
TC-II: 4 weeks for the elongation phase.
TC-III: 4 weeks for the rooting phase to PST equivalent.

Initial growth phase: 10 weeks PST vegetative growth.
Tuber enlargement phase: 6 weeks (11th to 16th week) to FST.
Drying phase: 4 weeks (17th to 20th week) without watering.
Dormancy phase: 6-8 weeks (21st to 28th week) at 25-30^{0}C.

Vegetative phase: 8 weeks after planting FST.
Flowering phase: 4 weeks (9th to 12th week).
Tuber enlargement phase: 4 weeks (13th to 16th week) to LFST.
Drying phase: 4 weeks without watering (17th to 20th week).
Dormancy phase: 6-8 weeks at 25-30^{0}C (21st to 26th week).

Succeeding full cycles are also 26-28 weeks each. Main bulb gets bigger with more shoots each time (to 16 with certain cultivars of 18 cm bulb diameter), producing as many as 16 marketable flowers in some cultivars, 6 to 7 maximum in other cultivars.

In summary, there are 12 weeks in the TC phase and 26-28 weeks in the growth cycle from PST to FST as well as from FST to LFST or LFST to VLFST Most calla growers recommend programmed production of export quality cut flowers under clear plastic cover, providing control of moisture and temperature during the first three or four flowering cycles. The fourth flowering cycle (especially if the bulbs are starting to show signs of degeneration (such as virus contamination) during the third flowering cycle), may be grown in the open field principally for the lower quality market. These bulbs may then be lifted for the homegarden market (or discarded if in poor condition) or allowed to produce a second flower crop without lifting from the field.

For good quality flowers, a wide differential in temperatures between day and night (of about 12 to 20^{0}C) will produce stronger stem and more intense coloration of reds and pinks (yellows are not affected). This could be achieved by opening the sides of the nursery during the night and enclosing during the day.

Gibberellic Acid (Pro-Gibb = 4% GA3 or Promalin = GA4+GA7+BA) treatment of bulbs (dipped for 30 minutes in 50-100 ppm solution) will force flowering in small bulbs, early flowering and more flowers/shoot in FSTs and LFSTs. A shoot from a small/young FST bulb (2-3 cm diameter or GA treated) will produce 1 or 2 small flowers with 3 to 4 leaves. A shoot from a large bulb (5 or more cm diameter) may produce a maximum of 3 flowers with GA Treatment but no more than 5 leaves from one shoot. There may be many shoots in

a large bulb if there is no natural subdivision. Some cultivars divide naturally producing easily detachable bulblets.

Bulb enlargement (which takes place during the 16th to 20th week of the growth cycle) may occur only when temperatures are warm (18-32°C). At lower temperatures, the bulb does not grow in size.

The dormancy or rest period requirement of the bulb (so that it would germinate rapidly when planted and then flower) could be satisfied by storage for 6-8 weeks at ambient temperature (20-30°C) and relative humidity (40-80%). Storage at cooler temperatures and more humid conditions (as keeping them in moist soil) would lengthen the dormancy period requirement. Storage of bulb much longer then 6-8 weeks at ambient temperature could result in early flowering but shorter stalk and less in number After completion of the rest period, bulbs could be stored for longer periods (to 4 to 8 months) at 10-12°C with minimum detrimental effects. Temperatures at 8°C and below would damage the shoots and bulb.

The plants should be at high turgor pressure (irrigated recently) at harvest time so that the stalk breaks easily and cleanly with a minimum quick pull pressure exerted by holding as close as possible to the base of the flower stalk

The grower should be very careful in buying bulb materials especially the FSTs and LFSTs as regards virus free materials. He should be able to recognize as soon as possible the visible symptoms of virus in the plant. Hopefully, the insect vectors (aphids and thrips) are not present or abundant in the plantation. Otherwise, the whole lot may have to be discarded. Good weed control is essential as the weeds harbor the insect vectors.

Notes On Sandersonia

After flowering and the foliage starts to dry out, watering should be stopped and rhizomes lifted a month later. Wash immediately and store in "just damp" untreated sawdust, pumice or vermiculite at 4-5°C for 60 days to complete its required rest period.

After completion of the rest period, the rhizomes germinate (sprout) rapidly upon removal from cold storage, even during transit movement of the materials. There are two growing points in the forked rhizome, one of which is dominant over the other (if the dominant one sprouts, the other may sprout much later or not at all. To produce two sprouts from this forked rhizome, it should be divided into two (evenly by weight to produce flowers of more or less the same size) and planted separately.

Seeds will go into deep dormancy (one to two years) if allowed to dry after harvest. To avoid this, seeds should be harvested at maturity and (without drying them) stored under "moist or just damp" condition for 3-5 months, after which they may germinate when planted in warm humid conditions.

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SANDERSONIA

PROPAGATION - PRODUCTION - HARVESTING

Sandersonia Aurantiaca is a genus of a single species and is clearly identifiable by its small clear orange bell shaped flowers which branch off a wiry green stem. Sometimes called "Golden Lily of the Valley" or "Chinese Lantern Flower" It is a member of the family Liliaceae and originates in Southern Africa, its distribution ranging from South-Eastern Transvaal to Swaziland, Natal and Eastern Cape.

New Zealand through a combination of fate and good management now has the largest quantities in the world of this South African plant. Sandersonia is also now a protected species in South Africa, is rarely seen growing and is forbidden by law to be picked. It was introduced to New Zealand 40 years ago

It is only in the last 10 years that it has been exported to any extent as a cut flower and has now become much sought after by many countries in the world. Sandersonia flowers which have a vase life of 2-3 weeks are fetching premium prices with up to $NZ 2 50 per stem being returned net (after all freight and charges) to the New Zealand grower for the top quality 80 cm branched stems. Straight 60 cm stems have been steadily averaging $NZ 1 50 - $2 00 each in the past three summer export seasons.

This beautiful, delicate, long lasting flower is enjoying unprecedented demand world-wide and looks to have many years potential as a high income earner for flower growers the world over

In its original habitat in South Africa, Sandersonia occurs naturally in moist grasslands at an altitude of 600-2000m in an area that has a high rainfall during the summer growing season (averaging 120-130mm per month from December-February) and a low winter rainfall when the plant is naturally dormant (15-20mm per month from June-August)

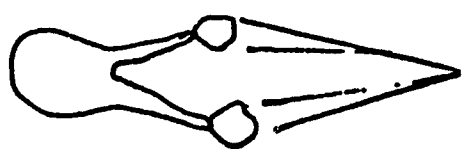
The mean daily maximum temperature in its area of natural occurrence ranges from over 26 C in January to below 14 C in July, and the mean daily minimum from 14 5 C in January to 31 C in July

PROPAGATION

Sandersonia grow from rhizomes. During each growing season the original rhizome dies but is usually replaced with two first generation "daughter" rhizomes, one of which is dormant. From each of the growing points develop a single shoot, root and the next generation of rhizomes.

Growing points

(b) First generation "daughter" rhizome



Growing points

First generation rhizome with secondary rhizome (marble) development.

A percentage of rhizomes will regrow additional rhizomes on the growing tips in the form of "marbles" as in (b) above This phenomenon appears to be a function of dry conditions followed by a wet period and normally happens well after flowering This marbling does not appear to occur if the flower is harvested One way to help stop this secondary growth if flowers are not to be cut is take the tips off the growing stems at flower maturity.

Quantitative information on optimum amounts of N P K. Fertiliser required by Sandersonia is the field in not yet available At present growers are incorporating 400-500 kg/ha of balanced 10-10-10 NPK Fertilisers as a base dressing Nitrogen can be applied as a regular liquid feed at a concentration of 200 ppm N during growing season but reduced when flower bud development commences This is especially important in the greenhouse situation as too much nitrogen will cause weak floppy stems and decrease vase life significantly

WEED CONTROL

Weed control is best achieved by fumigation of the soil prior to planting **Methyl Bromide** should be used and is especially recommended for pest and disease control if continuous cropping in the same ground is unavoidable A mixture of **Mehtyl Bromide** and **Chloropicrin** (70/30) can be used to assist in the eradication of soil borne pathogens Sandersonia are very susceptible to many pre-emergent herbicides and great care must be taken in their use Hand weeding is therefore recommended.

PESTS AND DISEASES

The main insect pest of Sandersonia appears to be Thrip Along with caterpillars, slugs and snails all these pests can be controlled by easily obtained insecticides and baits. Alternation of chemicals as with many crops is important to combat insect resistance **Orthene** (Acephate) is the most commonly used as it is broad spectrum and systemic This has been alternated successfully on a 7-10 day period during the growth to flowering stage with one or two of the following **Folidol M50** (Parathion-Methyl), **Decis** (Delthamethrin), **Mavrik Aqua Flow** (Fluralinate) and **Attack** (Permethrin/Pirimiphos-Methyl) An upturned wand is essential to eliminate thrips, moths and other small insects which can get up into the bells Grass grub larvae can also cause rhizome damage (chewing) in the latter stages of growth.

The major fungus disease in Sandersonia is **Rhizoctonia** which is characterised as die back at the growing point causing the leaves to wither up followed by the collapse of the whole stem. The rhizome underground will suffer soft brown rot spreading inwards from the growing point. This can largely be avoided by planting clean stock into fumigated soil, dipping rhizomes in fungicide (**Terraclor**) prior to planting and regular application of fungicide as a drench throughout the growing season.

The other main fungal disease which manifests similar symptoms to the above is **Sclerotia Rolfsii**. This disease is carried in small brown fruiting bodies which spread through the ground and invade growing rhizomes causing soft rot. Its presence can be noticed by the appearance of white mycelium filled with the fruiting spores at ground level It can often occur under dead litter so regular close observation of the crop is essential A drench with double strength **Octave 50 WP** (Prochloraz) or **Terraclor** at the rate of 3-4 litres per square metre has been found to be effective Where ground is affected by these fungal diseases it is essential to sterilize with **Mehtyl Bromide** or at least use **Chloropicrin** when fumigating prior to a following crop.

LIFTING AND STORAGE

After December flowering plants tend to die about the end of January onwards Watering should be stopped and the rhizomes are normally lifted from March-April. Rhizomes are lifted annually and owing to their very fragile nature should be dug by hand to ensure that the growing point is not damaged If damage to one tip does occur then new growth will be limited to the remaining tip on the other leg Rhizomes can be washed immediately after lifting, dipped in Terraclor air dried and must be placed in a protective medium within 24 hours to prevent dehydration. Be extremely careful not to overwet the storage medium.

Suggested storage mediums include "just damp" untreated pine saw dust, sphagnum moss or vermiculite Cold storage at 4-5 C is essential A "just" damp newspaper on top of the sawdust etc. can help keep moisture in and also ensure any excess moisture or condensation is soaked up

Secondary production can be advantageous if bulking up of material is required (due to the effective doubling of growth points) However it is not as desirable for ongoing flower

production as the "marbles" can easily break off during and storage rendering the first generation rhizomes useless Pushing rhizomes for weight gain to hasten replication may therefore not pay off for the above reason.

Sandersonia can be propagated by division of the daughter rhizomes or from seed. Micropropagation (tissue culture) has not been successful to date, as although it is relatively easy to get the plant stock into culture it has proved impossible to multiply and bring out.

Seed is produced in large numbers with a 3-5 gram rhizome yielding up to 50-70 seeds from each 15-20 flowers There are between 175,000 and 220,000 seeds per kilogram Pollination can be achieved by insects or by hand. Seed viability is not so much a problem as its germination which can take up to two years It is normally two years from seed to rhizome that are large enough to produce marketable flowering stems

Stem length and the number of bells per stem depends on the weight of the planted rhizome. With environmental production of a 3 gram rhizome will produce a marketable flower stem. Therefore the heavier the rhizome the better the stem with 5-10 gram rhizomes being of optimum size. many growers split or cut rhizomes in half prior to planting to ensure even flowering from both growing plants Rhizomes need to be at least 5 grams to carry out this practice

PRODUCTION

Commercial production of Sandersonia flowers has been predominantly outdoors in New Zealand. However due to the high value of the end product a very sheltered site is essential It takes at least 75 days from planting to flower harvest stage The normal New Zealand outdoor season begins with planting in mid September for November/December flowers Heating is not necessary if Sandersonia are grown over the summer in their natural growing season. Perimeter and overhead protection with shadecloth (10-15% shade factor) has been found to be a big advantage in both adverse wind conditions and sites with heavy sun. This protection will also reduce the evaporation rate, lower water usage and help avoid any environmental stress Overhead irrigation is recommended and two applications per day can often be necessary during hot periods Greenhouse or indoor production can be used to extend the flowering season of Sandersonia. Some growers have planted during Winter (June/July) and completed flowering by early October This early production can also be enhanced by pre-sprouting (25 C for 2 weeks in a moist medium-vermiculite or damp untreated sawdust) and planting into a heated greenhouse, either into containers containing a growth media (eg pumice/peat

mix) or the soil with a minimum temperature of 18 C If planting indoors ensure good ventilation and do not let the building overheat during the day as stems can become weak and vase life diminished.

Rhizomes can be planted out in raised beds (15cm high) 85cm to one metre wide with a walking path of 50cm between each row Mature flowering rhizomes should be planted out at approximately 100 per square metre (ie 10cm apart) with small rhizomes ex-seed production up to 200 per metre Rhizomes are best planted in 6 to 8 furrows (depending on size) at approximately the same depth as their length. Plant out small rhizomes by weight (eg 10 gm per metre) Both the management during the growing season and the lifting of rhizomes at the end of the season is considerably easier with raised beds and well defined furrows Lifting by mechanical means is impractical due to the delicate nature of the rhizome

Sandersonia prefer a friable soil and do not like high pH. Soil testing prior to planting is highly recommended with a pH of 5 5 - 6 5 being optimum. Test results need to be analysed and interpreted by a qualified soils consultant to establish an appropriate fertilizer mix. It has been well proven that soils with a high organic content have produced superior crops of both cut flowers and rhizomes The annual application of additional organic material or manure is especially important where a site is used on a continuous basis

It is imperative to check rhizomes at least monthly during storage as stored rhizomes can be susceptible to rotting caused by soil fungi and bacteria. If any problems are encountered it is advisable to increase the checks to weekly intervals removing any affected rhizomes Rotting rhizomes give off ethylene and this can lead damage of surrounding rhizomes Absolutely avoid overwetting the stored material

HARVESTING

Sandersonia stems are harvested for market at a relatively immature stage when the two lowest flowers are open. The next bloom should be partly opened and the next showing colour It is advisable to retain at least two leaves on the plant after cutting to ensure further development. It has been observed by some growers that up to twenty five per cent increase in rhizome weight can be achieved by allowing maturity of flowers to extend to three bells open and by leaving a third leaf on the remaining stem. Note that rhizomes from which the flower is harvested will not grow as big as those where the flower is left intact. It is also apparent that rhizomes from which flowers are harvested do not incur secondary growth or "marble" production.

Picking should be carried out in the cool of the morning and the cut stem placed in a conditioning solution containing chrysal Stems should be cool stored at 6-8 C for at least 24 hours in this solution. In any event they must be precooled prior to packing and despatch to help maintain vase life.

Sandersonia are normally bunched in fives with the end of the stems begin plunged into sachets of Floss to minimise stress and dehydration during freighting to the market. Wrapping the heads of the bunched flower stems in acid free tissue is also recommended Carton size is largely depended on your wholesaler but it has generally now been proven that the smaller "Florist" box is preferable for gaining the maximum return from this speciality flower An average of 50 stems (50cm+) is sufficient to fill a florist box. Overfilling can crush flowers and diminish market returns. It is important to make sure that the flowers are well packed in carton to stop any movement during travel. This can be achieved by stapling in a wood brace across the box.

CALLA LILIES: A NEW ZEALAND PERSPECTIVE

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THE GENUS

The calla lily (Zantedeschia) is not new to floriculture Members of the genus have been cultivated for many years as garden plants in Mediterranean climates In other parts of the world their flowers have been forced in greenhouses for use as potted plants or cut flowers The past popularity of callas was highlighted in 1948 by the publication of a special edition on Aroid Lilies by the American Plant Life Society

Recent years have shown an increased interest in the calla species which are available in pink, yellow, cream and white New Zealand breeders and producers have capitalised on this interest with a selected range of superior cut flower and pot plant cultivars These vegetatively propagated cultivars display a wide array of colours, forms and habits With the use of tissue culture as a means of rapid multiplication (Cohen 1983) New Zealand callas are now available to the world market as fresh cut flowers or as dormant tubers for flower forcing Exports of callas from New Zealand have been rapidly increasing over the past three years (Jamieson, 1988)

Commonly known as the calla lily, the genus *Zantedeschia* correctly belongs to the family Araceae It is more closely related to the caladium and does not have the same habit and cultural requirements as found in true liliums There are six known species in the genus (Letty, 1973)

Z. aethiopica	evergreen, white flowers
Z rehmannii	deciduous, small pink flowers
Z. albomaculata	deciduous, cream flowers
Z. elliottiana	deciduous, yellow/ gold flowers
Z. pentlandii	deciduous, yellow/gold
Z. jucunda	deciduous, yellow (not used horticulturally)

Over fifty years of crossing and selecting the species has produced the present range of cultivars available in New Zealand

The deciduous types form an underground tuber which is in a dormant state over winter Growth and flowering is not greatly affected by day length, however plants must undergo a rest period (6-8 weeks) before growth will resume The growing cycle ranges from 16 to 24 weeks and rest period can be induced by cold or dry periods Form and habit vary among the named hybrids Leaf shape is lanceolate, hastate or sagittate (lance, spear or arrow) Leaves can be heavily spotted with white markings, plain green, or variations in between Plants are either monopodial or sympodial in branching habit depending on the cultivar Established plants range in natural height form 30cm to 150cm tall

Flower stem heights should be between 60-90 cm for premium grade cut flowers Shorter stemmed flowers (30-40 cm) can be used as a "posy" grade at a lower price The "flower" is composed of a central spadix which bears the true male and female flowers, a coloured spathe and a scape The top of the flower spathe is round or

pointed in shape and the front can be open or semi-open In general the trumpet shaped spathe is the front Flower quantity is dependent on cultivar, tuber size, and growth regulator applications One to three flowers can be expected from a 4-5 cm diameter (2") tuber The flowers are green at macrobud stage and gain full colour upon opening After pollination flowers often deepen in colour, begin to re-green, and close Re-greening occurs from four days to 21 days after opening depending on the cultivar (Welsh, 1986)

PLANTING MATERIAL

Tuber Production

Propagation of the species can be done by seed, although this propagation is limited to the true species which have a limited colour range Division of tubers after lifting is a common means of increasing initial stock numbers This type of propagation should not be sustained for longer than two to three years as it is conducive to carry over and spread of viral and bacterial diseases

Micropropagation (tissue culture) must be employed for rapid increase of new cultivars To ensure stock is clean upon planting it must be free of virus disease upon initiation into tissue culture (Zettler, 1988) Once plantlets are removed from the flask they require two growing cycles before they reach a natural flowering size of 4-5 cm in diameter (2") six to eight week rest, natural flowering sized tubers can be achieved in just over 12 months if greenhouses are used for out of season forcing Tuber production can be cycled for year-round production, particularly when shipped from one hemisphere to another

Tubers are currently being offered from New Zealand as a natural flowering size 4-5 cm (2") for (NZ) FOB or as a growing on tuber 2-3 cm (1") for (NZ) FOB The large tubers are available from May to September and small tubers can be made available any time of year

Once tubers arrive they should be unpacked and placed right side up to sprout in trays prior to planting They may be held at ambient shed temperatures if they are to be planted within three to four weeks

Lifting and Curing

After flowering plants will begin to yellow and die back at the end of a growing cycle A protective skin will begin to develop on the tuber exterior This process can be accelerated by warm temperature curing after lifting Tubers are lifted from the field by modified potato harvesters Tubers will still be in a fragile state with roots attached and therefore are carefully gathered by hand Excess soil is washed off and tubers are inspected for soft rot which is easily recognised by milky white tissue and a distinctively bad smell Roots are left intact and tubers are placed upside down on racks for curing Curing in the field is not recommended as unexpected frost will damage tubers
Curing chambers or empty greenhouses are used to keep temperatures between 20-24 degrees C for approximately two weeks Air circulation is necessary to maintain humidity at 70-80% Curing conditions are very similar to those used for sweet potatoes Once curing is complete roots are manually removed and tubers are placed topside up in boxes with dry packing material around them Untreated dry sawdust, woodshavings or rice hulls are suitable materials

Storage

The duration and temperature used for storage will affect the time to flower from planting, flower stem length and productivity Warm storage (20 degrees C) will result in tubers being ready for replanting six to eight weeks Prolonged warm storage will result in elongated sprouts which can be damaged in shipping and at planting (Tjia, 1987) This method of storage gives optimum flower productivity and stem length.

Cool storage (at below 5 degrees C) is detrimental to flower productivity If temperatures drop to freezing tubers will be destroyed Temperatures of 8 degrees C will hold tubers in a non sprouted state for up to six months Although flower potential is sacrificed with long term storage it can be restored with the use of gibberellins Tubers stored for long periods will have shorter flower stems, less leaf area and flowers in a shorter time period Penicillium moulds may develop in storage, but this can be avoided by a dip in a benomyl fungicide (Benlate R) prior to storage.

Pre-plant Dips

Gibberellins (GA) can be used to induce flowering and therefore increase flower yield. They are applied as a pre-plant dip or spray Various rates of application have been reported as being successful

- GA_3 quick dip at 25 ppm for 30 seconds (Dennis, 1983)
- GA_3 soak at 500 ppm for 10 minutes (Corr and Widmer, 1987)
- GA_3 or GA_{4+7} and Benzyladenine (BA) soak at 50-100 ppm for 30 minutes (Tjia, 1988)

The wide range which researchers have found successful demonstrates the efficacy of the range of the product In New Zealand growers mostly use 50-100 ppm as a soak or spray until run-off over tubers just prior to planting

Gibberellic Acid is available in the USA as pro- Gibb$_R$ (GA_3) or as Promalin$_R$ (GA_{4+7} and BA) Treatments with GA will increase flower yield by two to three times the rate expected from non-treated tubers Tubers must be lifted in order to apply GA. No successful results have been reported from foliar application of GA.

FLOWER FORCING

Ground Preparation

Callas will grow in most soils provided they have adequate drainage Sandy loam soils are preferred as they are free draining, lifting is generally easier, and tubers require less cleaning than they would in heavy and sticky clay soils Organic matter should be incorporated into light soils to improve water retention and supply good aeration around the tubers.

From ground in pasture spray with Roundup$_R$ (glyphosate) herbicide and allow to die off Use cultivation techniques that insure a fine deep tilth. Beds should be one metre incorporating 400-500 kg/ha of balanced 10-10-10 NPK fertilisers as a base dressing. In general, too much nitrogen will result in excessive leaf growth and is thought to be conducive to soft rot infection.

Fertilisation

Quantitative information on optimal amounts of NPK fertiliser required by callas in the field is not yet available At present growers are adjusting pH levels to 6 0 - 6 5 and

incorporating 400 - 500 kg/ha of balanced 10-10-10 NPK fertilisers as a base dressing In general, too much nitrogen will result in excessive leaf growth and is thought to be conductive to soft rot infection

Density

Planting depth and density is widely dependent on size of tubers and expected duration in the ground Tubers should have twice their depth of soil on top once the planting hole is covered

Densities commonly used are as follows

System I Lift annually
4 rows per bed 20 cm (8") apart
20 cm between plants in rows
104,000 tubers/ha (43,000 acre)
For forcing under protection, tuber multiplication, altering flowering season, treating with GA.

System II Lift after two years
2 rows per bed 40 cm (16") apart
20 cm between plants in rows
65,000 tubers/ha (27,000 acre)
Standard for NZ field production

Planting of tubers can be aided by a roller peg marker and/or tractor mounted planting equipment

Irrigation

After planting, water is applied sparingly until leaves are unfurled No additional irrigation is necessary in the early stages of forcing when grown outdoors, exposed to rainfall Providing soil is adequately drained and aerated, generous amounts of water can be applied prior to and during the flowering period Once flowering is complete irrigation levels are reduced to discourage bacterial soft rots

Overhead irrigation does not affect blooms Where overhead watering is used 20lt/hr nozzles are spaced at 4m x 4m to give a fine overlapping spray
Ground level irrigation using perforated plastic pipe has also been used successfully. This system conserves water, alleviates muddy paths and may reduce the incidence of foliar diseases

Irrigation at flower harvesting is applied every second day just prior to picking which occurs at the same frequency Turgid stems at harvest time are essential when picking by means of pulling

Weed control

Callas are surface rooting plants therefore mechanical cultivation between plants is not recommended Where available, weed free organic mulches such as untreated sawdust or straw will aid in controlling weeds and conserve soil moisture and texture Limited experience by NZ growers has shown the following chemicals to be safe and effective for use with callas

Pre-plant Roundup® (glyphosate) or Amitrole® (amitrole)

	to eradicate perennial weeds.
Pre-emergent	Tenoran® (choloroxuron) immediately after planting
Post-emergent	Fusilade® (fluazifop-butyl,) for grass control
	Versatill® (clopyralid) for control of broadleaves and clovers. Both may be used over the top of the crop.

For control of weeds in paths Roundup® may be used, as the crop does appear to be tolerant to minor drift Paraquat® should not be used around callas as it can effect subsequent growth of the tuber Weed control late in the season is usually not a problem due to the dense canopy of foliage

Pest and Disease

The production of a saleable, high quality cutflowers at a profit is greatly dependent on a grower's ability to readily control pests and diseases in a crop Damage can occur from the following

Pest	**Damage**	**Control**
Thrips	Rasping of flowers	Prior to harvest use systemics such as Orthene® (acephate)
	Spread of virus (TSWV)	During harvest use Maverick® (fluvalinate)
Aphids	Distorted leaves and flowers	During storage and early stages of development use of Maldison® (Malathion)
	Spread of virus (DMV)	

Diseases

Bacterial soft rot (Erwinia sp) can cause losses in the field and during storage There is no effective chemical control that can be readily applied If soils are excessively wet or tubers incorrectly cured soft rot may inflict heavy losses

Blackspot caused by a fungus (Alternaria) can reduce the quality and longevity of flowers Symptoms usually occur on the spathe when wet, humid weather is persistent Rovral® (iprodione) is effective in suppressing the fungus and can be used on plants in the field and as a pulsing solution for flowers (Tjia and Funnell, 1985)

Virus has been reported in aroids including callas (Zettler), 1988) As large scale planting so callas increase, so too has the incidence of virus like symptoms To date viruses have not been a major problem in New Zealand Signs of viral infection are beginning to appear where growers have continuously used the stock for division propagation Many viruses have been recorded in *Zantedeschia* Two have been identified in New Zealand

- Dasheen Mosiac (DMV) Aphid vectored
- Tomato Spotted Wilt (TSWV) Thrip vectored

The only effective control is prevention. The following steps are recommended

1 Obtain tubers from a source which uses tissue cultured plant material that has been indexed as being free of known viruses

2. Remove any plants with virus symptoms, ie, strap like leaves, interveinal chlorosis, or striped flowers

3. Keep aphids and thrips under control

Harvesting

Flowers can be pulled or cut at the base of the stems (scape) Pulling flowers has the advantage of gaining extra length and speed in harvesting A disadvantage is the possibility of removing the flower primordia from auxiliary flowers Young weakly rooted plants can also be lifted out of the ground If flowers are to be pulled they must be turgid (watered the previous day) and gripped at the base, not mid-way up the stem

Cutting flowers slightly reduces length and requires more time in harvesting However, it does insure minimum damage to the plant and flower stem. Many growers use both techniques depending on cultivar, length and size of plant.

Any flower not considered saleable should be removed or have flower heads broken off to ensure seed heads are not formed Snapping flower heads off distorted or discoloured flowers leaves the scape intact so tubers producing poor quality blooms can be identified and removed at a later stage

The main production peak in New Zealand Tubers are planted outdoors in September or left in the ground from the previous season Market demand is high, however, prices soften and air freight space is at a premium out of New Zealand

Period C 25 December to 15 January

Worldwide demand is low, prices are low and availability of labour for picking is difficult Flower colour is a little faded due to high temperatures

Period D 16 January to 31 March

Harvest begins from stored tubers planted from November to January Prices strengthen as demand for flowers increases

Prices received over the 1987 season were as follows for the different grades (FOB NZ$)

AA	0 60 - 1 60
A	0 50 - 1 20
Mixed	0 40 - 1 00
Posy	0 30 - 0 80
Mini Posy	0 30 - 0 70

(See Appendix I)

Northern Hemisphere Production

In 1986 tubers from Topline Nurseries, Auckland, were sent to five test sites for field evaluation. Five cultivars (30 tubers of each) were sent to Minnesota, Illinois, Missouri, Georgia and Florida. Tuber size was 3-4 cm (1 5") in diameter and no growth regulator was applied Plantings were made in May at all sites and flowering occurred approximately 12 weeks afterwards Detailed results were sent back from the University of Minnesota and University of Georgia test sites

	Cultivars				
	Pink Persuasion	Majestic Red	Pacific Pink	Black Magic	Best Gold
Weeks to 1st flower					
(Minnesota)	12	13	12	11	10
(Georgia)	13	12	12	12	11
Stem length(Average)					
(Minnesota)	18 9	20 7	20.9	37 8	33 9
(Georgia)	21.2	26 0	19 9	40 3	35 4
Total Flowers from 30 tubers					
(Minnesota)	11	18	22	10	9
(Georgia)	7	18	15	3	5

Post Harvest Treatments

The following recommendations are given by exporter and NZ Ministry of Agriculture and Fisheries advisers

1 Pick flowers in the cool of the day

2 Flowers must be fully open on picking a tight buds will not open or produce good colour Pick prior to pollen shed to maximise vase life

3. Grade and bunch flowers in the shed and recut the stems

4 Place into a conditioning solution

20 grams sugar per litre of water to avoid stem roll

8 H.Q.C (100ppm) as a bacteriastat

** 1 gram of Rovral (50% WP) per litre of water if blackspot (alternaria) is a problem.

5 Reduce field heat by placing in cool stores at 4 degrees C in conditioning solution for 8-12 hours (overnight)

6 Maintain good hygiene Change conditioning solution between each batch of flowers Scrub bucket out with Chloroxa daily Mix conditioning solution daily Do not store If flowers are not shipped within 24 hours change to fresh water daily

7 Packaging will depend on the exporter or wholesalers' requirements Flowers must be dry when packed.

Grading standards in New Zealand are found in Appendix I.

Scheduling

Time to flowering will depend on storage conditions and cultivar Twelve weeks from planting to first bloom can be used as a guide when planning production.

Market Demand for New Zealand Exports

Flower production of callas takes place naturally over early summer, November to January in New Zealand This short flowering season is spread by early forcing under protection or by late planting of stored tubers

Period A Mid-October to first week of December

Early plantings are made in late July to August under protection or in warmer parts of the country Market demand is strong and prices are high. Yellow, gold and cream are preferred in Japan.

Period B First week of December to 24 December

This early test proves that callas can be field grown and flowering time is not greatly different from New Zealand nor is the difference significant between the two diverse climates Stem length was slightly taller in Georgia but flower number was reduced Both may be attributed to higher temperatures

With a larger grade of tuber (4-5 cm), use of gibberellins, and altered planting times, callas could be successfully grown in these two diverse climates Earlier plantings would be advised in Minnesota to avoid frosts on late flowers, and earlier plantings in Georgia would avoid high summer temperatures Conversely a later planting in Georgia would have the same effect

Recent plantings in Florida have indicated problems with flower colour fading when grown over summer Pinks and blush-tinted flowers will not develop good strong colour when grown under high temperatures or low light Scheduling to avoid these time periods is the key answer to the problem.

Tuber production from field grown stock in New Zealand is not available for dispatch to the USA until May This presents a dilemma for US growers eager to try callas for the spring market

Three viable solutions have been initiated by New Zealand tuber producers to satisfy earlier demands expected by US growers.

1. Large 4-5 cm (2") tubers produced in New Zealand can be stored long term in temperature controlled rooms for dispatch in November-January

2 Small 2-3 cm (1") tubers can be shipped to US producers prepared to grow on tubers for another growth cycle (six months)

3 Small 2-3 cm (1") tubers are shipped to a third country (tropical) to be grown-on year round, offering continual supply of New Zealand bred and propagated varieties

Suppliers of New Zealand tubers are listed in Appendix 2

Conclusion

The success of flower growing in New Zealand is through export. New Zealand is a small country with a high standard of living and lies very far from its markets We cannot compete with many other countries on volume or price

We live in a garden of diversity in plant material both endemic and introduced. Our real place of strength is to supply the world with new and unusual cut flowers that fetch premium prices The flow on of plant material for these cut flowers is inevitable as it justifies crop improvement breeding programs and helps increase overall demand

The kiwifruit success story has put New Zealand on the map as a major horticultural exporter Like any new exotic crop once it has proven successful it is heavily invested in until it reaches a commodity status Our strength is to keep finding new crops, introducing a product and moving on as supply reaches demand and profitability is lessened The stage seems set for another winner Kiwi Callas - New Zealand Calla.

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