

Program: New Varieties for the Ornamental Industry

PROJECT: **New Heliconia and Ginger Varieties for the Ornamental Industry**

Project Officers: **D. Marcsik, M. Houtt, M. Connelly and C. Ford**

Location: **BARC and Growers properties**

Objective:

To enhance market opportunities for the ornamental industry by providing new and unique Zingiberale (Heliconia and Ginger) varieties over the next three years.

Heliconia

Introduction:

A two-year 'on-farm' evaluation of nine open-pollinated (OP) *Heliconia psittacorum* seedling selections has been completed. DBIRD released all nine varieties to the public and members of the cut-flower growers group gave a name to each: 'Pink Blush', 'Flamenco', 'Pearl', 'Fantasia', 'Rosie Q', 'Red Devil', 'Rose Red', 'Exotic' and 'Cracker Jack'.

A *Heliconia rostrata* seedling selection was evaluated for suitability as a cut-flower type and the results are reported here as well.

Method:

During the 'on-farm' evaluation, both yield and observational assessments were conducted by the growers on all nine *Psittacorum* seedlings. In addition, vase-life studies were conducted on them to determine their suitability as cut-flower types.

Two plants of the *H. rostrata* seedling were established at the BARC block in 2002. Observations were made on seedling vigour and vase-life over one growing season.

Results:

From the yield data 'Pearl' was found to be the most prolific producer of flowers for both the wet and dry season. Growers observed plants of 'Pearl' to bush out quickly and were very productive (Table 1). 'Cracker Jack' was another seedling that was quite productive both in the wet and dry seasons, as was 'Rosie Q'. 'Pink Blush' and 'Flamenco' were both found to have good wet season production, with dry season yield being fair to poor, respectively. Three selections, 'Fantasia', 'Rose Red' and 'Exotic' had good wet season production but were poor in the dry (Table 1).

Three selections were identified as new "forms" of *Psittacorum*s: 'Pink Blush' a robust large inflorescence form with a thick long stem; 'Flamenco' a beautiful coloured large pink inflorescence; and 'Pearl' a rare pale lemon to cream coloured inflorescence (Figure 1). All these were derived from *H. psittacorum* 'Parakeet', and were found to be excellent cut-flower types with significant vase-life (Table 1). Another seedling selection derived from *H. psittacourm* 'Parakeet' was 'Fantasia' that was rated by the growers as satisfactory and a good cut-flower type.

Three other selections identified as good cut-flower types were 'Rosie Q', 'Red Devil' and 'Cracker Jack' (Table 1). Both 'Red Devil' and 'Rosie Q' are seedlings from *H. psittacorum* 'Lady Di' while 'Cracker Jack' was derived from *H. psittacorum* 'Lizette' (Figure 1). 'Rose Red', another seedling derived from *H. psittacorum* 'Lady Di' performed only as satisfactory as a cut-flower. 'Exotic', a seedling derived from *H. psittacorum* 'Suzi' was found to be a poor cut-flower type by the growers due to its short stems and poor yield. However, some of the growers commented that the variegated leaves could be used as a source of foliage and it was released for this trait.

The *H. rostrata* seedling selection CP-01 was found to be of a standard *rostrata* type. Results from the assessment found vase-life ranged from four to seven days for the 10 inflorescences sampled. Vase-life ranged from eight to 21 days. Figure 2 shows a *H. rostrata* inflorescence after 11 days from harvest to be still acceptable.



Figure 1. New *Heliconia psittacorum* varieties



Figure 2. *H. rostrata* seedling CP-01 inflorescence after 11 days from harvest

Table 1. Vase-life evaluations of new *Heliconia psittacorum* varieties and observations of cut-flower growers

Variety	Yield ^a		Vase-life 'days to not suitable for vase' ^b	Grower comments
	Wet season	Dry season		
'Pink Blush'	Good	Fair	26	Huge flower. Good vase life. Big flower.
'Flamenco'	Good	Poor	21	Good colour, beautiful flower. Good shape. Good flower, low yield.
'Pearl'	Very good	Very good	21	Bushes out, high yield. Productive; does not mark. Great colour. Good yield in dry, flower a bit small.
'Fantasia'	Good	Poor	21	Small flower head.
'Rosie Q'	Very good	Very good	19	Good production, small size. Good yield, nice colour.
'Red Devil'	Very good	Good	20	Tough, lots of flowers. Small flower head
'Rose Red'	Good	Poor	15	Different colour.
'Cracker Jack'	Very good	Very good	24	Productive, red; flowers when needed. Blows out too early.
'Exotic'	Fair	Poor	17	Stem length a bit short. Leaves are good, variegated.

Key: a = Industry estimates; b = Average number of days not suitable for vase (ageing >35%)

Conclusion:

The potential for developing new *Heliconia* products from open-pollinated seedlings is evident from the nine new *Psittacorums*. Significant differences were observed in colour and form between seedlings derived from the *H. psittacorum* 'Parakeet', compared with other seedling populations where there were only slight differences in colour, such as those derived from *H. psittacorum* 'Lady Di'. Overall, these selections provide the local cut-flower industry with an expanded range of colours and some new types suitable for the Top End.

The *H. rostrata* seedling selection CP-01 showed variable vase-life and cannot be recommended as a replacement for "standard" rostrata or "Ten day" rostrata. However, some industry evaluation of this selection is warranted given that there is some indication of improved vase-life for some harvest dates. The sourcing of seed material of other *Heliconia* cut-flower varieties and species from overseas could provide a range of new colour and unique flower forms of *Heliconias* for the industry and should be pursued in future.

Note: Further information on each of the new *Psittacorums* can be found on *Fact Sheets* on the Horticulture web site: www.horticulture.nt.gov.au

Zingiber

Introduction:

The six 'Darzing' varieties that resulted from the *Zingiber* breeding project in 1998 are now in the final commercialisation phase of the project. All six varieties are undergoing Plant Breeders' Rights (PBR) registration as part of this process.

Also from the original *Zingiber* breeding project, a number of other *Zingiber* hybrids were selected by DBIRD horticulturists and are known as 'non-Darzing' hybrids and inter-specific hybrids. These hybrids were established at the BARC block and further evaluated under different cultural conditions. This report discusses the yield and post-harvest assessments of these selections conducted over one growing season.

Screening of new accessions is fundamental for the ongoing development and improvement of *Zingibers* as cut-flowers. Several new *Zingiber* accessions have been introduced in the project and some of the preliminary evaluations of these have occurred.

Method:

The 'Darzing' PBR examination was conducted on two grower trial locations, Humpty Doo and Elizabeth Valley. The 'Darzing' and comparator plants were grown in a completely randomised design and maintained under standard commercial management practices. Two on-site examinations were conducted, due to differences in flowering times of the 'Darzing' varieties. The first examination was conducted in early October on 'Dawn', 'Blaze' and 'Chocolate Delight', and the second in November on the later flowering selections 'Pinelime', 'Golden Glory' and 'Sunset' together with comparators. A range of inflorescence characteristics was measured for each 'Darzing' variety and comparator.

Plants of 'non-Darzing' hybrids vegetatively propagated from stem cuttings were planted at the BARC block in August 2002 under full sun. Similarly, vegetative propagated plants of inter-specific hybrids were planted in the 80% shade area at the BARC block to assess these hybrids growing under favourable cultural conditions. Both areas were deep-ripped and rotary hoed to form raised beds with the same pre-plant applications. Under tree sprinklers were used in both areas and soil moisture was

monitored with tensiometers. Both areas were fertigated twice a week when the first inflorescence shoots appeared and during the peak flowering times, and only once a week during the off-flowering periods. Data was collected a bit over one flowering season on water use, yield, and vase-life.

Only some of the new *Zingiber* accessions were planted at the BARC block in the 80% shade area. Other accessions were retained in pots located at the BARC nursery until strong enough to plant in the field (Table 4). Similar management practices were applied as for the other *Zingibers* planted at the BARC block. Data was collected from those accessions that flowered during the 2003-04 period. At the end of October 2003, the cut-flower growers group (CFG) took a field walk at the BARC block to view the *Zingibers* during their peak flowering.

Results:

Measurements collected from the PBR examinations were analysed and compiled into a description for each of the six 'Darzing' varieties as part of phase 2 of the PBR process. These descriptions have been published in the 'Public Notice' of the *Plant Varieties Journal*, **17**(1), (2004). Under 'Public Notice' the six varieties will be on a six-month probation period before being granted full PBR status.

With regards to the 'non-Darzing' hybrids planted under full sun conditions, approximately 40% did not survive due to a suspected bacterial rhizome rot. Symptoms of the rhizome rot first appeared in plants during the 'build-up' period in 2002, and spread further through the block during the wet season. In the shade area, the rhizome rot problem was not as severe with only about 20% of the plants lost.

The yield and vase-life results are presented in Table 2 for the 'non-Darzing' hybrids, and Table 3 for the inter-specific *Zingiber* hybrids. In general, the yield for both 'non-Darzing' and 'inter-specific' *Zingiber* hybrids was significantly lower compared with the yield data recorded from the original field trial conducted at CPHRS during 1999–01. This was primarily due to the poor site conditions, poor soil health and the prevalence of rhizome rot.

In general, the average total length of most 'inter-specific' hybrid inflorescences ranged from 20 to 30 cm, with hybrid 4.17 having the longest inflorescence at 38 cm (Table 3). Also, the average number of days of vase-life was no greater than 14 days for most of the 'inter-specific' hybrids. Some of the 'inter-specific' hybrids had nice aniseed smell several days after they were picked which may be a positive attribute. A selection of 'inter-specific' hybrids to be released for 'on-farm' evaluations in the near future is presented in Figure 3.



6.05



4.17



G1.41



1.10



3.02



2.71

Figure 3. 'Inter-specific' *Zingiber* hybrid selections for 'on-farm' evaluations

The CFG group field walk provided members who were not part of the original project group an opportunity to view these new *Zingiber* hybrid selections. The selections presented in Figure 4 are most liked by growers on that field walk.



5.35



1.35



6.14

Figure 4. 'Non-Darzing' hybrid selections most liked by members of the CFG group

Not all the new *Zingiber* accessions flowered in the first season. Three accessions that did flower and had some post-harvest studies conducted were ZI 15, ZI 18 'Red Jeli', and ZI 22 'Coffee' (Table 4). The most promising cut-flower type was 'Red Jeli' with its red coloured bracts, nice form and attractive bi-coloured stems (Figure 5). Also, vase-life for 'Red Jeli' was found to be reasonable. 'Coffee' was the best producer of flowers and was the last to finish flowering around March. ZI 15 rated poorly as a cut-flower type due to its very short stems <10 cm (Figure 5). However, it was observed to be very strong and vigorous when other *Zingiber* plants growing nearby were infected with the bacterial rhizome rot. Other *Zingibers* that flowered, but were not studied post-harvest due to low flower numbers, were ZI 13 and ZI 30 (Figure 5).



Figure 5. New *Zingiber* accessions

Conclusion:

The prevalence of the rhizome rot problem at the BARC block has limited any future planting of *Zingibers* on this particular site. Thus far, the Plant Pathology Section has not isolated the pathogen directly responsible for the rot. It has been observed that *Zingibers* grown on sites of heavier soils are more prone to the rot problem than on free-draining, poor lateritic sands with a slope. Furthermore, it is suspected that if a pathogen is involved, it is readily distributed by water, such as splashing and rain. Reports received by growers indicate that this rhizome rot is a problem as more *Zingibers* are grown commercially.

The 'non-Darzing' *Zingiber* hybrids are planned to be released together with the 'Darzing' selections as part of the commercialisation process later this year. As for the inter-specific *Zingibers*, they are to be released under a 'non-propagation' agreement for further 'on-farm' commercial evaluations. Members of the CFG group have placed orders for two of the new *Zingiber* accessions 'Red Jeli' and 'Coffee', with a nursery in Queensland.

DBIRD Horticulture acknowledges the generous supply of new *Zingiber* accessions by Bruce Dunston, Queensland.

Table 2. Yield and post-harvest evaluations of 'non-Darzing' *Zingiber* hybrids, BARC 2003-04

Plant No.	Two tone	Stem colour	Total length (cm)	Yield ^a	Vase-life		Commenced flowering	Comments
					Days to 'not saleable' ^b	Days to 'not vaseable' ^c		
5.54	No	Green	49	81	9	16	mid-July	
6.43	No	Green/brown	48	54	10	15	early-July	
G2.49	No	Green	48	81	10	19	early-July	Severe bract staining
G2.53	No	Green/brown	48	61	7	16	early-July	
5.37	No	Green	72	14	8	14	September	Moderate bract staining
G2.25	Yes	Green	68	16	7	14	September	Moderate bract staining
97.22	No	Green	32	45	9	16	August	Bottom bracts prone to splitting
97.65	No	Green	52	80	8	20	mid-July	Excellent vase-life, very little bract staining
97.68	No	Green	55	12	6	15	September	
5.35	Yes	Green	59	18	7	14	October	Huge inflorescence head
6.26	Yes	Green	70	17	5	12	October	Severe bract staining
1.35	Yes	Green	57	74	6	13	early-August	Severe bract staining
6.14	Yes	Green	47	17	8	13	early-August	Looks similar to 'Chocolate Delight'

Key: a = Number of inflorescences/plant; b = Average number of days to 'not saleable' (first signs of ageing); c = Average number of days to not suitable for vase (ageing >35%)

Table 3. Yield and post harvest evaluations of 'inter-specific' *Zingiber* hybrids, BARC 2003-04

Plant No.	Two tone	Stem colour	Total length (cm)	Yield ^a	Vase-life		Commenced flowering	Comments
					Days to 'not saleable' ^b	Days to 'not vaseable' ^c		
1.10	No	Red	26	5	7	12	early-October	
2.18	No	Red/brown	22	21	7	12	early-September	
2.23	No	Brown/green	30	38	8	13	mid-September	
2.71	No	Red	33	12	6	13	early-September	
3.02	No	Red	30	11	8	15	late-September	
3.18	No	Red/green	26	23	7	13	mid-October	
3.59	No	Red/brown	25	17	7	13	early-September	
5.48	No	Brown/green	28	24	7	14	mid-October	
6.29	No	Red	29	5	7	14	mid-October	Day flowers do not completely hang out.
6.76	No	Red	24	10	5	11	mid-October	
GR1.1	No	Red	23	14	9	11	mid-September	
GR2.1	No	Red/brown	24	20	8	13	mid-September	
1.25	No	Red/brown	32	26	7	13	early-September	
G1.41	No	Red/brown	21	6	4	11	early-October	
4.17	No	Brown/green	38	18	6	13	early-October	Nice aniseed smell, day flowers do not fall out easily
6.05	No	Brown/green	28	26	7	13	early-October	Nice aniseed smell, does not push out heaps of day flowers
4.44	No	Red/brown	36	28	8	16	early-September	
G3.41	No	Red	23	11	6	12	mid-October	Nice ginger smell
ByxZp9	No	Green	26	22	4	13	October	Slight aniseed smell, visible bract staining
Unknown 8	No	Green	29	7	4	7	mid-October	Nice aniseed smell
Unknown 6	No	Green	30	24	7	10	November	Slight aniseed smell

Key: a = Number of inflorescences/plant; b = Average number of days to not saleable (first signs of ageing); c = Average number of days to not suitable for vase (ageing >35%)

Table 4. Preliminary screening and evaluation of new *Zingiber* accessions, BARC 2003-04

Species	Cultivar/selection	Acc. No.	Status	Date Planted	Plant Nos	Yield	Vase-life ^a – days to not saleable (n) ^b	Comments
<i>Zingiber psuedopungens</i>		ZI 13	BARC Nursery					Has flowered in the pot. Inflorescence has closed pointed bracts on upright stem.
<i>Zingiber</i> species	"Long Jowie"	ZI 14	BARC Nursery					Has not yet flowered,
<i>Zingiber</i> species		ZI 15	Shade block	30/08/02	1	10 - 15	5 (5)	Short pale white-green coloured inflorescence <20 cm long. Cones turn pink with age. Goes dormant in the dry season.
<i>Zingiber</i> species		ZI 16	BARC Nursery					Thin stemmed and narrow leaved plant. Has not yet flowered.
<i>Zingiber</i> species	"Yellow Champagne"	ZI 17	BARC Nursery and Shade block	18/02/03	1			Only one flower, weak plant.
<i>Zingiber</i> species	"Red Jeli"	ZI 18	BARC Nursery and Shade block	25/11/02	1	15 - 20	4 - 7 (5)	Red coloured inflorescence.
<i>Zingiber</i> species	"No. 2"	ZI 19	BARC Nursery and Shade block	17/09/03	1			Has not yet flowered.
<i>Zingiber</i> sp. Nova	"Dong"	ZI 20	BARC Nursery and Shade block	17/09/03	1			Thin-stemmed and narrow-leaved plant. Has not yet flowered.
<i>Zingiber</i> species	"Malay Yellow"	ZI 21	BARC Nursery and Shade block	25/11/02	1	1		Only one flower to date. Very early flowering.
<i>Zingiber</i> species	"Coffee"	ZI 22	BARC Nursery and Shade block	25/11/02	1	30	6 (3)	Very large clone, colour of milk coffee. Good producer of flowers
<i>Zingiber</i> species		ZI 27	BARC Nursery					Has not yet flowered.
<i>Zingiber</i> species		ZI 29	BARC Nursery					Foliage similar to ZI 20. Has not yet flowered.
<i>Zingiber</i> species		ZI 30	BARC Nursery and Shade block	14/10/03	1	7		Inflorescence similar to <i>Z.offensii</i> , but is a bigger and robust-looking clone.

Key: a = Number of days to not saleable (first signs of ageing); b = Range of vase-lives for all assessed stems/accessions; (n) = number of stems assessed/accession.

Curcuma

Introduction:

The success of the breeding work on *Curcumas* that resulted in 16,000 hybrid seeds demonstrates that conventional breeding can be a practical approach towards developing new varieties. However, just as successful hybridisation and good seed set are important, so is the germination of the hybrid seeds, to ensure the ongoing survival of the new progenies. This report discusses the *Curcuma* breeding work since the hybridisation work.

In recent years a large number of new *Curcuma* hybrids have been developed in Thailand both for cut-flowers and potted colour, that comprise the majority of *Curcumas* commercially marketed to Japan and Europe. A new *Curcuma* hybrid "Laddawan" sourced from Thailand by a DBIRD horticulturist was planted and assessed as a cut-flower type over one flowering season. Results are discussed in this report.

Method:

A selection of approximately 6,000 hybrid seeds identified to be promising cut-flower types, based on the ranking of the parents for particular selected traits were sown in 50 mm square native tubes containing peat-perlite (50-50) mix. Seeds were sown the last week of November 2003 and placed in the shade house at the BARC nursery under automated irrigation. Seed germination was assessed and recorded every two weeks.

Plants of *Curcuma* hybrid "Laddawan" released from the DBIRD Post Entry Quarantine facility and grown further at the BARC nursery were established in two sites at the BARC block. Ten plants were established in full sun and another ten plants were established under 70% shade. Both sites were planted on 18 February 2003 and maintained under similar management practices as discussed for the *Zingiber* hybrid plants. Yield and post harvest studies were recorded off plants from both sites over one flowering season.

Results:

Approximately 74% of all the 116 hybrid progenies including the self-crossed seeds germinated. Collectively, of all the progenies and self-crossed that had some germination recorded, approximately 77% had less than 50% germination. Seeds in tubes that did not germinate have been retained for further assessment subsequently.

Curcuma "Laddawan" is a hybrid cross between *C. cordata* and *C. alismatifolia* (Figure 6). Over the dry season all of the "Laddawan" plants went dormant with the first shoots appearing around mid October. Inflorescences first appeared at the beginning of December with the first stems harvested from full sun plants around mid December and a week later from plants in the shade area. The total number of inflorescences harvested ranged from 10-15 stems/plant in the sun, and 15-20 stems/plant in the shade area (Table 5). There was only a slight increase in stem length with inflorescences growing in the shade compared with the full sun, and no significant difference in head length or diameter. Flower colour intensity was found to be better under the shade, as well as an extended flowering season by four weeks over the plants in the sun. The only problem experienced with plants growing in the shade area was there was a tendency for some stems to be weak and to bend over. Also, symptoms of spotting on the inflorescence and stem were observed to be more pronounced in the shade compared to the full sun. However, the spotting problem was not observed to be as severe as seen on most *C. alismatifolia* selections.

In relation to vase-life, the average number of days to 'not suitable for vase' was a difference of three days between inflorescences grown in full sun compared to in the shade (Table 5). However, the most significant finding from the vase-life studies was the impact of maturity of flower head on vase-life. Inflorescences that had visible day flowers open only up to half way along the inflorescence (i.e. bracts 1 to 4) lasted significantly longer, compared to when the day flowers were open further than half way along the inflorescence (i.e. bracts 5 to coma end). For improved vase-life "Laddawan" should be picked relatively young when day flowers are only open on the lower half of the inflorescence.

Conclusion:

Overall, curcuma seed germination was generally poor with 77% of the progenies and self-crossed seeds having less than 50% germination. Further investigations will need to be conducted to improve *Curcuma* seed germination, such as for example, the application of different concentrations of acids previously investigated on *Zingiber* and *Etilingera* seeds to improve germination.

Curcuma hybrid "Laddawan" had particular attributes for a promising cut-flower such as excellent form, good colour, and long stem. However, it was only satisfactory in relation to vase-life of less than 14 days and may only be useful for the local market rather than interstate sales. In other findings, "Laddawan" performed significantly better under shade in relation to colour, yield and a slightly longer flowering time.

DBIRD Horticulture Division acknowledges the generous supply of "Laddawan" rhizomes by Pichai Manichote of Thailand.

Table 5. Field and post harvest evaluations of Curcuma hybrid “Laddawan”

	First picked	Last picked	Yield (stems/plant)	Average stem length (cm)	Average inflorescence head length (cm)	Average inflorescence head diameter (cm)	Vase-life ^a – days to ‘not saleable’	Vase-life ^b – days to ‘not suitable for vase’
Sun	mid-Dec	March	10 – 15	38	24	8	5	11
Shade	mid-Dec	April	15 – 20	43	25	8	4	8

Key: a = Average number of days to not saleable (first signs of ageing); b = Average number of days to ‘not suitable for vase’ (ageing >35%)



“Laddawan” inflorescences



“Laddawan” growing in shade area

Figure 6. Curcuma hybrid “Laddawan”

PROJECT: Irrigation and Nutrition Management in Alpinia as a Possible Control of Alpinia Leaf Scorch

Project Officers: C. Wicks and M. Connelly

Location: Commercial Orchard, Lambell's Lagoon

Objective:

To identify if improved irrigation and nutrition management can assist in reducing the level of Alpinia leaf scorch.

Introduction:

Alpinia purpurata is a member of the Ginger family. It grows into large clumps with many (12-20) tall (>2 m) stems but has only a shallow (<50 cm) root system that grows from a large rhizome. Alpinias flower from the terminal of mature stems. It is commercially grown for the production of cut-flowers that are highly popular. The development of a commercial Alpinia industry in the NT is still in its infancy and a range of production and business issues still need to be resolved.

One of these production issues is a condition known as Alpinia leaf scorch. The symptoms first appear as small (<1cm²) lesions in the leaves of mature plants. The small lesions develop into large lesions running the length of the leaf. The lesions transfer to the inflorescence when it emerges, which then scars and desiccates. Thus, this condition reduces the yield of Alpinia orchards.

During investigations of this condition, it was suggested by agronomists and growers that it could be related to either a nutrient imbalance or to stress induced by over-watering. The nutrition status of plants was studied over a two-year period when samples were taken from leaves at the top and bottom of the stems as well as from leaves showing early scorch symptoms. The soil water status was investigated for 12 months using tensiometers placed at 20 and 40 cm in wet and in dry areas as well as by measuring the level of input on the wet site.

Shade level and irrigation type determined the two sites used. The "wet" site was in full sun and was watered by sprinklers placed within the clumps. The "dry" site was in the shade of large trees with irrigation placed to water both the trees and the Alpinia clumps.

Results and Discussion:

The investigation of nutrient status did not provide any clear answers. There were no significant differences between the samples taken from the bottom, top or "spotted" leaves. However, the level of some nutrients was in some cases vastly different from those recommended by the Hawaiian industry. Table 1 shows the (averaged) nutrient levels for the three sample areas along with the recommended levels in Hawaii.

The level of calcium in the young 'top' leaves was less than half the recommended level as were levels of some micronutrients. When this is combined with the high to very high levels of the three main macronutrients, nitrogen, phosphorus and potassium, it can be argued that there is a nutrient imbalance, which may be expressed by the leaf scorching. This imbalance is not catastrophic. It can be easily rectified by using foliar sprays of micronutrients or increased application of micronutrients to the soil.

This expression of nutrient imbalance could especially be the case where waterlogging occurs. In other crops, it is known that waterlogging can induce deficiencies even where soil nutrient levels may be adequate.

During investigations of irrigation management of Alpinias in a commercial orchard, it was seen that there was a wide variation in soil water levels. Figure 1 shows the soil-water tension under Alpinias grown with or without shade. Alpinias grown under shade trees often suffered from water deficit (soil tension > 40 kPa) at 20 cm while Alpinias grown under the full sun occasionally suffered from water logging (soil tension < 5 kPa) at 20 cm.

Table 1. The nutrient level (mean \pm standard error) of Alpinia leaves sampled over two years at a property in the Darwin rural area

Element	Hawaiian recommendations	Sampled bottom leaf	Sampled spot leaf	Sampled top leaf
Nitrogen (%)	2	2.46 \pm 0.10	2.34 \pm 0.14	2.68 \pm 0.13
Phosphorus (%)	0.16	0.22 \pm 0.01	0.23 \pm 0.01	0.28 \pm 0.02
Potassium (%)	1.8	2.45 \pm 0.19	2.38 \pm 0.24	2.82 \pm 0.16
Calcium (%)	1.8	1.07 \pm 0.12	0.98 \pm 0.10	0.79 \pm 0.12
Magnesium (%)	0.40	0.52 \pm 0.03	0.46 \pm 0.05	0.43 \pm 0.02
Manganese (ppm)	450-700	326 \pm 68	177 \pm 35	224 \pm 34
Iron (ppm)	30-60	64.3 \pm 5.3	51.8 \pm 3.1	63.6 \pm 4.6
Copper (ppm)	10-15	7.89 \pm 0.45	7.33 \pm 0.49	7.8 \pm 0.37
Zinc (ppm)	40-90	28.1 \pm 3.1	28.3 \pm 5.6	33 \pm 3.1
Boron (ppm)	15-25	14.8 \pm 2.93	20 \pm 5.09	15.4 \pm 3.7

Leaves were sampled from the bottom and top of stems as well as those showing early symptoms of Alpinia leaf scorch. The nutrient levels recommended for Alpinias grown in Hawaii are shown for comparison.

Similar information is shown in Figure 2, which displays soil water tension and irrigation inputs for Alpinias grown without shade. The water input from rain is not shown, because over the study period, there was 1.5 kL of rain water per clump whereas irrigation input was 33.1 kL per clump. Even during peak rain weeks, the amount of irrigated water applied was over twice as much as the amount of rain (data not shown).

The effect of this high irrigation input can be seen in Figure 2 where the soil water tension at 20 cm only rarely rises above 15 kPa and never reaches 20 kPa. It can also be seen that the soil water tension only rises over 20 kPa very early in the 2001 wet season when water requirements are at their peak. This means that for almost the entire period studied, the amount of water entering the system was greater than the amount of water the soil could hold. In those conditions not only are the plant roots often waterlogged but any fertiliser applied would also be washed away from the roots.

Using the data available, it is difficult to determine an optimal level of irrigation. However, during the study period there was a period of early wet (September - November 2001) during which soil water tensions were highest. As soil water tensions during this period never rose above 30 kPa, it can be argued that irrigation inputs were not too low. The dramatic rises in soil water tension during this period occurred when daily irrigation fell below 80 L/clump. This suggests that no less than 80 L of water should be applied per day either as irrigation or rain.

The reduction in soil water tension occurred when irrigation exceeded 120 L/clump/ day. Often soil water tension at 40 cm was below 15 kPa, which is very wet for soil that is in the lower reaches of the

root system. This suggests that even at 120 L/day, too much water may be applied. However, it is not possible using this data to calculate more exactly what is the optimum upper level of irrigation.

Conclusion:

The analysis of nutrition and irrigation levels in this commercial Alpinia orchard suggests that the nutrient levels are partly not in imbalance and that the amount of water being applied is too high. It is recommended that growers apply micronutrients by foliar spray to keep all nutrients in balance. It is also recommended that mature Alpinia clumps be given between 80 and 120 L water/day. A final recommendation is that growers monitor soil water tension with tensiometers at 20 cm so that it is never over 15 kPa while tensiometers at 40 cm should read between 15 and 30 kPa.

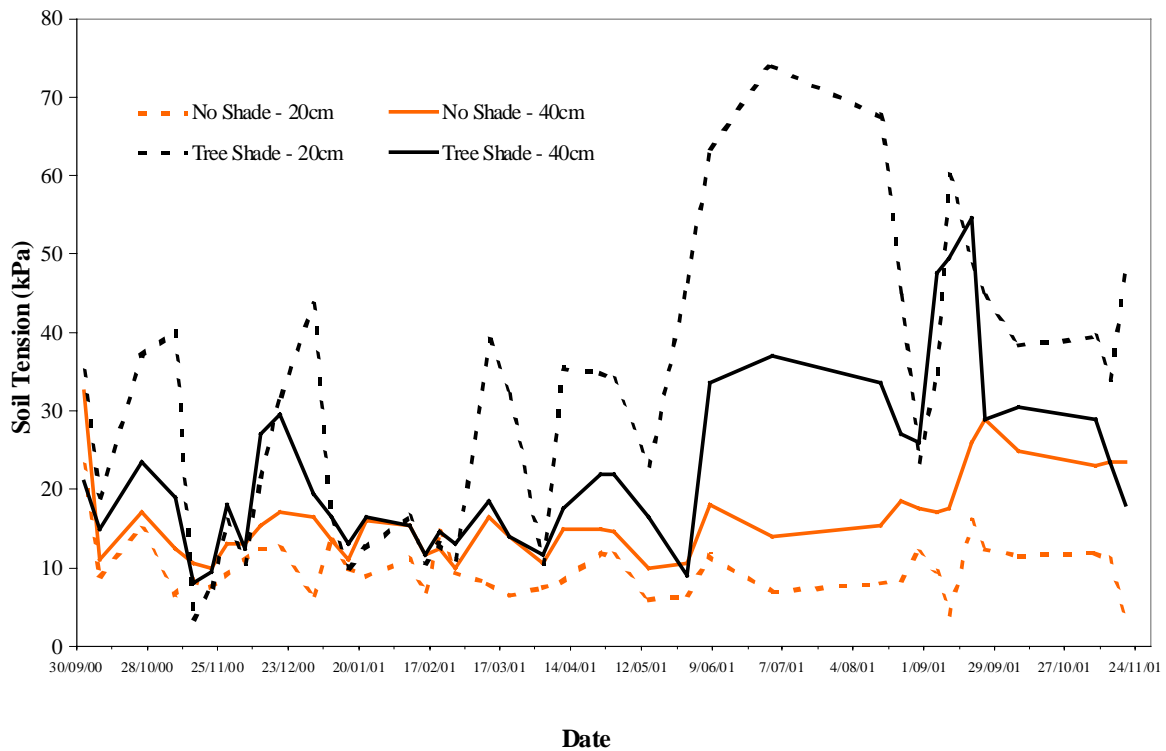


Figure 1. Soil Water tension at 20 and 40 cm for Alpinias grown with no shade or with tree shade

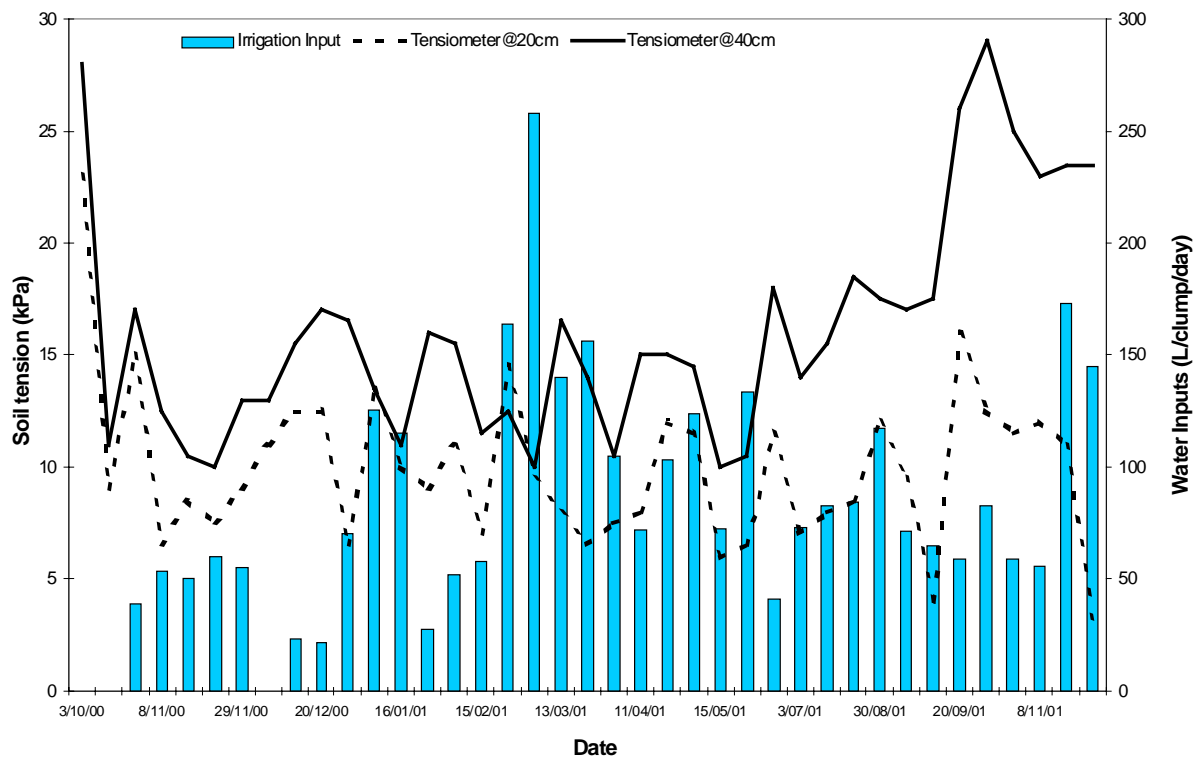


Figure 2. Soil water tension and irrigation inputs for Alpinias grown without shade