Propagation of Zingiberaceae and Heliconiaceae[1]

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Increased interest in tropical cut flower export in developing nations has increased the demand for clean planting stock. The most popular items have been various gingers (*Alpinia, Curcuma,* and *Heliconia*). This paper reviews seed and vegetative methods of propagation for each group. Auxins such as IBA and NAA enhanced root development on aerial offshoots of *Alpinia* at the rate 500 ppm while the cytokinin, PBA, enhanced basal shoot development at 100 ppm. Rhizomes of *Heliconia* survived treatment in 48º C hot water for periods up to 1 hour and 50º C up to 30 minutes in an experiment to determine their tolerance to temperatures for eradicating nematodes. Pseudostems soaks in 400 mg/LN-6-benzylaminopurine improved basal bud break on heliconia rhizomes.

GINGERS

A few genera set seed and do so readily (some *Alpinia* spp., *Etlingera, Hedychium*), but most are propagated by simple division of the rhizomes. Some species of *Alpinia* and *Globba* develop aerial offshoots in axils of floral bracts. These are not sprouting seedlings but vegetative growths will produce plants identical to the parent. A few lesser genera bear aerial bulbil-like structures in bract axils.

Seed

Self-incompatibility has been reported in *Costus* (WOOD, 1992), *Alpinia purpurata* (HIRANO, 1991), and *Zingiber zerumbet* (IKEDA & TANABE, 1989); while other gingers set seed readily.

The seeds of *Alpinia, Etlingera*, and *Hedychium* are borne in round or elongated capsules which split when the seeds are ripe and ready for dispersal. In some species a fleshy aril, bright orange or scarlet in color, covers the seed, perhaps to make it more attractive to birds. The seeds of gingers are black, about 3 mm in length with an oily, tough seed coat. They may be sown shallowly in a slightly acid, well-drained medium. The range of times for germination is variable, with 2-3 weeks suggested by some sources and up to 3 months by HIRANO (1991), but the gingers germinate readily compared to the heliconias.

Seedlings may be transplanted to larger pots as soon as they are large enough

[1] Palestra proferida no 1º Simpósio sobre Zingiberales Ornamentais, realizado de 3 a 8 de setembro de 1995, Campinas, SP.

to handle. They will tolerate full sunlight but require substantial irrigation to flourish.

Aerial Offshoots

Inflorescences of the common red ginger (*Alpinia purpurata*), the Tahitian ginger, and the pink 'Eileen MacDonald' produce aerial offshoots as they mature. The light pink 'Jungle Queen' and red 'Jungle King' and most of the new hybrids of the Ginoza series do not develop many of these aerial offshoots although a few have been observed on very old inflorescences. The weight of a developing inflorescence with offshoots causes it to bend to the ground as a natural tip layer.

Large aerial offshoots already have developed root initials and may be removed from the inflorescence and planted right away. It is better, perhaps, to allow root systems to develop by holding the offshoots in vermiculite under mist, or by starting them in peat pellets, or foam propagating blocks. Roots develop in 2-3 weeks time. Transplant these into 6" pots

Table 1. Rooting responses of aerial offshoots of *Alpinia purpurata* to 10 minute basal treatments with auxin solutions. Data at 3 weeks (1986) and 5 weeks (1987).

Auxin	Cocn (a.i. ppm)	Rooting Index[z] (± S.E.)	Rooting Percent
		1986	
IBA	0	3.0 ± 0.5	65
	100	3.4 ± 0.7	70
	500	3.6 ± 0.3	68
	1000	3.6 ± 0.5	90
	2000	3.1 ± 0.8	62
		1987	
Control		2.5 ± 0.6	51.5
IAA	100	3.2 ± 0.6	80.0
	500	3.3 ± 0.7	84.0
	1000	3.1 ± 0.6	69.0
IBA	100	3.7 ± 1.1	72.5
	500	3.7 ± 1.0	85.6
	1000	3.7 ± 0.8	85.9
NAA	100	3.6 ± 0.6	91.6
	500	3.9 ± 0.4	92.7
	1000	2.8 ± 0.8	81.1

[z] Rooting Index: 5 = heavily rooted, 4 = moderate root system, 3 = lightly rooted, 2 = alive/no roots, 1 = dead.

or 1 gallon containers in a well-drained medium; fertilize and water them until a larger root system has developed. The tuber-like aerial structures produced by various *Globba* species may be grown out in pots, peat pellets, or in sterile culture.

Recent propagation studies with different-sized aerial offshoots and three different root-promoting hormones showed that these aerial offshoots do respond to such substances (Table 1). The best concentration was 500 ppm of either naphthaleneacetic acid (NAA) or indolebutyric acid (IBA). The offshoot bases were soaked for 10 minutes in the solutions and placed in vermiculite under an intermittent mist system. Rooting was much faster with the hormones and the small and medium sized offshoots produced the best root systems (Table 2).

The foliage of rooted *Alpinia* offshoots was soaked in cytokinins which are known to promote shoot development. Our objective was to stimulate many basal shoots. N-(phenylmethyl)-9-(tetra-hydro-2H-pyran-2-yl)-9H-purin-6-amine (PBA, trademarked as ACCEL) was effective in stimulating more basal shoots when compared to the controls or to N-6-benzyladenine (BA) (Tables 2,3).

Division

Gingers (and heliconias) have a sympodial rhizome system. Usually, new branches develop at the base of an upright pseudostem. While rhizome segments will propagate, regeneration is slow if dormant pieces are used. Gingers such as the *Curcuma* require a storage pe-

Table 2 - Effects of *Alpinia* shoot size on responses to auxin and cytokinin treatments (1987).

Treatment	Size of Aerial Offshoot		
	<10cm	10 - 20 cm	>20 cm
	Rooting Index		
Control	2.7	2.9	1.8
IAA	3.3	3.2	3.1
IBA	4.0	3.6	3.4
NAA	3.2	3.4	3.0
	Rooting Percent		
Control	58.7	56.7	36.6
IAA	82.7	78.7	70.2
IBA	88.4	81.0	80.3
NAA	76.8	75.5	66.2
	Basal Shoot Number		
Control	0.9	1.8	1.9
N6-BA	1.1	1.7	1.7
PBA	1.7	2.5	2.6

riod before sprouting occurs. The preferred propagation unit for non-dormant gingers is a 6-12 cm portion of a rhizome with 20-30 cm of its associated pseudostem.

The rhizome piece is trimmed of rotted portions and dead roots and dusted with a 50% captan or 50% WP benlate dust. Observe the root systems closely for mealybugs. Dip affected ones in diazinon (0.4% of the 50% WP diazinon in water) or carbaryl (Sevin) at 0.1% in water if the insects are present. Insecticidal dips such as used for cut flowers may also be used. The rhizome pieces can be planted directly in the field or in containers or started in flats of moist vermiculite. New pseudostems develop from the base of the old one, and the new roots develop in association with them. Similarly, from rhizome pieces without a pseudostem, new shoots develop which root at their bases.

Tissue Culture

The edible ginger, *Zingiber officinale*, has been tissue-cultured (HOSOKI & SAGAWA, 1977), as have several *Curcuma* species used medicinally or as spices. The process may be useful to free plants from nematodes and other pathogens. Edible ginger growers have found that plants freed from disease via tissue culture grow faster and produce more rhizomes.

Alpinia purpurata has also been the subject of successful micropropagation efforts (CHANG & CRILEY, 1993; ILLG & FARIA, 1995). Explants were derived from axillary buds in the bracts of the inflorescence, and acceptable multiplication rates were achieved.

Cuttings

Some of the species of *Costus* and *Tapeinochilos* may be propagated by cuttings taken from terminal or lateral shoots. A rooting compound such as Hormodin #3 (0.3% IBA) is dusted on the base of a 15 to 20 cm cutting, and the cutting is inserted into a perlite or vermiculite medium and placed under intermittent mist. Rooting occurs in about 4 weeks time.

HELICONIA

Seed and division are the usual methods propagation of heliconia. Not all species set fruit, and the seedlings are variable (HIRANO, 1989), so clonal propagation by division is preferred. Growth habits range from tightly clumped to long-internoded, running rhizomes.

Table 3 - Mean basal shoot production of rooted *Alpinia purpurata* shoots to 10 minute foliar soks in cytokinin. Counts after 6 weeks (1986) and 8 weeks (1987).

Cytokinin	Concn (a.i. ppm)	No. basal shoots/plant 1986	1987
Control		1.7	1.3
N6-BA	100	1.9	1.4
PBA	100	2.4	2.1

Seed

KRESS (1987) reports that hand pollination should be carried out between dawn and mid-morning as that is when the stigmas are most receptive. Many heliconias are self-fertile and set seed when hand-pollinated. Interspecific crosses have been more difficult to achieve, but the occurrence of natural hybrids show that it is possible. A summary of some of the natural hybrids is given by KRESS (1990).

Two to 3 months are required for the berry-like fruits to mature. Mature fruits are bluish in color (red to yellow-orange in Pacific species) and contain 1 to 3 seeds with tough, stony seed coats. Seed size varies but many are about 6-10 mm long. In some species the pedicel subtending the fruit elongates to push it above the bract where it may be easily seen by fruit-eating birds. Seed should be removed from the fleshy fruits, surfaced-sterilized in 1% sodium hypochlorite for 2-5 minutes, and planted immediately, if possible. If not, store the seed in a plastic bag with a slightly moist medium such as sphagnum or peat moss or dampened fine charcoal (CARLE, 1989). There are some suggestions (KRESS & ROESEL, 1987; STILES, 1979) that the embryo is poorly developed at fruit maturity, and that the seed coat itself may not harden up finally until just before ripening. The combination of rudimentary embryo and hard seed coat often means a long dormant period. Scarification of the seed coat has not been particularly helpful in hastening germination. The seeds germinate sporadically over a long period, 3 months to 3 years (CARLE, 1989). Soaking seeds which have been cut in half in a solution of 2,3,5-triphenyl-2H-tetrazolium chloride will cause the embryo to stain bright pink. This color reaction is a sign that the embryo is alive and metabolically active and is used to test for seed viability.

The question of whether to sow freshly harvested seed or to hold it for a period of time has been addressed (KRESS & ROESEL, 1987), but the great variety of heliconia species makes it difficult to generalize that one way will be best for all (MONTGOMERY, 1986). It has been suggested (STILES, 1979) that embryo development and germination are timed so that germination can occur at the onset of the next rainy season in their native wet-dry tropics. For this reason a warm-moist stratification period may be helpful. Place the seed in moist vermiculite or milled sphagnum moss in a plastic bag; hold in shady warm conditions until germination activity is observed; and then transfer the germinating seeds to pots or flats.

Division

Segments of the fleshy rhizome with a 15 to 30 cm portion of the upright pseudostem are cut with a sharp knife. Remove damaged and dead roots and trim off old leaf bases and rotted portion of the rhizome. One recommendation (SEWAKE & UCHIDA, 1995) is to dip the cleaned rhizome in a 1:4 to 1:9 solution of household bleach (*sodium hypochlorite*) for one minute before planting into a clean medium. Where rot organisms are a problem, dust the rhizome with 50% WP captan and place in moist perlite or vermiculite. While the pseudostem itself will die, roots will grow from its base and new pseudostems will develop from buds at the base. Root development takes about 4 weeks and activation of the bud 4 to 6 weeks. Application of cytokinin to the pseudostem improved lateral bud production (Table 4).

All major types of nematodes (burrowing, root-knot, lesion, reniform, and spiral)

have been recovered from heliconia root systems. Field-grown rhizomes may carry nematodes and should be treated to minimize this problem. Hot water treatments have been successful for banana (TRUJILLO, 1964; WARNER, 1972) and tuberose (RHOADES, 1966). After trimming of the roots, pseudostem bases (4-5 cm diameter) of *Heliconia stricta* (Waimea Arboretum Acc. No. 78p260) were soaked in hot water (48, 50, 53 or 56° C) for durations up to 1 hour, then cooled, dusted with 50% WP captan, and planted in vermiculite. After 8 weeks good survival was evident at 48° C at all durations and with 50% survival at 50° C up to 30 minutes (Table 5).

Treatment at 48° C should be sufficient to kill nematodes (Rhodes, 1966). A British Ministry of Agriculture bulletin (1972) suggests that the hot water should be in the range of 50° to 55° C, but these temperatures and longer durations of exposure killed small rhizome pieces. Addition of a surface sterilant such as commercial bleach (5% a.i.) (1 part bleach to 9 parts water and soak for 10-15 minutes) or formaldehyde (37% a.i.) (1 part formaldehyde to 99 parts water) would also reduce microorganism contamination. The duration of exposure would have to be determined by trial and error, but 15 to 30 minutes should be adequate for small sized rhizome pieces. After the hot water treatment, cold water rinse, and fungicide dust, the plant material should be handled to prevent re-contamination. Do not replace in old contaminated bags. Plant the treated pieces in a sterile propagation medium or hold them in a plastic bag until root development is obvious and then transfer them to pots for 3-4 months to become established. Field soils should be fumigated before clean planting stock is transplanted.

Tissue Culture

At the first meeting (1985) of the Heliconia Society International, John L.

Table 4. Budbreak response of *Heliconia chartacea* rhizomes to soaks and injections of cytokinins.

Technique	Cytokinin	Concn	% Mortality	No. Breaks per pseudostem
		mg/l		
Rhizome soak	none		0	1.5
	BA	400	40	1.2
Pseudostem soak	none		0	1.8
	BA	400	20	2.8
Injection (1 ml)	none		16	1.8
	BA	200	25	2.3
	PBA	200	40	2.0
	TDZ	200	60	1.0

Cytokinins: BA N-6-benzylaminopurine
PBA N-(phenylmethyl)-9-(tetrahydro-2H-pyran-2-yl)-9H-purin-6-amine
TDZ N-phenyl-N'-1,2,3-thiadiazol-5-ylurea

Table 5 - Survival, root, and shoot production of rhizomes of *Heliconia stricta* (Waimea Arb. Acc. # 78p260) 2 months after hot water treatments

Temperature	C	Duration of exposure (min.) 0	15	30	45	60
			% Survival			
Control		100				
	48		100	75	100	25
	50		50	50	0	0
	53		0	0	0	0
	56		0	0	0	0
			Avg. Root number/rhizome			
Control		8.2				
	48		6.0	7.2	7.2	1.6
	50		2.2	2.0	0	0
	53		0	0	0	0
	56		0	0	0	0
			Shoot number/rhizome			
Control		1.2				
	48		1.7	1.2	1.2	0
	50		0.7	0.7	0	0
	53		0	0	0	0
	56		0	0	0	0

Griffis of Oglesby Plant Labs (Hollywood, FL 33023) reported establishment of successful tissue cultures of 'Andromeda' and 'Golden Torch' from meristems. They developed their procedures in house and did not publish the details. Recently, procedures for commercial scale multiplication of *H. psittacorum* have been published (NATHAN et al., 1992, 1993) using bud and rhizome tissue.

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