Table 2. Effect of auxin source and concn on root initiation of *Cryptanthus bivittatus minor*.

Compound	Concn mg/l			
	0.0	0.1	1.0	10.0
IAA	1.7[z]	2.1	2.0	2.7
IBA	2.6	1.6	2.2	3.0
NAA	2.7	2.5	6.7	3.0

[z]Average number roots per plantlet.

indole-3-acetic acid (IAA) and α-napthaleneacetic acid (NAA) were incorporated into a minimal organics agar medium (4). Data were collected at 4 and 6 week intervals (Table 2).

Results and Discussion

Preliminary experimental work comparing establishment of explants in a rotating versus stationary liquid medium showed that rotation was necessary for survival and growth. At no stage of growth could the explants be submerged. The addition of citric acid to the medium and disinfecting soln resulted in increased growth in a shorter period of time. Average loss of the initial explant was 18%. Results indicated that by placing the plant to be used as a source of explants in a dry, air conditioned room the percentage loss in Stage I was decreased. The loss in Stage I varied from crop to crop and could be attributed to the vigor of the mother plant or possibly to daylength.

The successful production of this plant in culture necessitated the establishment of a callus piece in a multiplication medium (Table 1) to produce shoots. At 4 week intervals, shoots 7-8 mm and larger were harvested. As callus pieces grew, more medium was put into each culture vessel up to a maximum of 20 ml liquid. With each subculture the number of shoots produced increased markedly. Some of the cultures showed an unidentified bacterial contaminate. Knauss (3) reported several organisms associated with plants grown *in vitro* resulted in reduced vigor, color and in some cases death of tissue. A definite difference was noted in production between contaminated and apparently clean cultures. Apparently clean cultures yielded 36.0 plantlets while obviously contaminated produced only 14.6 plantlets. In a period of 9 months, 10,000 plantlets were produced from 1 mother plant with 25 buds. Normal production by asexual means under greenhouse conditions is 6-9 plantlets per year from an established stock plant. Callus pieces were kept in culture through 10 subcultures with a very low frequency of mutation. Plantlets were almost entirely green at this stage and the rooting stage. NAA had the greatest effect on root initiation with an average of 6.7 roots per plantlet (Table 2). Jones and Murashige (2) found that IAA promoted the best root formation of the various bromeliads they examined.

Plantlets taken from State III to be planted into beds or flats were ready for transplant in 4 months. The loss in this phase of growth was less than 1%. At the higher light intensities in the growing areas the *Cryptanthus* quickly resumed its normal pink-brown coloration.

This study demonstrated that the growth of *Cryptanthus bivittatus minor* by plant tissue culture methods is economically feasible with the production of over 60,000 plants within 10 months. The need to establish clean cultures was evident from the difference in production between clean and contaminated cultures. Root formation was directly related to auxin source and concn.

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EFFECT OF SUCROSE LEVEL, MEDIUM COMPOSITION AND pH ON THE IN VITRO GERMINATION OF POLLEN FROM SPATHIPHYLLUM FLORIBUNDUM (LINDEN & ANDRE) N. E. BR. MAUNA LOA AND VRIESEA MALZINEI E. MORR.[1,2]

R. J. HENNY
IFAS Agricultural Research Center, University of Florida, Apopka, FL 32703

Additional index words. Calcium, boron, nutrition.

Abstract. **Attempts were made to germinate pollen from** Spathiphyllum floribundum **(Linden & Andre) N.E. Br. cv. Mauna Loa and** Vriesea Malzinei **E. Morr. in various artificial media. Optimum germination of** Spathiphyllum **pollen occurred in a nutrient medium with sucrose levels of 5 or 10% while** Vriesea **pollen germinated well at levels from 5 to 30%. The addition of boron or calcium to the germination medium was essential for germination of** Vriesea **pollen. Germination of** Spathiphyllum **pollen was also increased by the addition of boron and calcium but not to the extent of** Vriesea **pollen.** Spathiphyllum **pollen germinated satisfactorily only when the medium pH was between 4.0 and 7.0, whereas good germination of** Vriesea **occurred in the pH range of 4.0 to 8.0.**

Pollen germination *in vitro* has been studied in many horticultural crops (4, 5, 7, 8). The ability to germinate pollen *in vitro* is important to plant breeding programs where it is often necessary to determine pollen viability after long periods in storage. *In vitro* germination and tube

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growth is one method of testing pollen viability which is often more reliable than the use of stains alone (6). The sensitivity of a pollen to artificial environments must be determined so an accurate and consistent indication of viability can be obtained. This study tested several factors and how they affected the germination of *Spathiphyllum floribundum* 'Mauna Loa' and *Vriesea Malzinei* pollen *in vitro*.

Materials and Methods

Pollen was collected from flowers on the day of anthesis from plants grown in a greenhouse at a local nursery near Orlando, Florida. Germination media were prepared in distilled water and pH was adjusted with 1N HCl or 1N KOH. Pollen was germinated the same day as collected, in single drops of medium placed on microscope slides containing two 0.72 inch (18 mm) wide x 0.02 inch (0.5 mm) deep wells. Each well constituted 1 replication and a total of 100 grains in each of 4 replications/treatment were counted in a field under a light microscope at 65 or 100X. Slides were incubated on moist filter paper in 6.0 inch (150 mm) x 0.6 inch (15 mm) plastic petri dishes for 18-24 hr at 73°F ± 2° (23°C) in an air-conditioned lab. Pollen grains which produced a tube equal to its own diameter were counted as germinated. In addition to simple sucrose solutions, *Spathiphyllum* and *Vriesea* pollen was placed in a previously reported medium for pollen germination (3), referred to as the basic medium throughout this paper. In separate experiments, requirements for germination were determined by altering the composition, pH and sucrose levels of that basic medium.

Results and Discussion

Sucrose alone was not sufficient for optimum germination of *Vriesea* or *Spathiphyllum* pollen. *Vriesea* pollen germinated poorly or not at all while *Spathiphyllum* pollen germinated somewhat better but always significantly less than in the basic medium (Table 1). Best germination of *Spathiphyllum* (47.5%) was at 20% sucrose and *Vriesea* (21.8%) was at 30% sucrose compared to 80.0 and 85.0% for the basic medium respectively (Table 1). Some researchers have concluded that sucrose only controls the osmotic pressure and does not supply nutrients for pollen tube growth (8). Other work showed a positive correlation between sugar concn and percent germination and indicated a nutritional effect (7). Both *Spathiphyllum* and *Vriesea* pollen require other factors in addition to sugar for optimum germination.

In the basic medium, *Spathiphyllum* pollen at 5.0 or 10.0% sucrose germinated significantly better than at 0.0, 20.0 or 30.0% (Table 2). Tubes grown in media without sucrose appeared thin compared to those at 5.0 or 10.0% sucrose whereas at 20.0 and 30.0% sucrose the tubes were very short, thickened and often swollen at the tips. *Vriesea* pollen was less responsive to sucrose levels in the basic medium as there was no significant difference in germination at the 5.0% level or above (Table 2). The 10.0% sucrose level was selected for all future studies.

Table 1. Percent germination of *Spathiphyllum* and *Vriesea* pollen as affected by various sucrose levels[z,y].

Sucrose Level (%)	Pollen Source	
	Spathiphyllum	*Vriesea*
0	7.5 a	0.0 a
5	19.2 b	0.5 a
10	37.8 c	0.0 a
20	47.5 d	0.0 a
30	4.0 a	21.8 b
Control[x]	80.0 e	85.0 c

[z]Sucrose solutions in distilled water.
[y]Mean separation within columns by Duncan's multiple range test, 5% level.
[x]Basic medium consisting of 100 ppm H_3BO_3, 300 ppm $Ca(NO_3)_2 \cdot 4H_2O$, 200 ppm $MgSO_4 \cdot 7H_2O$ and 100 ppm KNO_3 in 10% sucrose.

Table 2. Percent germination of *Spathiphyllum* and *Vriesea* pollen as affected by the sucrose level of the basic medium[z,y].

Sucrose Level (%)	Pollen Source	
	Spathiphyllum	*Vriesea*
0	42.2 ab	32.0 a
5	70.5 c	79.5 b
10	72.2 c	84.2 b
20	50.2 b	81.0 b
30	36.8 a	86.2 b

[z]Each medium contained 100 ppm H_3BO_3, 300 ppm $Ca(NO_3)_2 \cdot 4H_2O$, 200 ppm $MgSO_4 \cdot 7H_2O$ and 100 ppm KNO_3.
[y]Mean separation within a column by Duncan's multiple range test, 5% level.

Germination of *Vriesea* pollen in 10.0% sucrose containing either 300 ppm calcium or 100 ppm boron was not significantly different from the basic medium (Table 3). Sucrose alone or sucrose plus 200 ppm magnesium or 100 ppm potassium, however, did not significantly increase germination above that in distilled water. Apparently, calcium and boron are essential for optimum germination of *Vriesea* pollen. Similar results have been reported with several other types of pollen (1, 3, 8).

Table 3. Percent germination of *Spathiphyllum* and *Vriesea* pollen as affected by individual components of the basic medium[z].

Medium Components					Pollen Source	
10% Sucrose	100 ppm H_3BO_3	300 ppm $Ca(NO_3)\cdot 4H_2O$	200 ppm $MgSO_4\cdot 7H_2O$	100 ppm KNO_3	*Vriesea*	*Spathiphyllum*
+[y]	+	+	+	+	92.2 b	78.8 d
−[x]	−	−	−	−	23.0 a	41.5 a
+	−	−	−	−	0.8 a	53.0 b
+	+	−	−	−	71.8 b	59.8 c
+	−	+	−	−	88.0 b	61.8 c
+	−	−	+	−	0.0 a	50.5 b
+	−	−	−	+	0.0 a	53.5 b

[z]Mean separation within columns according to Duncan's multiple range test, 5% level.
[y]Complete basic medium.
[x]Distilled water.

Spathiphyllum pollen germinated significantly better in the basic medium than in other treatments (Table 3). However, the addition of calcium and boron significantly increased germination compared to media with only 10.0% sucrose, or 10.0% sucrose plus 200 ppm magnesium or 100 ppm potassium. Germination in distilled water was significantly less than all the above treatments. Calcium and boron were the most important cations for germination of *Spathiphyllum* pollen though magnesium and potassium in the basic medium apparently helped germination.

The pH of the cultural medium has been shown to affect pollen germination of several plant species (2, 5). There was no significant difference in germination of *Spathiphyllum* pollen within the pH range of 5.0-7.0 (Table 4), whereas *Vriesea* pollen germinated equally well from pH 4.0-8.0. Germination of *Spathiphyllum* pollen was drastically reduced at pH 3.0, 8.0 and 9.0, while *Vriesea* barely germinated at pH 3.0 or 9.0. Previous work with several species (3) indicated the optimal pH for pollen growth was rather narrow with best results generally at pH 7.3 or 8.3 and poorest results at pH 5.3. *Spathiphyllum* pollen was tolerant of an acid medium but not basic. In contrast, *Vriesea* pollen was adaptable to a relatively wide range of pH.

Table 4. Effect of pH on percent germination of *Spathiphyllum* and *Vriesea* pollen in the basic medium[z,y].

Medium pH	Pollen Source	
	Spathiphyllum	*Vriesea*
3.0	6.2 a	6.5 a
4.0	77.2 b	94.5 b
5.0	88.0 c	95.0 b
6.0	83.0 bc	97.2 b
7.0	88.2 c	95.2 b
8.0	1.2 a	92.8 b
9.0	2.0 a	11.2 a

[z]Medium consisted of 10% sucrose, 100 ppm H_3BO_3, 300 ppm $Ca(NO_3)_2 \cdot 4H_2O$, 200 ppm $MgSo_4 \cdot 2H_2O$ and 100 ppm KNO_3.

[y]Mean separation within a column by Duncan's multiple range test, 5% level.

Results indicated that pollen from *Spathiphyllum floribundum* cv. Mauna Loa and *Vriesea Malzinei* can be germinated successfully *in vitro*. The method described in this paper can be used as an accurate indicator of pollen viability at harvest or following periods of storage. Both types of pollen are currently being used in storage studies.

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AN INITIAL EVALUATION OF DRIP IRRIGATION ON WOODY ORNAMENTALS IN CONTAINERS[1]

D. M. WEATHERSPOON
IFAS Agricultural Research Center, Rt. 3, Box 213B, Monticello, FL 32344

Abstract. **Drip irrigation systems were compared with a sprinkler system on 4 species of woody ornamentals growing in 1-gal (ca. 3.8 liter) containers. Data included plant growth indexes, visual ratings of roots, quantities of water applied and runoff, and variation within each system in quantity of water delivered to individual plant containers. Little difference in plant growth resulted. Drip irrigation reduced water applied and runoff 75 and 90%, respectively. A problem in improving efficiency of drip systems is variation in output from one emitter to another within a system.**

Rapidly increasing demands on water supplies of south and central Florida and other areas are requiring consideration of alternatives to sprinkler irrigation. Drip systems should be considered in establishment and expansion of nurseries. Florida has approximately 15,000 acres[2] in woody ornamental production with over 90% devoted to container plants. An increase to 25,000 acres by 1985 is projected (3). Harrison (2) and Furuta (1) have found container nurseries applying between 56 and 120 inches of water per year. Assuming 1 inch of water equals 27,000 gal per acre, from 1,512,000 to 3,240,000 gal per acre are applied per year with sprinkler irrigation. Assuming 13,500 acres are in container production and sprinkler irrigated, 20 to 40 billion gal of water are applied per year in Florida container nurseries. A 50 to 75% reduction would be highly desirable, if accomplished without excessive increase in production cost. Therefore, objectives of this research were to determine: (1) Feasibility of using drip irrigation in container nurseries; (2) Quantity of water required; and (3) Quantity of waste water runoff.

Materials and Methods

In 1975 Chapin Leader Tubes, Micro-drippers, and Twin-wall hose; DuPont Viaflo tubing; and Rain Bird sprinklers were installed. Each system with 3 replications was placed on separate slightly sloping nursery beds. Each replication consisted of a 100 sq ft bed enclosed within a 4-inch high frame. A collecting apron channeled runoff from each bed into a basin. Frame, bed, and apron were lined and covered with 6 ml black polyethylene ground-

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[2]For metric conversions see Table near the front of this Volume. Ed.