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HORT 5051

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Scadoxus nutans

Taxonomy:

Scadoxus nutans is a tropical epiphyte endemic to southwestern Ethiopia. The species is currently placed under the order Asparagales and within the family Amaryllidaceae. This group of plants was formerly placed under the genus *Haemanthus* (Blood Lily), however the genus *Scadoxus* was created to represent this more distinct group of plants[2]. Currently, the genus *Scadoxus* comprises nine species indigenous to Africa.

Geographic Distribution:

Scadoxus nutans is found only in Ethiopia, specifically in the regions of Kefa and Illubabor[3]. The species can be found between 5° and 8° north latitude at elevations between 1000 and 2300 meters. *S. nutans* has not been introduced to any other locations or environments except for specimens located in botanical gardens or personal collections.

Native Habitat:

As an epiphyte, *Scadoxus nutans* is frequently found growing on trees although reports exist of the plant growing on the ground, often on old decayed trunks or rocks[3]. *S. nutans* is not host specific, having been observed on many tree species of the southwestern Ethiopian highlands (*Elaeodendron buchananii, Sapium ellipticum, Schefflera abyssinica*, and *Ilex mitis*). At these elevations in Kefa and Illubabor daily highs range from 16° to 30°C, with the highest temperatures occurring in March, April, and May[4]. These warm months precede the rainy

season, which begins in June and lasts until September[4]. *S. nutans* flowers during the dry season in its native habitat, setting fruit that presumably ripens at the beginning of the wet season begins in the following year. The species is likely under threat from deforestation occurring within its small native range[2].

Taxonomic Description:

Scadoxus nutans is predominately found growing as an epiphyte on the aforementioned tree species, although it has been found growing on rocks at ground level. The species is described as an evergreen herb of variable total height (30-100 centimeters) with lanceolate leaves of 20-40 centimeters in length and 8 centimeters in diameter[3]. As a monocot, *S. nutans* leaves possess a parallel veintation pattern with a wavy leaf margin. Leaves form a pseudostem that is slightly swollen at the base in addition to possessing a distinct pattern of red dots. The inflorescence is classified as a nodding umbel 10-20 centimeters tall and composed of 20-30 individual scarlet to orange-red flowers[3]. The fruit, equally showy, is a deep red berry approximately 15 millimeters in length that encloses 1-3 thinly walled seeds with an opaque seed coat[3]. The fruit of *S. nutans* takes one year to mature. Roots are translucent when young and do not possess root hairs, overall the root system can be described as fibrous.

Name and Description of Varieties/Cultivars on the Market:

There are currently no named cultivated varieties in existence: specimens derived from wild collected seed or plant material in botanical or personal collections represent the extent of *Scadoxus nutans* cultivation.

Propagation Methods

From Seed:

No official information exists for a *Scadoxus nutans* germination protocol. The goal of this part of the research was to collect information on germination rates on different media for the purpose of devising a production schedule for seed-grown *S. nutans*. On February 11th, 2013 six *S. nutans* seeds were received in a packet containing ample moisture. Due to the thin seedcoats, S. nutans seed is not viable for long periods and must be sown soon after harvest from the plant. Vivipary is also a common trait within the genus *Scadoxus*, where the seeds begin to germinate before abscission from the fruiting umbel[3].

Three different media were used to test the speed and effectiveness of *S. nutans* germination. Media 1 was composed of rockwool, Media 2 a mix of bark, coir, perilite and sand, with Media 3 being the commercially available germination mixture Berger BM2 (Figure S2). Seedlings were germinated beginning on February 13th, 2013 in a greenhouse at the University of Minnesota in St. Paul, Minnesota. The greenhouse temperature was maintained at a constant 21°C at all times with a 16 hour photoperiod at a light intensity of 150 μmol. A misting system that sprayed the bench every 10 minutes was used to keep the seed moist at all times.

As a whole, germination of *S. nutans* seed occurred in a range of 1-3 weeks from the date of sowing (Figure 1). The seed grown on Media 1 (rockwool) had the most expedited germination and development, with germination of one seed occurring in a week and true leaves appearing by week 3. One of the seeds germinated on the rockwool media was determined not to be viable upon sowing, for it lacked a healthy green embryo similar to the one present in the other five seeds. Those seedlings germinated on Media 3 were the slowest to grow and develop, with those germinated on Media 2 falling in between these two extremes.

Figure 1.
***S. nutans* Germination Log**
Sown on 13-Feb 2013

	Date				
Media Type	**18-Feb**	**25-Feb**	**11-Mar**	**25-Mar**	**Germination %**
1 (2 seeds)	Newly Emerged Radicle (1 seed)		First true leaf (1 seed)		50
2 (2 seeds)	No Germination	Newly Emerged Radicle (1 seed)	Newly Emerged Radicle (1 seed)	First True Leaf (2 seeds)	100
3 (2 seeds)	No Germination	Newly Emerged Radicle (1 seed)	Newly Emerged Radicle (1 seed)	First True Leaf (1 seed)	100

On March 25th, 2013 when five of the six seeds had germinated, the true leaves became chlorotic presumably from a lack of nutrients. Seedlings were then placed on capillary mats in a cooler greenhouse (18.3°C constant temperature, 16 hour photoperiod) and received a constant calcium nitrate liquid fertilizer supplied from the mat (50 ppm). While leaves appeared less chlorotic after two weeks, the low humidity and cooler temperatures had a major impact on the growth and development of the seedlings. On April 15th, 2013 seedlings were potted into 4 inch pots containing a bark/rice hull mix, fertilized with 15-15-15 Osmocote slow release fertilizer and placed back into the mist house. The second true leaf was observed on plants growing in Medias 1 and 3 on May 3rd, 2013.

In-vitro Propagation:

Due to the limited number of seed available as well as the limited time that *Scadoxus nutans* seed is viable, tissue culture was explored as a potential way to more quickly reproduce the species on a commercial level. As a commercial production method, the tissue culture industry began in the United States during the 1970s with the goal of vegetatively producing

orchids on a large scale[1]. Due to the epiphyte and monocot habits of *S. nutans*, a modified orchid tissue culture protocol was followed.

On March 30th, 2013 leaf tissue from *S. nutans* seedlings was harvested for use as tissue culture explant material. Leaf tip sections (approx 1 centimeter in length) were removed from true leaves on the seedling material. To remove pathogens from the greenhouse grown material, leaf tissue was sterilized in a 5% Clorox bleach, 0.1% polysorbate-20 solution for 1 minute followed by three rinses in distilled water for 1 minute each. The tissue culture media used for the experiment was based off of the P6793 Phytamax Orchid Multiplication Media from Sigma-Aldrich, supplemented with 8.8 μmol (2 mg/L) of benzyladenine, a cytokinin used to promote cell division and shoot differentiation (Figure S3). Cultures were lighted with fluorescent lighting under a 24 hour photoperiod at 23°C. Leaf explants were either placed perpendicular (base implanted within media) or parallel (leaf surface implanted within media) to the surface of the petri dish. By April 20th, 2013 all four explants that had been oriented perpendicularly in culture had tissue that was brown and dying; where the two explants that were orientated parallel to the media remained green. The explants that were orientated parallel to the media were harvested for evidence of cell division and shoot differentiation under a microscope. Only one of the six explants was contaminated.

No visible shoot differentiation was detected by unaided visual observation on April 24th, 2013. Material from one stable, healthy explant was analyzed under a microscope for differences in cell structure compared with greenhouse grown leaf material. Cuticle cells on the tissue-cultured material were observed to lack the organization of those on the greenhouse grown material. Additionally, the leaf cells on the tissue culture material appeared to have undergone more division than those on the greenhouse grown material, evidenced by the shorter and more

numerous cells within a given area under the same magnification (Figure S4). This could be indicate the begins of callus formation, however the duration of the tissue culture experiments was not long enough to produce a definitive conclusion.

Product Specifications:

With vivdly-colored large, scarlet flowers, *Scadoxus nutans* would make for a highly desirable container plant for indoor or outdoor use where the climate is favorable enough.

Market Niche:

Collectors of rare African plants, amaryllis enthusiasts, and orchid collectors would be all be potential purchasers *of Scadoxus nutans*. With showy, scarlet flowers and a flowering time between November and February, the plant has potential for use as a flowering holiday plant similar to others in the family Amaryllidaceae. Tissue culturing of *S. nutans* would enable vegetative production year round and also likely lower the amount of time to generate a mature plant capable of flowering. *S. nutans* could be marketed as a rare or unique plant, but care must be taken by growers not to exploit the plant in its limited native habitat. Due to the current length producing mature flowering plants, this crop will not be a major crop at first: mostly it will find success among enthusiasts and collectors. *S. nutans* potential as a bedding plant in tropical climates has not been explored, although its need for light soil will be a limiting factor in this aspect of its cultivation. Nonetheless, the plant will make a great conversation piece as a container specimen for its unusual growth habit, speckled leaf bases, and scarlet flowers.

Anticipated Cultural Requirements:

Scadoxus nutans is not anticipated to be frost tolerant as it is never exposed to subfreezing temperatures in its native habitat. A conservative hardiness estimate is therefore placed at 1.6°C, or USDA hardiness zone 10b. Heat tolerance will likely be moderate, although

high humidity will likely suit *S. nutans* cultivation the best. Soil should be fertile, porous and high in organic matter. A slow release fertilizer such as Osmocote 15-15-15 is beneficial for maintaining a vigorous plant, although it is unknown how soil fertility affects flowering in *S. nutans*. Indoor culture requirements should be similar to many Orchid species, with high humidity and moderate temperatures being essential for success. Temperatures during the winter fo *S. nutans* should be maintained around 19° or 20°C with decreased humidity to mimic the natural dry period during this time. Watering and ambient humidity should be increased as temperatures warm in the spring and summer to promote vigorous growth.

From this study plant growth regulators are not necessary in traditional production, however cytokinins and auxins will be crucial in tissue culture production: more research is needed to determine optimal rooting and shoot differentiation media. In growing from seed, 128 plug trays filled with rockwool should be used because of the rockwool's ability to retain moisture while allowing for proper air circulation, much like the moss or bark *S. nutans* seeds would germinate on in the native habitat. While the diseases of *S. nutans* have not been studied, heavy soil will likely cause the dampening off of seedlings. Insect and fungal problems will likely be similar to those on Orchids or Amaryllis.

Production Schedule:

After harvesting, seed must be kept moist. Sowing should occur soon (1-2 weeks) after harvesting in February in a mist house using the methods described approximately during week 7 in the growing calendar. Seed will have germinated by week 10 if it is viable and possess the first, mature true leaves by week 13. At this point the seedlings should be transplanted into a 4 inch pot with a bark based potting mixture supplemented with a slow release fertilizer. Ambient temperatures and humidity should remain high to mimic the wet season that *Scadoxus nutans*

would experience during this stage of growth. At a date 4 to 5 years from sowing, the plant will be mature enough to flower[2,3].

Because of the 4 to 5 year juvenile period, production of *S. nutans* from seed will not likely be economically viable for the average grower. *In-vitro* germination of seed to create stock explant material would be beneficial in aiding the vegetative propagation of this species through tissue culture. Vegetative production should also shorten the juvenile period, allowing for the expedited production of flowering plants for sale.

Needs for Genetic Improvement:

Breeding for plants with shorter leaves would be beneficial, as the foliage tends to hide the aesthetic flowers. There seems to be natural variation in this trait given the range of leaf dimensions observed within the species.

Supplemental Figures

Figure S1
S. nutans Seedling Dimensions
Date Observed: 3/30/2013

Media Type	Plant #	Height (cm)	Width (cm)
1	1	4.2	1.3
2	1	2.5	1.1
	2	3.6	1.1
3	1	2.5	0.7
	2	1	0.1

Figure S2
S. nutans Media Types

Media 1	Rockwool
Media 2	20% Coir, 20% Sand, 20% Perlite, 40% Bark/Rice Hull mix
Media 3	Berger BM2 Germination Mix

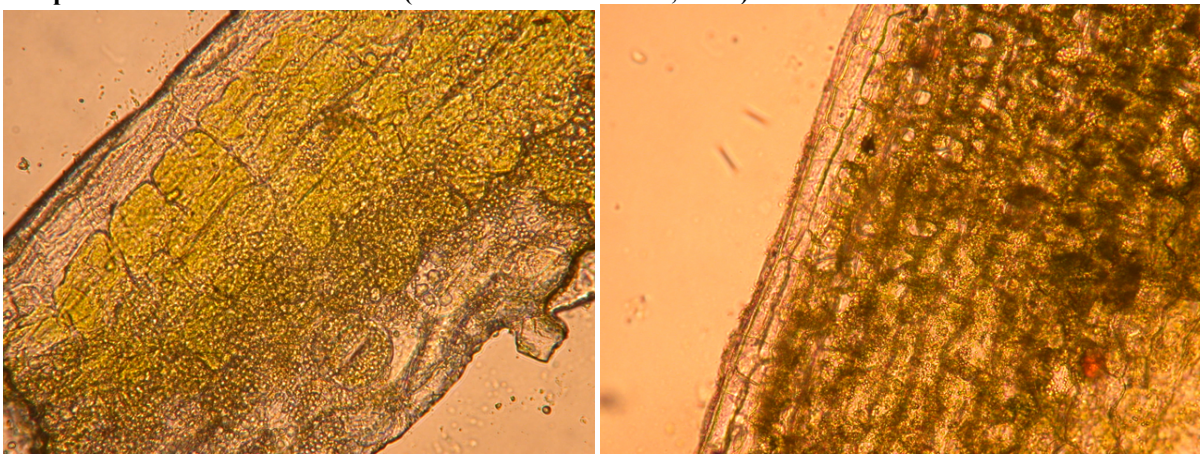
Figure S3

Sigma-Aldrich P6793 Media

Component	**Mass (mg/L)**
Ammonium nitrate	825
Boric acid	3.1
Calcium chloride anhydrous	166
Calcium nitrate	0.0125
Calcium phosphate tribasic	0.0125
Cobalt chloride • 6H2O	37.24
Ferric sulfate	27.85
Ferric tartrate • 2H2O	90.35
Magnesium sulfate	8.45
Manganese sulfate • H2O	0.125
Molybdenum trioxide	0.415
Molybdic acid (sodium salt) • 2H2O	950
Nickel chloride • 6H2O	85
Potassium sulfate	5.3
Organics (mg/L)	
6-Benzylaminopurine (BA)	2
Dimethylallylaminopurine	1000
Glycine (free base)	100
Indole-3-acetic acid	0.5
Indole-3-butyric acid	0.5
Kinetin	2000
MES (free acid)	0.5
myo-Inositol	20,000
alpha-Naphthaleneacetic acid	1

Figure S4

Comparison of *S. nutans* leaf tissue (Lens: Neofluar 16/0.40, 160/-)



Tissue Cultured
Less differentiated cuticle

Greenhouse Grown
More distinct cuticle cell

References:

[1]Govil, S., & Gupta, S. C. (1997). Commercialization of plant tissue culture in India. *Plant Cell, Tissue and Organ Culture*, *51*(1), 65-73.

[2]Hutchinson, J. (2007). Glorious Scadoxus. Extract from Devon Group NCCPG Newsletter. 4-9.

[3]Hutchinson, J., & Wondafrash, M. (2011). 699. SCADOXUS NUTANS. *Curtis's Botanical Magazine*, *28*(1), 23-31.

[4]Ofcansky, P., & Berry, L (1991). Ethiopia: A Country Study. Washington: GPO for the Library of Congress. http://countrystudies.us/ethiopia/41.htm