Building a Greenhouse from the Ground Up

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Sacramento Orchid Society
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So, Who am I?

- UC Davis Professor of Engineering
- 33 Years on Faculty
- Teach Electronic Materials
- Research in Light Sources
- Married, six kids
- Live on 10 acres between Davis and Winters
- NOT an orchid expert!

25 Years living in “The Three Palms”

This is all very nice and Interesting, But …

WHY IS THIS GUY
TALKING AT
OUR ORCHID-SOCIETY
MEETING ???

Six Years Ago
I Got “Promoted”

Complete with a new office:
A Room With A View!

… and four bare walls with a used Steelcase desk

TGFTJ: Thank Goodness for Trader Joe's!

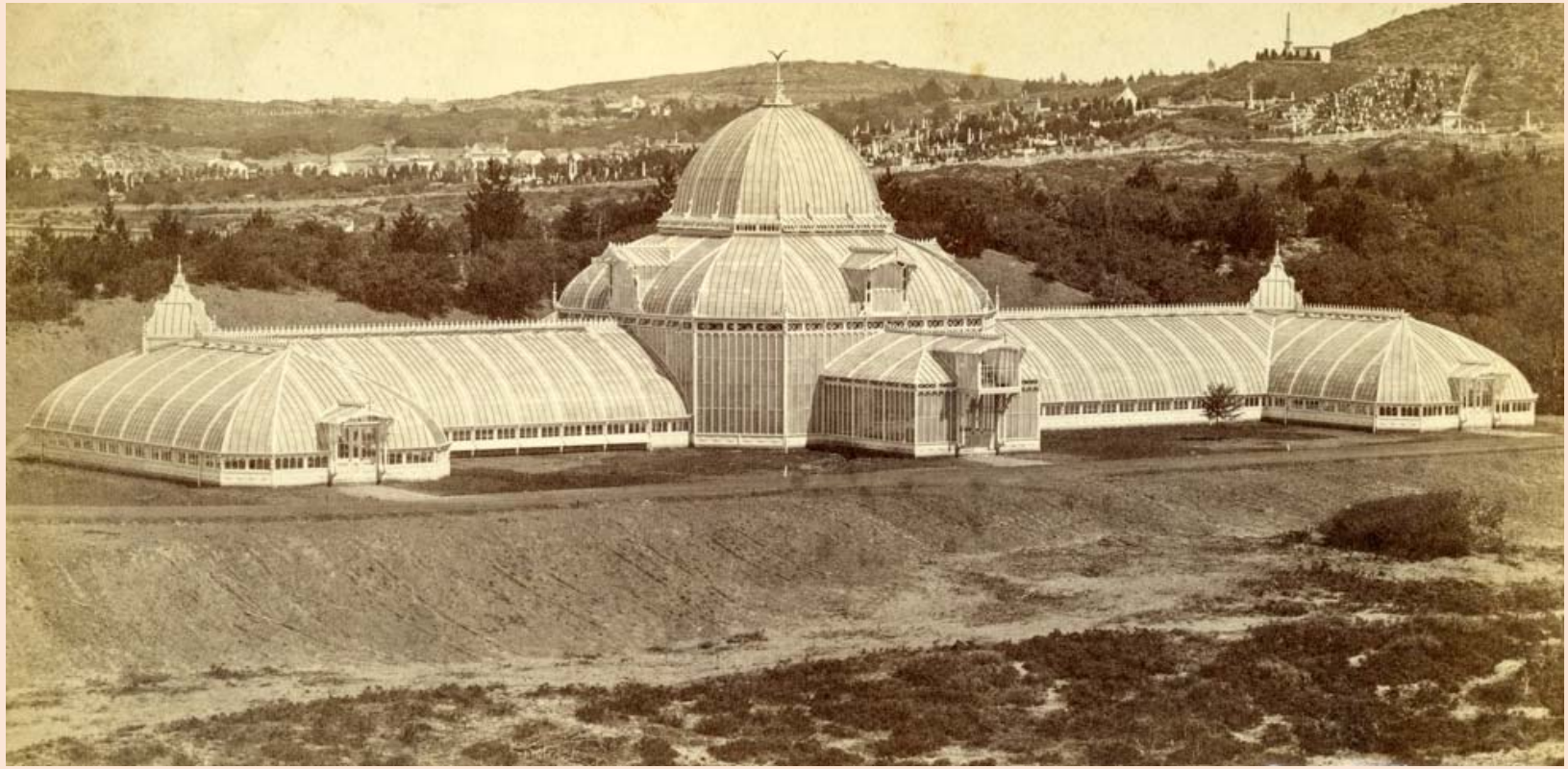
Blooms for Three Months and then you throw it out

… and, of course, go buy another one!

All for only $12!

I’m Not Dead Yet!

A Day In The Park, Six Years Ago



“Add Water Weekly
Add Fertilizer Monthly”

+

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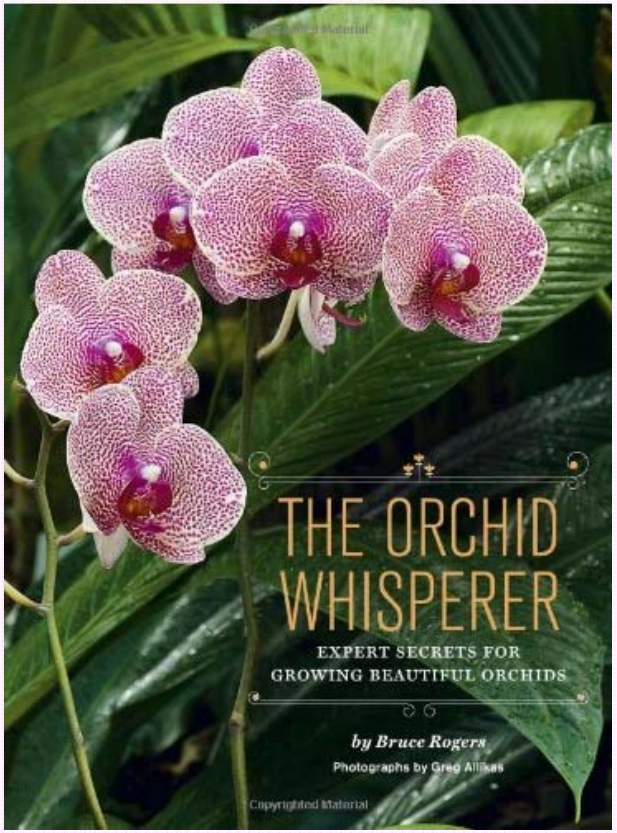
The Book: “The Orchid Whisperer”

Paperback Book

By San Francisco Orchid Society Member,
Bruce Rogers

Terrific Little Book for the Novice

*It mentions the **Sacramento Orchid Society** and lists its website!*



Come to the SOS

Go to the Spring Show

… Get the BUG!

I had walked into

WONDERLAND

I Need a Greenhouse! *Wait*, I've GOT a Greenhouse!

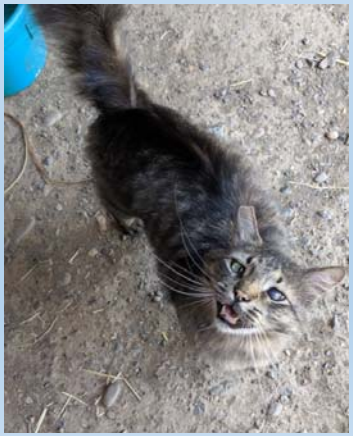
Well …

After 42 years of marriage, six kids, putting everyone through college, helping with down payments, paying for weddings …

I know about

Quid Pro Quo

Carla gets the Barn, the Horses, the Trailer …



BUT, I get …

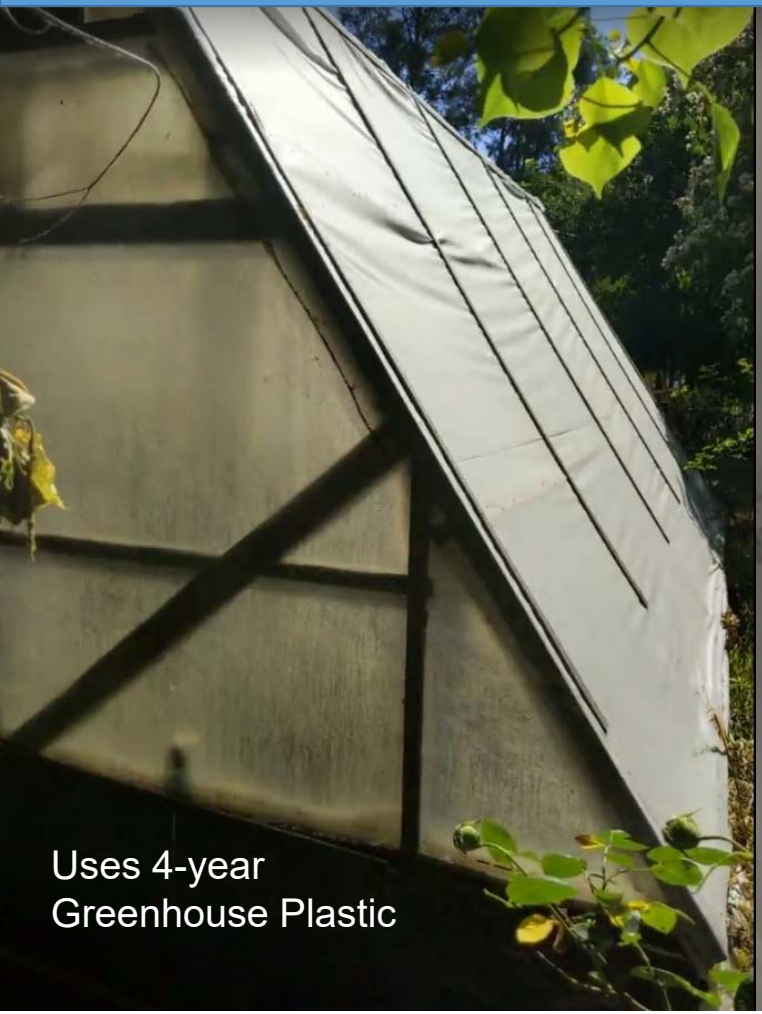

The Greenhouse!

Needed A Little Work

- Rebuild
- Light
- Temperature
- Humidity
- Water
- Air Motion
- Racks for Plants
- Pest Control

Rebuild!

- Just $150 worth of lumber from Home Depot
- Screws, Staples, Cheap Paint
- Fans from Tractor Supply ($30)
- Bug spray …



Voila!
My
“Greenhouse”!

You can insulate the 4-Year Greenhouse Plastic on the inside with bubble wrap

Add a $25 pre-fab door from the Habitat-For-Humanity Store

Shade Cloth

- Essential to control the AMOUNT of light from the sun
- Comes in rolls or in pre-fab cloths
- Wide variety of prices, colors and configurations

Light Meter

- Huge variety of configurations and prices
- Plants are not precise and orchids are highly adaptable, so “precise” light meters are not essential
- Meter pictured here ($14.61 from Wal-Mart) is JUST FINE

Thermometer and Humidity Gauge

- $13.56 on Amazon
- Measures Temperature
- Measures Relative Humidity
- Displays High/Low values from the previous 24-hour period
- Many variations, including wireless versions which allow tracking of conditions in the greenhouse

Pests … Ugh

Better Living
Through Chemistry!

Heater

- Electrical, Gas or Steam units for greenhouses
- Prices vary from $35 to $750+
- Quality forced-air (electric or gas) units are more economical to use
- Electrical space heaters are cheaper to buy; but use more power

My $25 heater from Target …

It’s survived THREE Winters thus far, and still chugs along!

Thermostat

- Need TWO:
  - Heater Control
  - Cooling Control
- Use one designed for greenhouses
- $34 on-line
- Use one with sufficient Amps for the heater or cooler

Cooler

- Keep the temperature in the greenhouse below 85 degrees F at all times
- Do NOT use air conditioning (desiccating and VERY expensive)
- Evaporative coolers are “ok”. Unit shown is 6000CFM ($400)
- Better is a “wetwall” which is more efficient, less expensive to operate, higher humidity, … kits are expensive ($2100); but Home-Built Wet-Walls are **easy** to build yourself

Pad and Fan Evaporative Cooling

- A 75 year-old technology
- The most-common summer cooling method
- Often pads are composed of wood shreds
- Wet-wall pads are composed of cellulose
- Wet-wall exhaust fans are placed on the opposite wall: *the greenhouse is inside the cooler!*

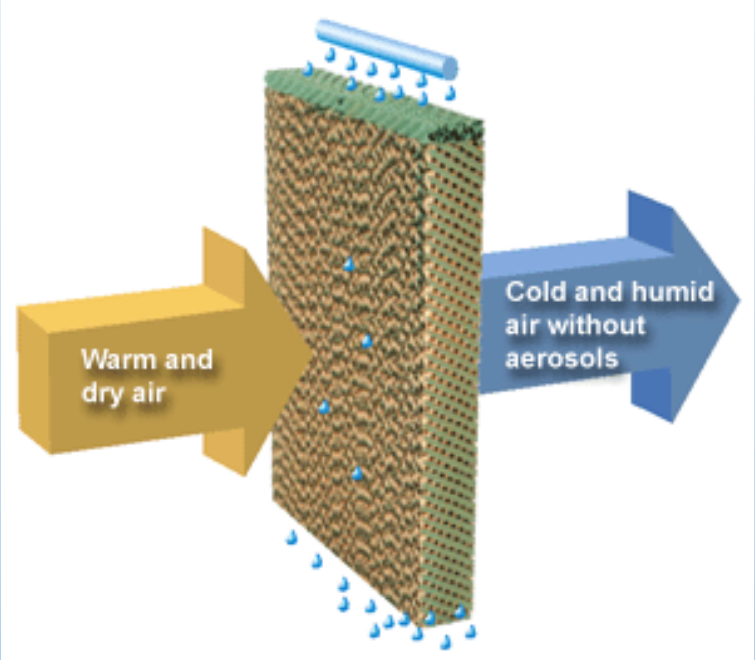
Effectiveness of Summer Cooling

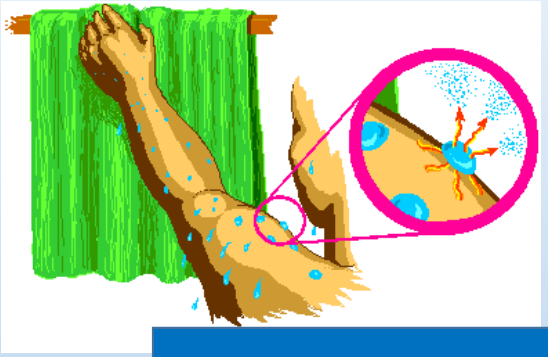
- Fan and pad cooling can lower to 80% of the difference between the wet and dry plant temperatures
- Mister (Fog) cooling can lower the temperature by nearly all of the difference
- Both of these systems are most effective at low humidity, such as in Sacramento

Evaporative Cooling

- Based on heat absorption during the evaporation of water
- Relatively inexpensive compared to other types of cooling

How does the Wet-Wall work?





It's the same principle as when we cool off after stepping out of the shower!

Pad Types and Specifications

- Excelsior pads (wood fiber) had to be framed in wire mesh for support; required annual replacement
- Cross-fluted cellulose is the most popular today, can last up to 10 years
  - *Should be kept from heavy rains*
  - *Only move if dry*
- Other types of pads include aluminum fiber, glass fiber, and plastic fiber
- Pads are thick (4”) and have a cross-fluted design in order to maximize evaporation with such a high rate of air flow

Cross-fluted cellulose pads

- Come in height increments of ft
- Available in 2, 4, 6, and 12 inches thick
- A 4-inch-thick pad will handle an air intake of 250 cfm/ft^2; a six inch 350 cfm/ft^2
- By way of comparison excelsior pads can only support an airflow rate of 150 cfm/ft^2
- You want vents over the exterior of the pads to seal the external air source off when active cooling isn’t needed

Rate of Air Exchange

- Measured in cfm (cubic feet per minute)
- The basic standard is 8 cfm/ft^2 of floor space
- In warmer climates 1 volume per minute recommended roughly 11-17 cfm/ft^2
- At higher elevations, increase the rate of air exhaust. Evaporation rates decrease with increases of elevation
- Consider light intensity, temperature rise across the greenhouse and the Pad-To-Fan distance

More Details

- Water must be delivered to a 4-inch pad at the rate of 0.5 gpm per linear foot of pad
- For a 6-inch thick cellulose pad a 0.75 gpm per linear foot is required
- Longest recommended delivery pipe is 60ft for the 4 inch system and 50 ft for the 6 inch system1/8 inch holes every three inches are required for both systems
- Holes point upward and release water into an impingement cover – water drips down onto a distribution pad

Calculating Air Removal Rate

1. Calculate the standard cfm = Greenhouse area X 8 cfm/ft
2. Correct for the standard rate of air removal using the larger of F_{house} or (F_{vel})
3. $F_{house} = F_{elev} \times F_{light} \times F_{temp}$
4. Total cfm = standard cfm X (F_{house} or F_{vel})
5. Select the fans to install

Exhaust Fan Placement Rules

- Should not be more than 25 ft apart
- If the end of the greenhouse is 60 ft wide you will need at least 3 fans
- Fans should be evenly spaced at plant height
- Place fans on leeward side of the greenhouse
- Rules change with multiple, interconnected houses
- Protect fans from weather and provide screening on both sides for protection (and keep wildlife out!)
- Air movement can cause special problems in larger houses

Wet-Wall Home-Build

Made entirely with supplies from Home Depot: ~$250

An easy, excellent YouTube video explains the entire process:

https://www.youtube.com/watch?v=A67u3NyC9w8

Or “google”
Greenhouse Evaporative Cooler Build

My Wet-Wall in Operation!

One Full Volume of the green-house Exhaust per minute!

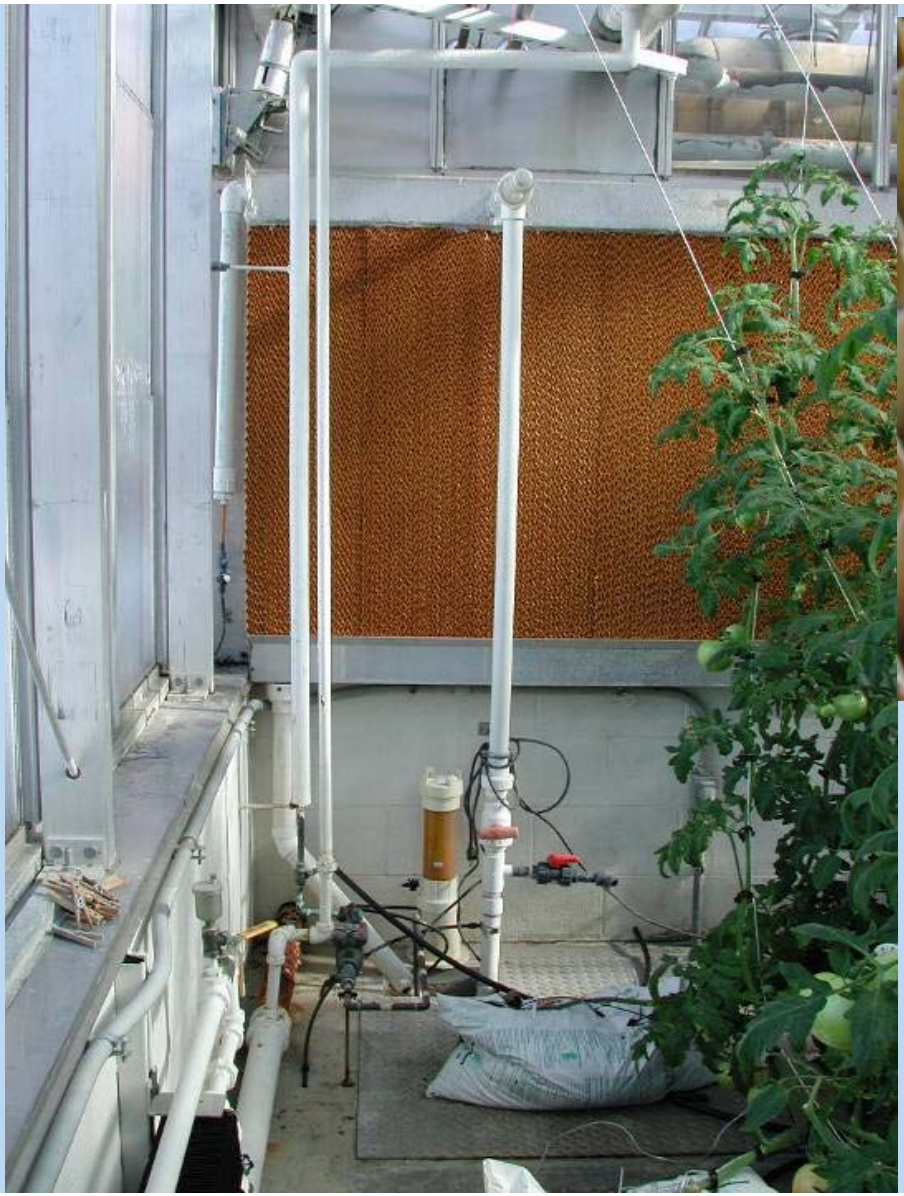
Wet-Wall on the West ←

→ Exhaust Fans on the East

Commercial Wet-Wall

Identical to the type in use at Gold Country Orchids in Lincoln, CA

Some features of the commercial wet-wall installation



Clean Water

- “Reverse Osmosis” (RO) water systems are the gold standard, BUT, you need to use care in selecting fertilizer

- Alternatively, calcium filters ($13) do “ok” and can be replaced twice a year

- Do not use water-softeners!

Micro75 System ($140) from Floriculture in Fair Oaks

Misters

- Very easy to make using Netafim fog nozzles ($6 shown) and flexible irrigation tubing from the garden shop, or …
- Patio mister kits ($20 shown from Orbit) are at most home and garden stores
- Use either RO water or a calcium filter!

My Misters … Inexpensive, but effective

Humidistat with Integrated Solenoid

- Controls water flow to the misters according to the measured relative humidity
- $94 from the Greenhouse Megastore in West Sacramento
- More precise than using a timer

Fans

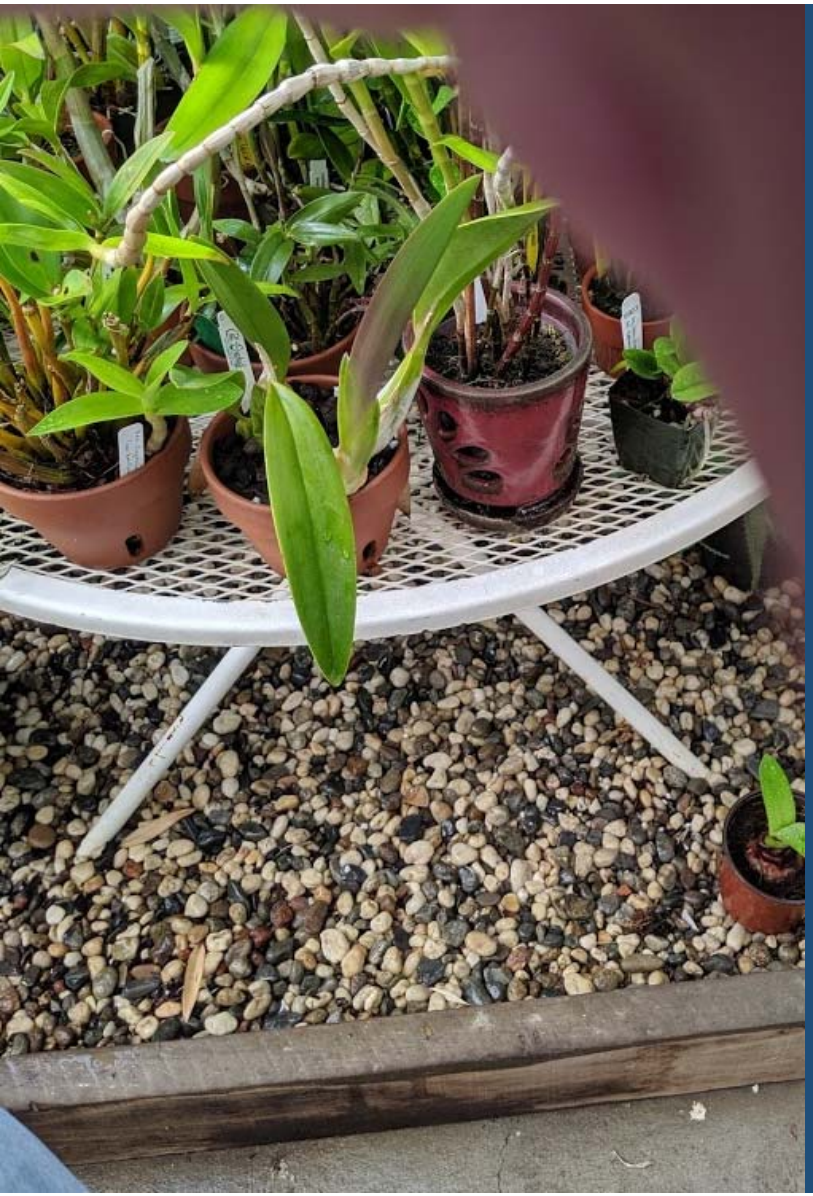
- Schaeffer Greenhouse fans (shown) are a bit more expensive ($130); but are efficient and last forever. Built for greenhouses!

- Alternatively, oscillating fans can move the air around and keep plants from rotting. Replace them every couple of years: $15 at Costco

Two Oscillating Fans do the trick for me!

Timers

- Huge variety, available at almost all hardware stores
- Water timers ($10 - $150)
  - Misters
- Electrical timers ($12 - $200)
  - Heater
  - Wet-wall and exhaust fans
  - Cooler
  - Oscillating fans
- USE TIMERS WITH CORRECT AMPS!



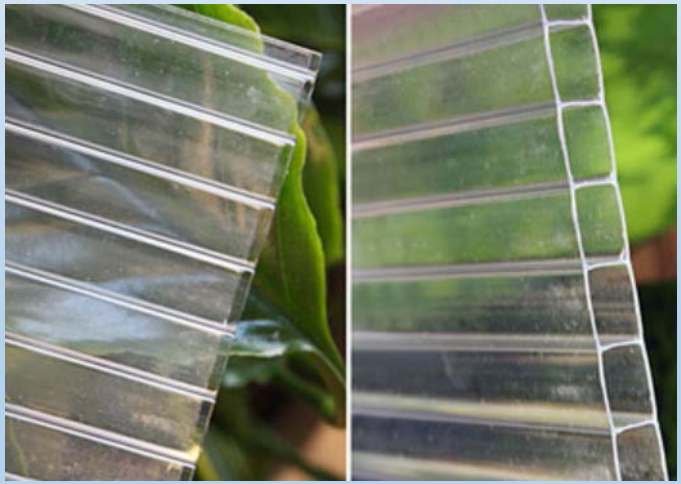
Plant Stands:

On the cheap now …

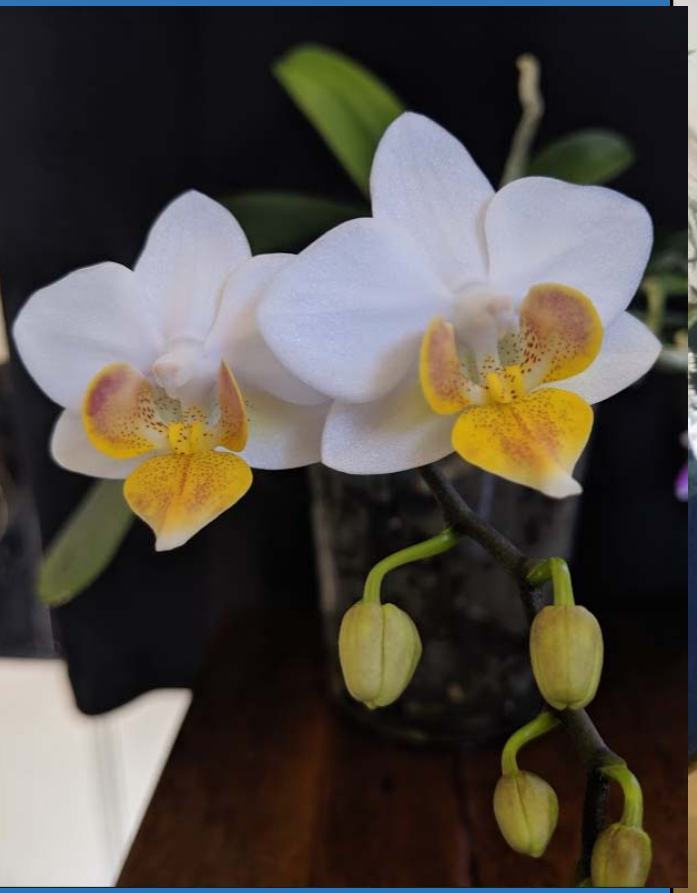
but going **Class Act** soon!

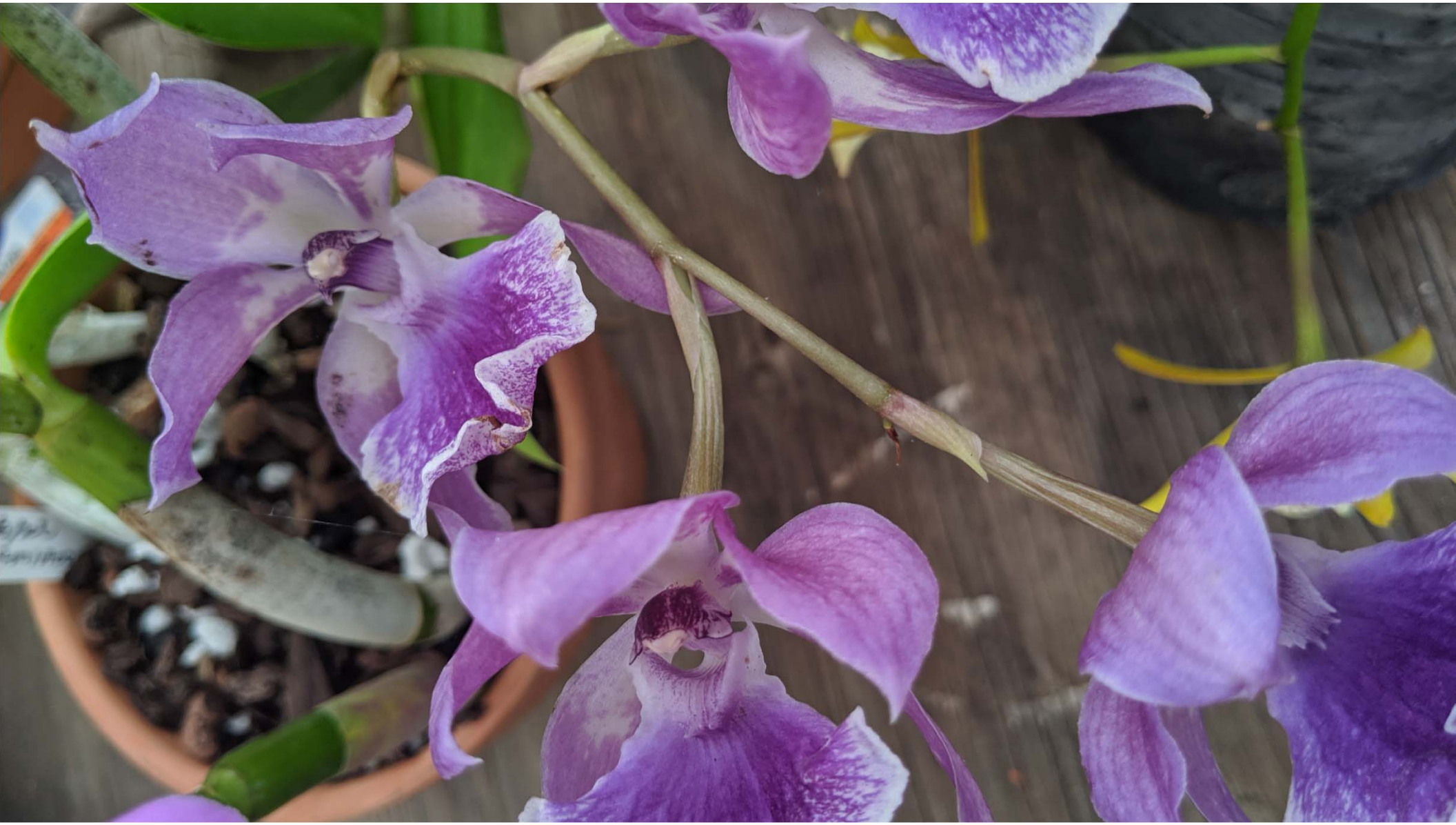
“If you give the mouse a cookie …”

- Tables and misters for the outside orchids
- Double-wall solid-plastic roofing instead of 4-year greenhouse plastic
- Sink, counter, cabinets and shelves



My Reward





Thank You

and Blessings

from *The Three Palms*