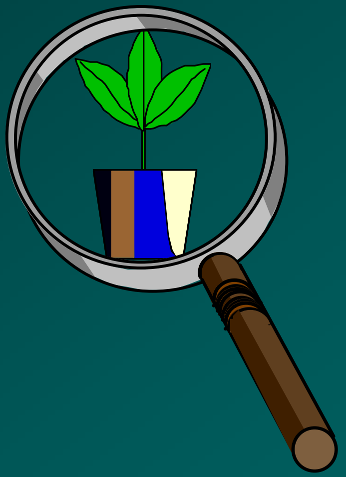
Fluff, Stuff and Anything Else You Want to Add !



- Ted Bilderback
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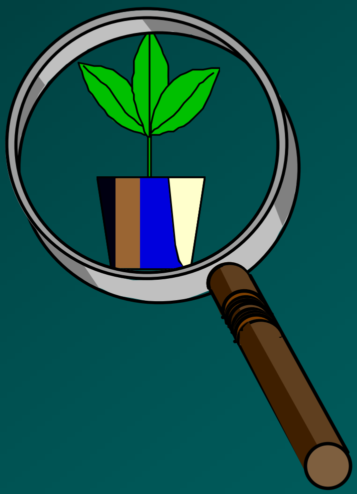
- http://www.ces.ncsu.edu/depts/hort/nursery

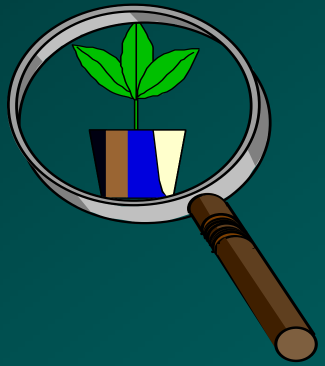
Substrates Components Studied



Incomplete List of Components

- Pine Bark / Fir Bark, Composted Hardwood Bark,
  Pine Chips, Whole Tree Substrate
- Sphagnum Peat Moss, Coir, Sawdust, Bagasse
- Sand, Soil, Pumice, Industrial Clays and Aggregates
- Composts –Yard, Animal Wastes, Garbage, Peanut Hulls, Rice Hulls, Mushroom Compost, Cotton Gin & Stalks
- Tire Wastes
- Perlite/Vermiculite

PourThrough



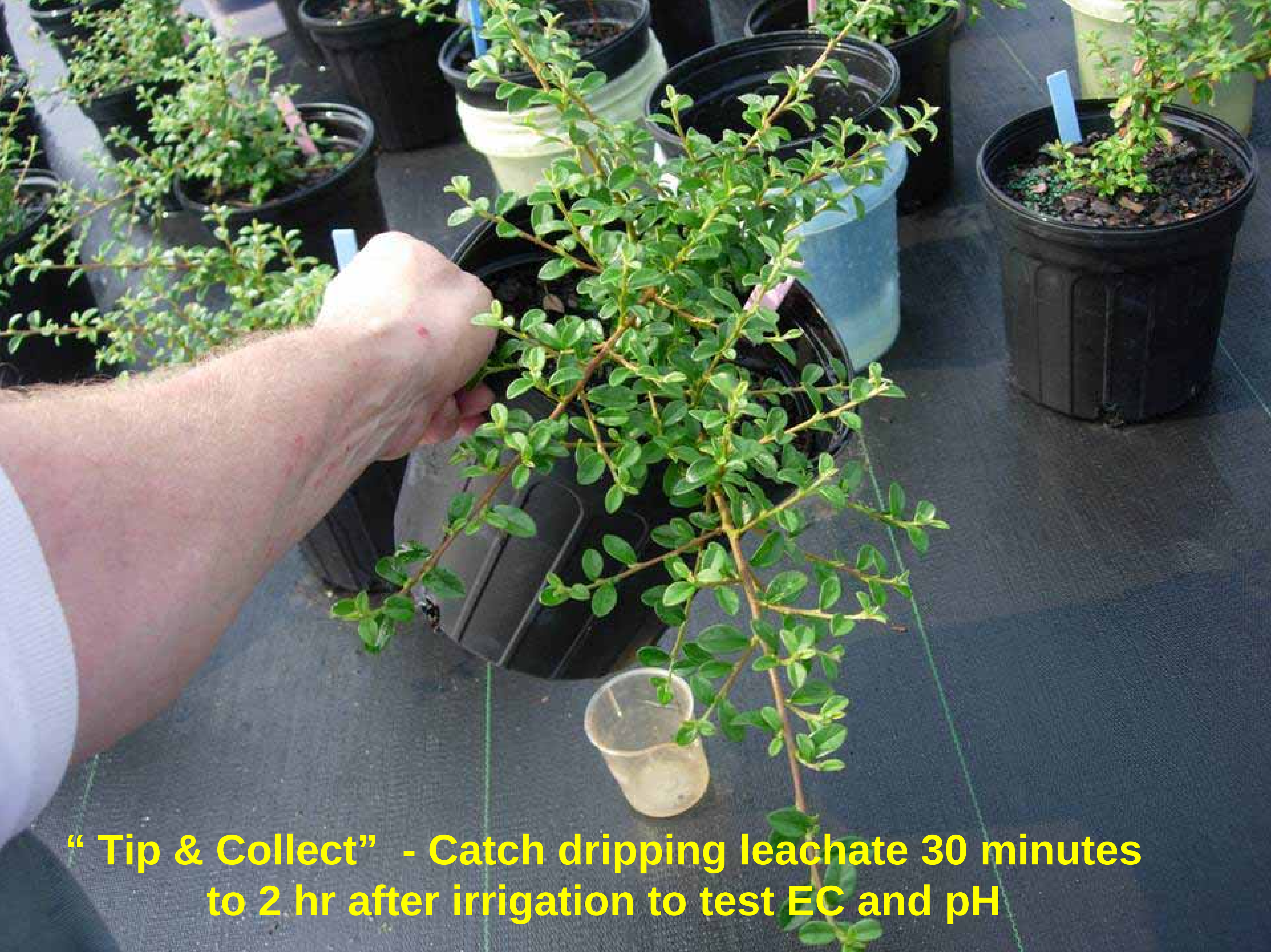
Leachate Extraction Procedure

- Check Electrical Conductivity (soluble salts)
  - fertilizer concentration
  - Units= mhos/cm^2, mS/cm^2, µS/cm^2

- pH of substrate solution

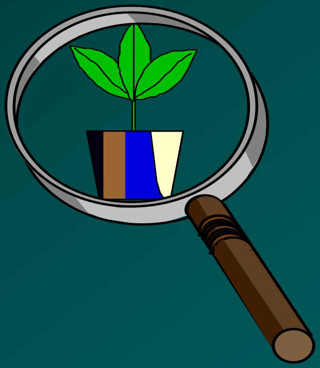
- Lab analysis for nutrient


Pour
PourThrough
Extraction~ 120 ml / 1 G
pot


“ Tip & Collect” - Catch dripping leachate 30 minutes
to 2 hr after irrigation to test EC and pH

The Secrets in the Sauce!!

Monitoring Soluble Salts



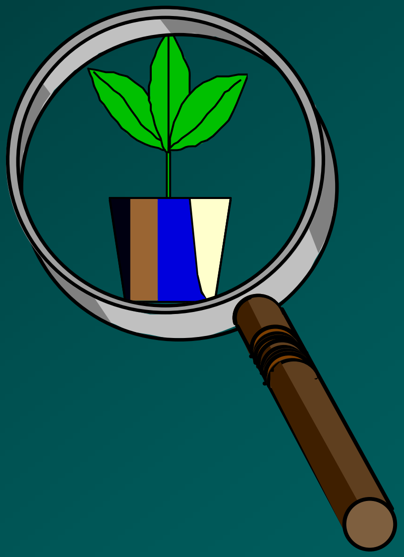
Using the PourThru Extraction Procedure

Steps for Using the PourThru Extraction Method

- Irrigate nursery containers
- Wait 30 minutes to 2 hr after irrigation
- Pour irrigation water over top of container or simply collect drainage from container
- Read leachate pH and EC with pens/meters
- Record data
- Send sample to lab for nutrient analysis if desired

- There are many pH and conductivity meters and pens available. They may read different units so be prepared to make conversions

Nursery Production Practices



Physical Properties

Properties Effected by Container Size

- Air Space/Air Filled Porosity
- Container Capacity / Available Water Content
- Properties UnEffected by Container Size
- Total Porosity
- Unavailable Water Content
- Bulk Density

Feels Good?
Looks Good?
What’s the AFP?

Feels Good?

Looks Good?

What’s the AFP?

Measuring Air Filled Porosity

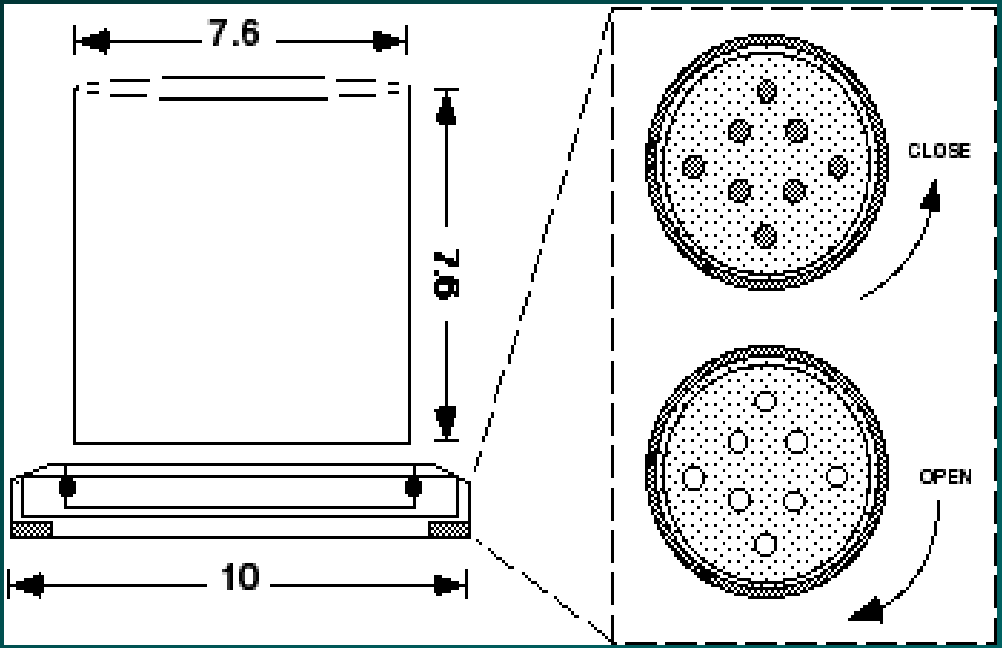
- Not Standard Procedure for Commercial Labs
  - Abandon Measurement due to inconsistent results
- Not Frequently Measured by Nursery Professionals
  - Few Guidelines
  - Messy
  - Inconsistent Results
- Objective of this presentation
  - Suggestions to attain uniform observations for AFP

Why APF?

- APF is dependent upon container height
- Initial APF of Substrate important
- Organic components decompose
  - APF decreases
- APF at Market Point most important
  - Greatest value when roots most at risk
- Aggregates like pumice resist loss of APF

North Carolina State University Horticultural Substrates Lab

Porometer Information



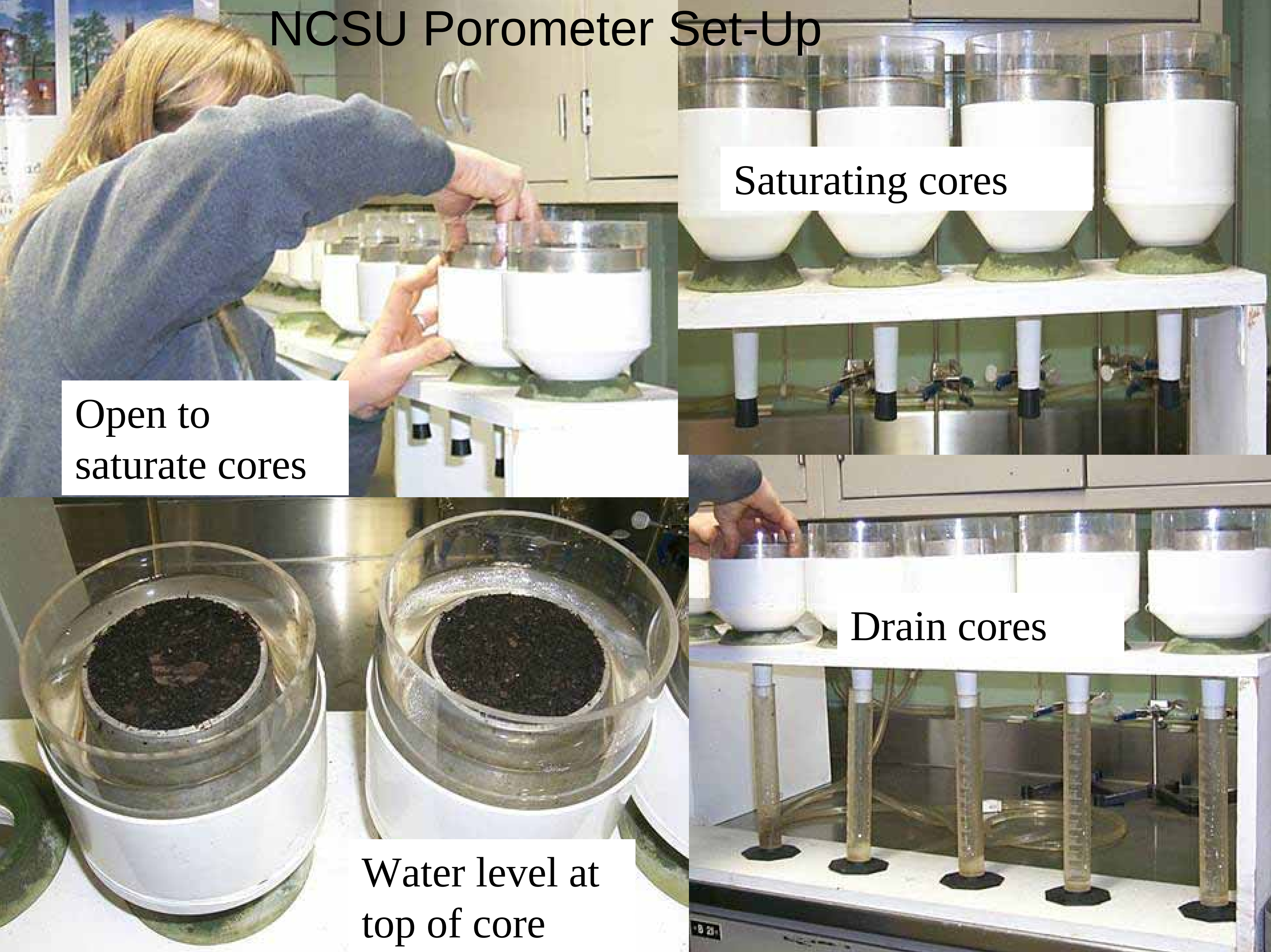
NCSU Porometer

The NCSU porometer for measuring physical properties uses standard 7.5 cm soil cores that snap into base plates which rotate to open or close the holes allowing cores to be saturated and drained.

Physical property analysis of substrates begins with filling 3 stacked soil cores. The column is tapped 3 times on the work bench before removing the center soil core for analysis

Clamps are removed from the three cores.
Cores are separated and top and bottom surfaces screed to create the exact volumes of the middle core

NCSU Porometer Set-Up



After drainage, cores are weighed, oven dried and weighed again to determine container capacity of the substrate

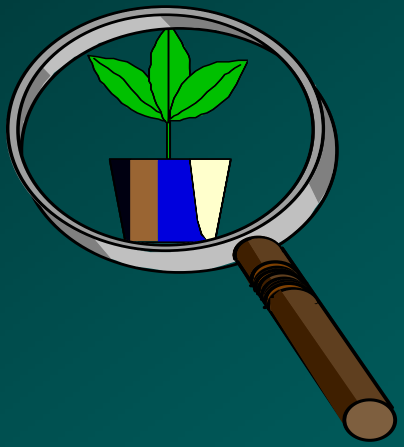

Permanent Wilting Point=
15 bar (~220 psi)

One inch rings at permanent wilting point are removed from the 15 bar extractor. Cores are weighed and placed into an drying oven.

After oven drying, cores are weighed again; the difference is unavailable water content.

Nursery Production Practices:

Normal Ranges for Physical Properties (By Volume)

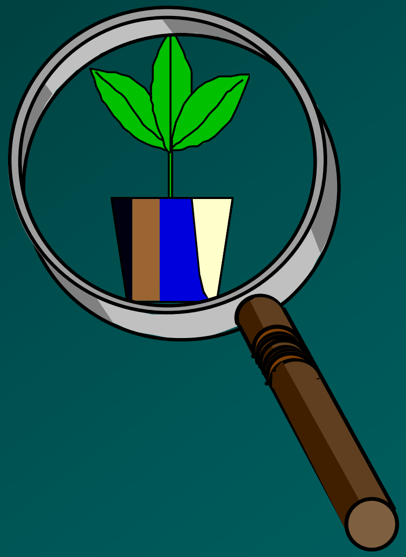


- Total Porosity - 50-85%
- Air Space - 10-30%
- Container Capacity - 45-65%
- Available / Unavailable Water Content - 25-30%
- Bulk Density- (oven dry weight)

0.19 to 0.52 g/cc (12 to 32 lbs/ft^3)

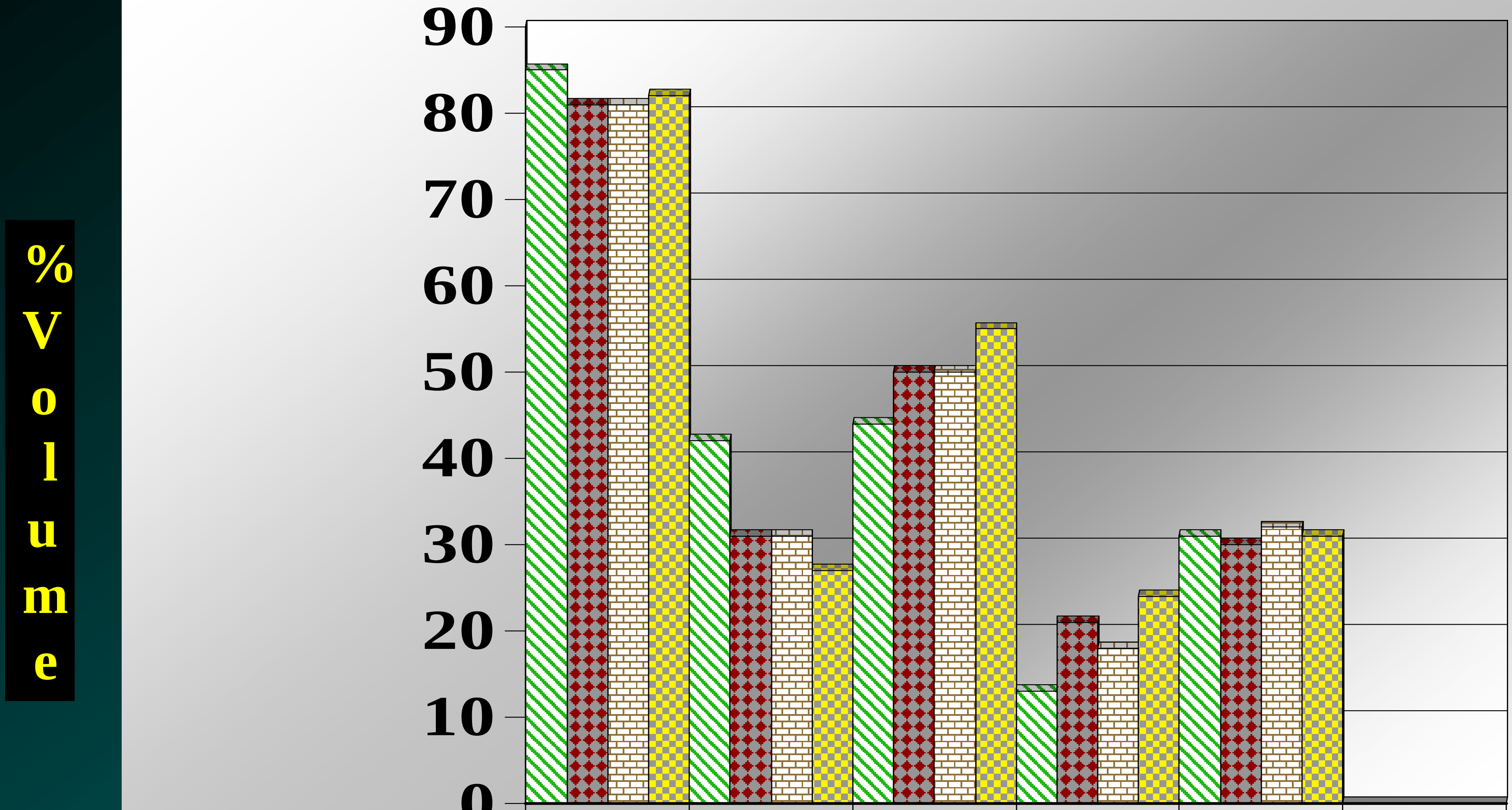
Nursery Production Practices:

Particle Size Effects of Substrates



- **Stability of Components Important**
- **Organic Components decompose over time**
- Components “Fit” to create Air & Water Content
- Fine Particles < 5 mm create water holding pores
- Desire a maximum of 20 to 30 % fine particles

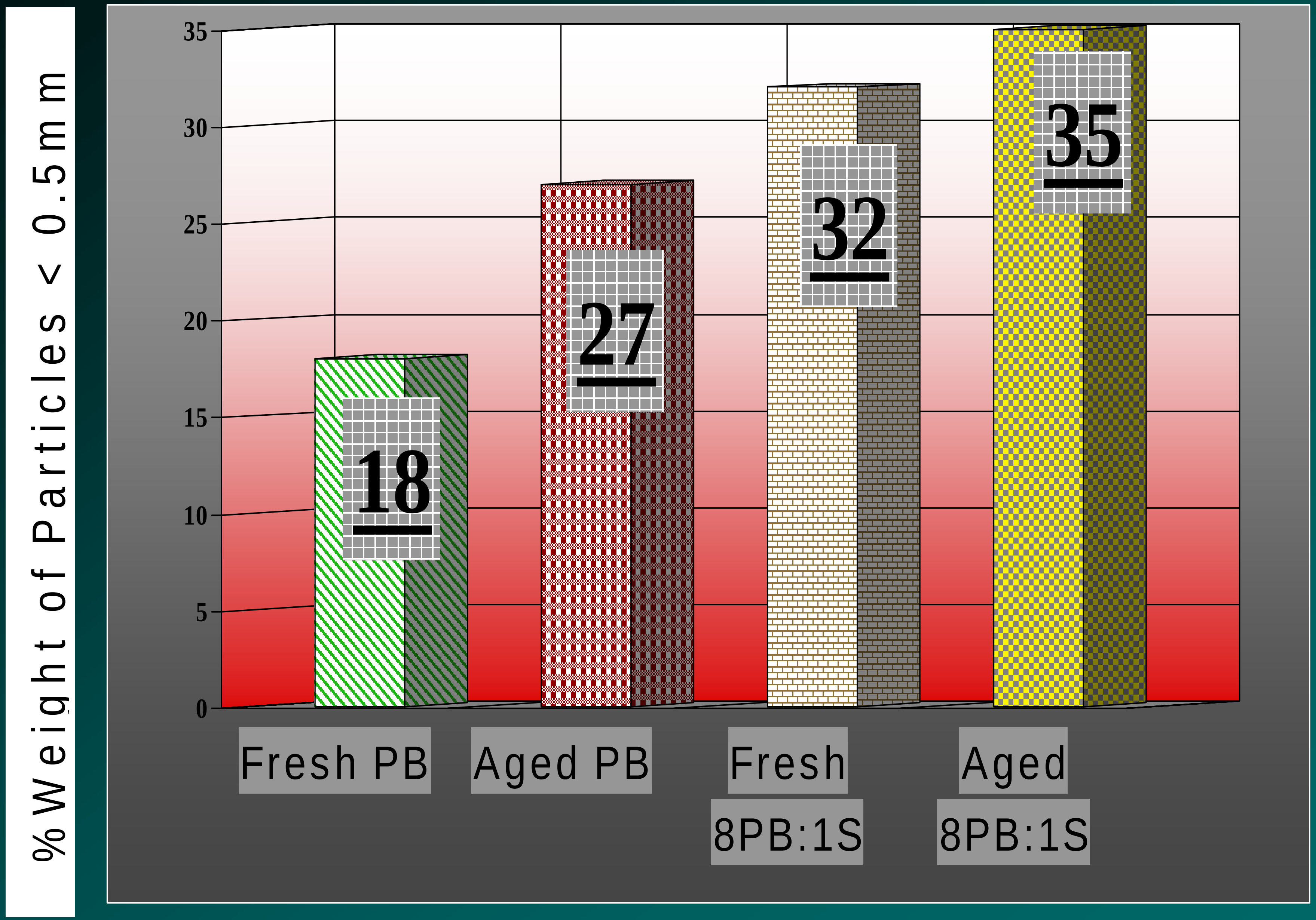
Physical Properties of Substrates



	TP	AS	CC	AW	UAW
Fresh PB	85	42	44	13	31
Aged PB	81	31	50	21	30
Fresh 8PB:1S	81	31	50	18	32
Aged 8PB:1S	82	27	55	24	31

Samples are oven dried,sieved and particle weight on each sieve recorded

Weight of Fine Particles



Decomposition of some organic components occurs rapidly reducing air space and becoming water logged and poorly drained

Fresh Pine Bark has recognizable bark, cambium and large chunks. Aged pine bark has finer particles and is a darker color.

Peanut Hulls Composted with pine bark

Peanut Hulls Composted with pine bark

Stable Components

Course Aggregates or sand can be used as components when organic components decompose rapidly. Aggregates, coarse well point sand or clays will help preserve aeration as compost, pine bark and peat moss break down to finer particles.


Permatile


24/48 industrial clay


5/20 industrial clay


Well point sand

Amending Container Substrate With Clay

How Do You Manage Fresh Versus Aged Pine Bark?

Tiffany Harrelson, Stu Warren and Ted Bilderback

Table 2. Effect of age of bark on physical properties of an 8 pine bark : 1 sand substrate.

Bark	Total Porosity (%)	Air Space (%)	Container Capacity (%)	Available water (%)	Unavailable water (%)	Bulk density (g/cm3)
			Pine Bark at treatment initiation			
Aged	87.3 a	25.2 b	61.1 a	26.3 a	35.8 b	0.19 a
Fresh	88.3 a	39.3 a	49.0 b	9.8 b	39.2 a	0.17 b
			Pine Bark : Sand (8:1) at 56 days after treatment initiation			
Aged	82.8 b	25.9 b	56.9 a	22.7 a	34.3 a	0.32 a
Fresh	85.4 a	36.3 a	49.1 b	15.8 b	33.3 a	0.32 a
			Pine Bark : Sand (8:1) at 336 days after treatment initiation			
Aged	74.9 b	17.0 b	57.9 a	30.0 a	27.9 b	0.35 a
Fresh	80.1 a	24.9 a	55.2 b	22.3 b	32.6 a	0.35 a

yMeans within columns and weeks after treatment initiation followed by the same letter are not significantly different as determined by Fisher's protected LSD, *P* = 0.05.

Fluff ©

Top and Root Dry Weight of *Cotoneaster* 'Skogholm' grown in aged pine bark substrates amended with Fluff©

Substrate Treatments	Top Dry Weight	Root Dry Weight
0% Fluff; PB no lime/micro's	88.0	19.0
0% Fluff; 1Sand: 8 Pine bark	95.3	19.1
15% Fluff; 85% Pine bark	**96.8**	20.6
30% Fluff; 70% Pine bark	87.0	19.6
45% Fluff; 55% Pine Bark	**96.7**	**21.7**

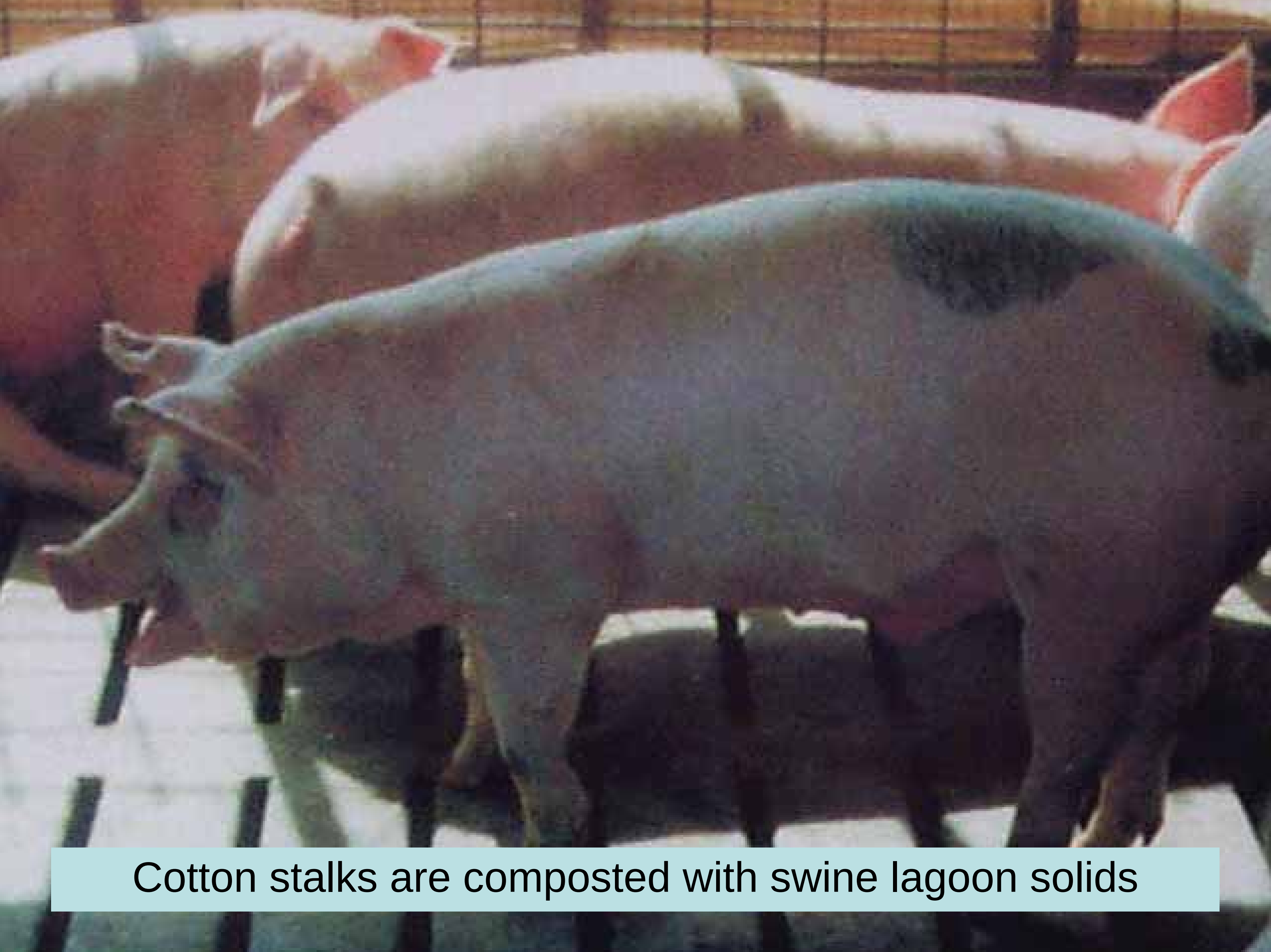
Table. Results of Initial and Final Physical Properties of Aged Pine bark amended with Fluff©.

Substrate Treatments	Air Space Initial	Air Space Final	Available Water Initial	Available Water Final
0% Fluff; 100% Pine bark	**32.5**	**30.4**	**22.3**	**21.9**
15% Fluff; 85% Pine bark	30.6	32.0	23.6	21.1
30% Fluff: 70% Pine bark	**33.2**	**29.7**	**21.2**	**23.0**
45% Fluff; 55% Pine Bark	**32.6**	**32.4**	**20.1**	**21.5**
Pine Bark: Sand 89% PB:11%S	**23.2**	**20.9**	**28.4**	**29.4**
Normal Ranges	10.0- 30.0		23.0-35.0	

(% volume)

Final physical properties measured after **19 Weeks**.

Cotton Stalks can be used as a potting substrate component after composting



Cotton stalks are composted with swine lagoon solids

Cotton Stalk + Swine Lagoon Solids Compost

Top and Root Dry Weight of *Cotoneaster* ‘Skogholm’ grown in aged pine bark substrates amended with cotton stalk / swine solids compost

Substrate Treatments	Top Dry Weight	Root Dry Weight
0% Cotton Cmp; PB no lime/micro	88.0	19.0
0% Fluff; 1Sand: 8 Pine bark	95.3	19.1
15% Cotton Cmp; 85% Pine bark	107.4	17.8
30% Cotton Cmp; 70% Pine bark	107.3	18.2
45% Cotton Cmp; 55% Pine Bark	**121.01**	**23.4**

Table. Results of Initial and Final Physical Properties of Aged Pine bark amended with Cotton Stalk Compost.

Substrate Treatments	Air Porosity Initial	Air Porosity FInal	Available Water Initial	Available Water Final
0% CottonC; 100% Pine bark	**32.5**	**30.4**	**22.3**	**21.9**
15%Cotton ; 85% Pine bark	**29.2**	**27.7**	24.4	25.3
30%CottonC: 70% Pine bark	**29.3**	**27.0**	**24.1**	**26.2**
45% CottonC: 55% Pine Bark	**23.5**	**25.4**	**29.1**	**26.5**
Pine Bark: Sand 89% PB:11%S	**23.2**	**20.9**	**28.4**	**29.4**
Normal Ranges	10.0- 30.0		23.0-35.0	

(% volume)

Final physical properties measured after **19 Weeks**.

Home Remedies for Physical Property Measurements

Develop a Standard-

- Fill (5-10)pots to the top- tap 3 times

  Strike excess
- Hand irrigate pots thoroughly and allow to drain 30 minutes
- Weigh all pots and calculate the average weight
- Use this average to compare new inventory shipments

Home Recipe System for AFP

Shrinkage- cause of inconsistent results →

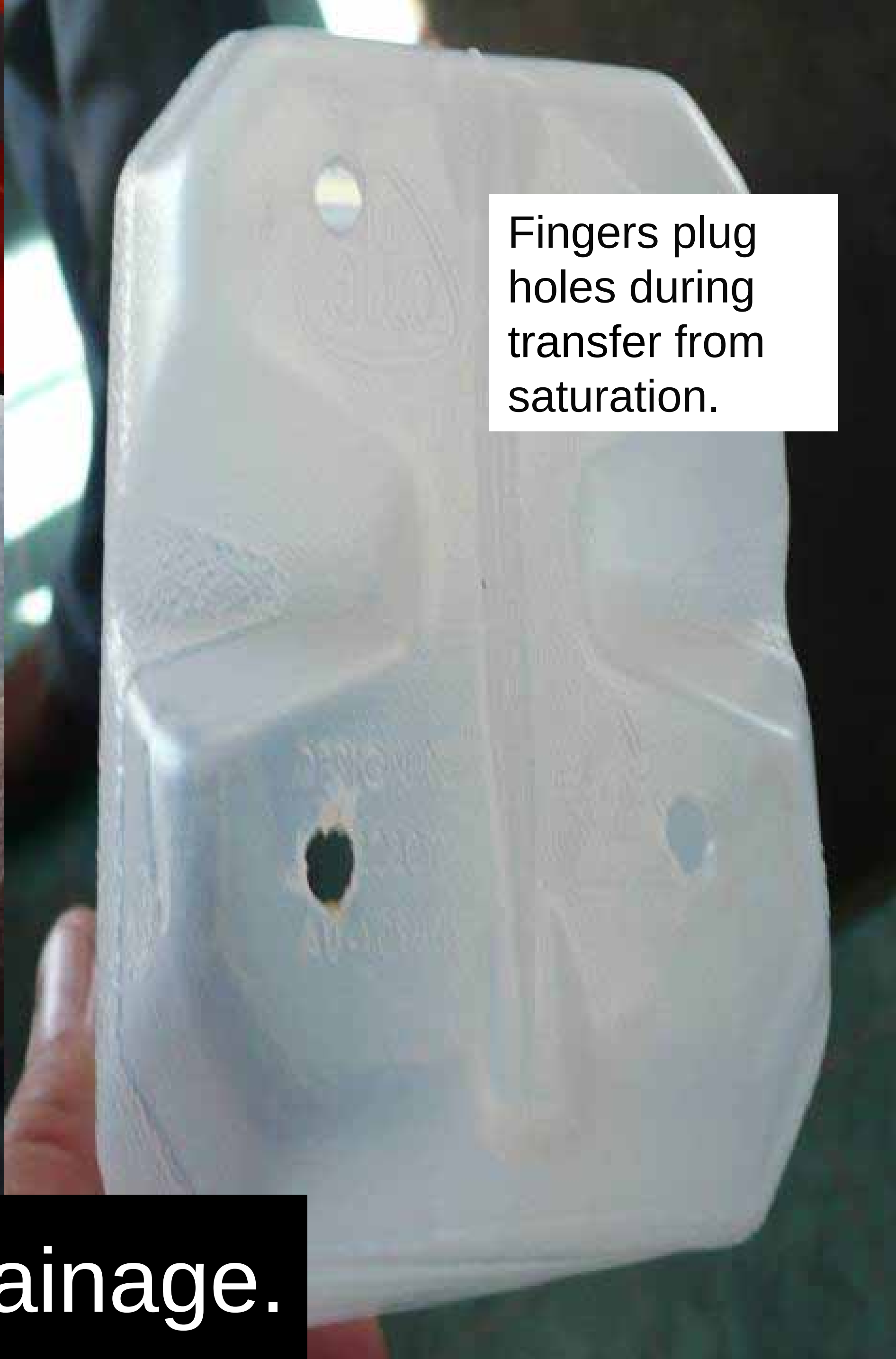
Pre-moistening and Packing Procedure can reduce variation


Care must be taken during saturation.
Particles floating out of porometers produces
inconsistent results. Re-pack and start over.

Home Recipe Equipment for Measuring AFP of Substrates

Construct porometers same height as nursery container

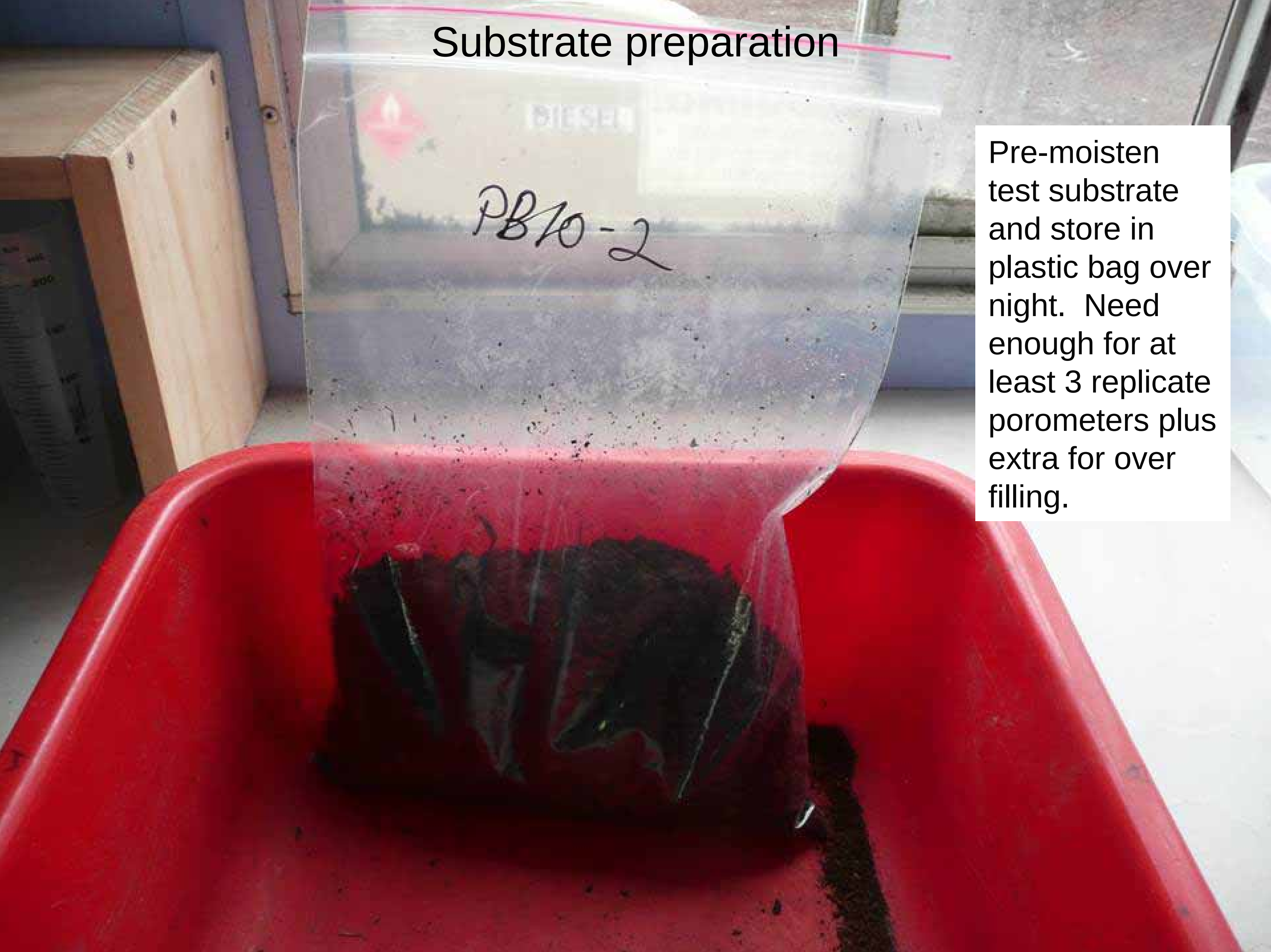
Measure volume of porometers. Best to create equal volume porometers.



Fingers plug holes during transfer from saturation.

Drill 3 to 4 holes for drainage.

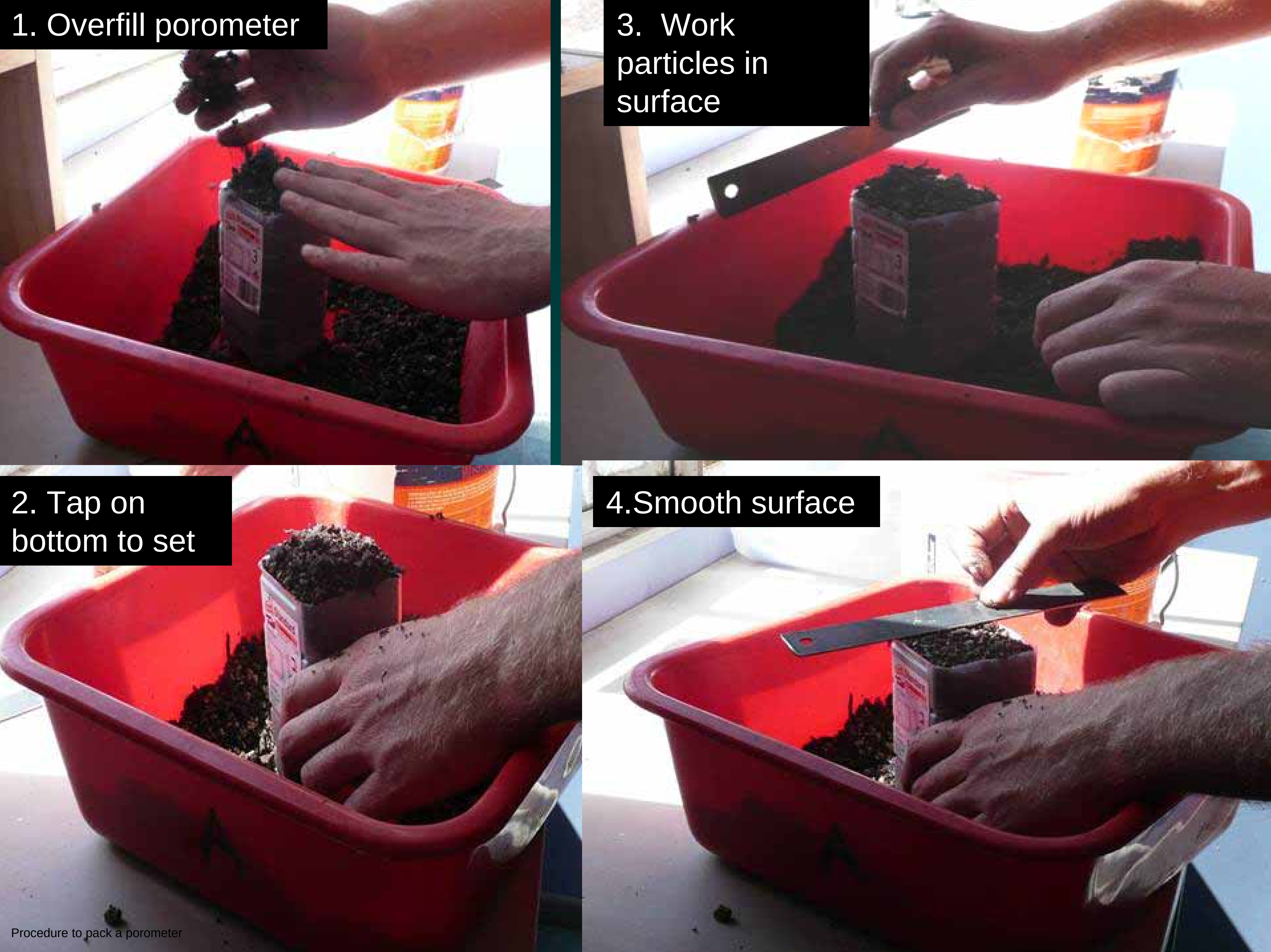
Substrate preparation



Pre-moisten test substrate and store in plastic bag over night. Need enough for at least 3 replicate porometers plus extra for over filling.

Pre-moisten substrate- Squeeze Test- a few drops of water between knuckles. Put in plastic bag and equilibrate over night before packing porometers.


NZ Peat Southland Tree and Shrub Mix is 35% peat moss (0-20mm);
35% composted pine bark (0-13mm); and 30% medium pumice.



Procedure to pack a porometer

All porometers should have same volume and packing should result in equal weight of each porometer.

How to saturate and drain a porometer

1. Saturate porometers

2. Saturate 45 min to 2 hours

3. Glistening indicates saturation

4. Quickness counts- fingers in drain holes- move porometer to pan

Interpretation of AFP

% AFP	Interpretation
5%	Wetland crops only
10%	Minimum for New Mixes - Plugs or shallow containers
15%	Low for Nursery Mixes
20%	Better for Nursery Mixes
30%	Propagation Mixes
35%	Frequent irrigation required
40%	Epiphytes

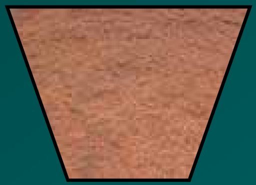


Table 1. Milk Carton Porometer (MCP) Data for NZ Peat Southland Tree and Shrub Mix[z]

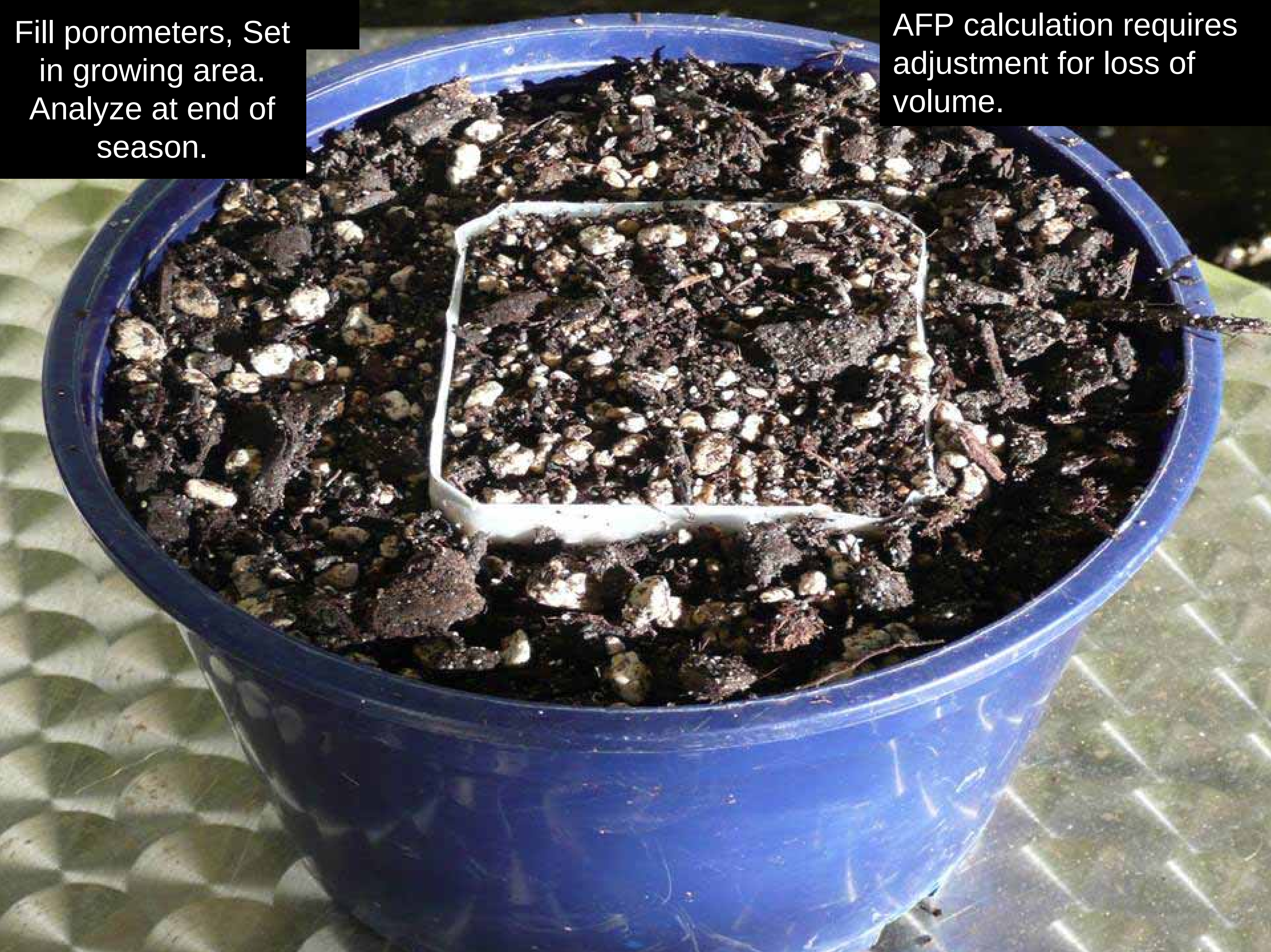
Porometer	Pack Weight[y] (g)	Total Volume (ml)	Drained Volume (ml)	AFP[x] (%)
MCP1	511.5	719	210	29.2
MCP2	505.0	720	232	32.2
MCP3	503.5	700	225	32.1

[z]NZ Peat Southland Tree and Shrub Mix is 35% peat moss (0-20mm); 35% composted pine bark (0-13mm); and 30% medium pumice.
[y]Variation in AFP could be decreased by adjusting MCP1 to MCP2 & MCP3 pack weight .
[x]Percent Air Filled Porosity calculated by dividing Drained Volume by Total Volume.

NCSU Porometer mean of 3 replications for this substrate was 29.5% AFP.

Summary for Home Remedy AFP Procedure

- Pre-moisten test substrates
- Squeeze test for moisture
- Equilibrate moisture overnight in a plastic bag
- Construct porometers with equal volumes
- Pack porometers to the same weight
- Saturate and drain 3 times
- Re-pack if more than 2 mm shrinkage occurs
  - Pack for equal weight
- Measure drained pore space
- Calculate AFP [Drained volume/Total volume]


Fill porometers, Set in growing area. Analyze at end of season.
AFP calculation requires adjustment for loss of volume.