

Low Technology Hydroponic Methods for Growing Potatoes in Hawaii

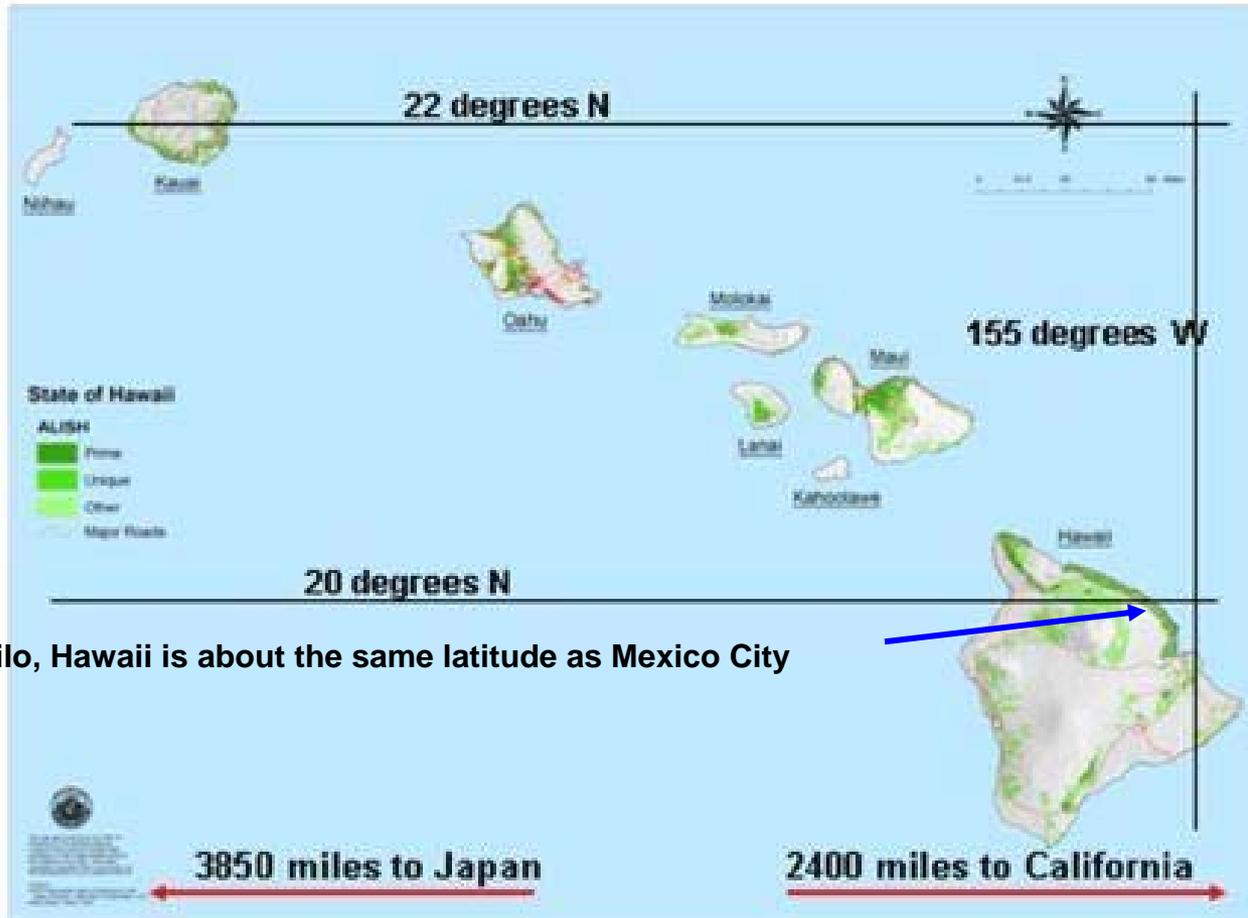
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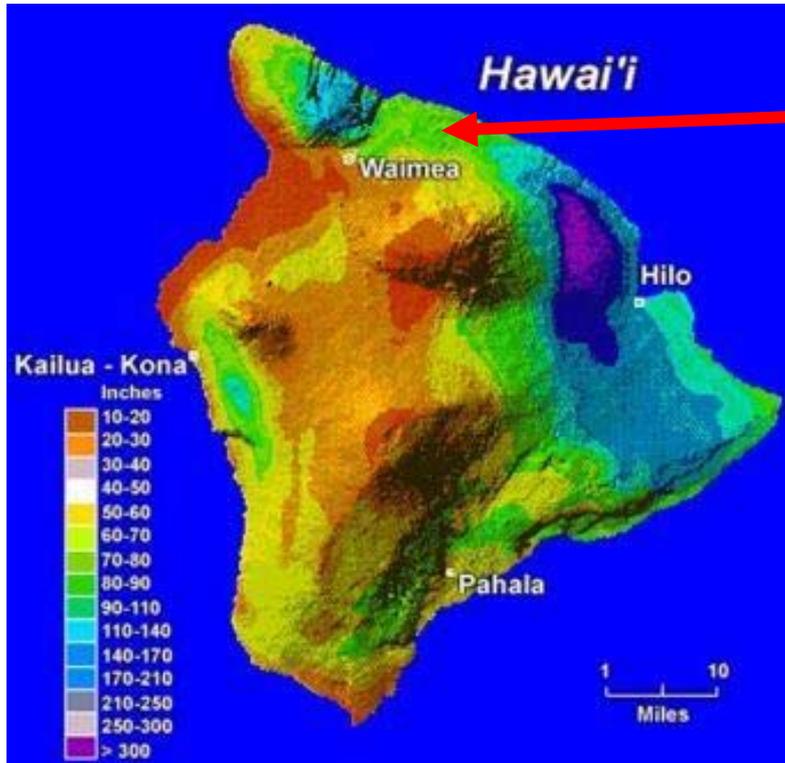
Hilo, Hawaii is about the same latitude as Mexico City

The Big Island



Potato experiments were conducted at 850 m elevation

The orchid isle



**Potato
experiments**

Mauna Kea – 4205 m







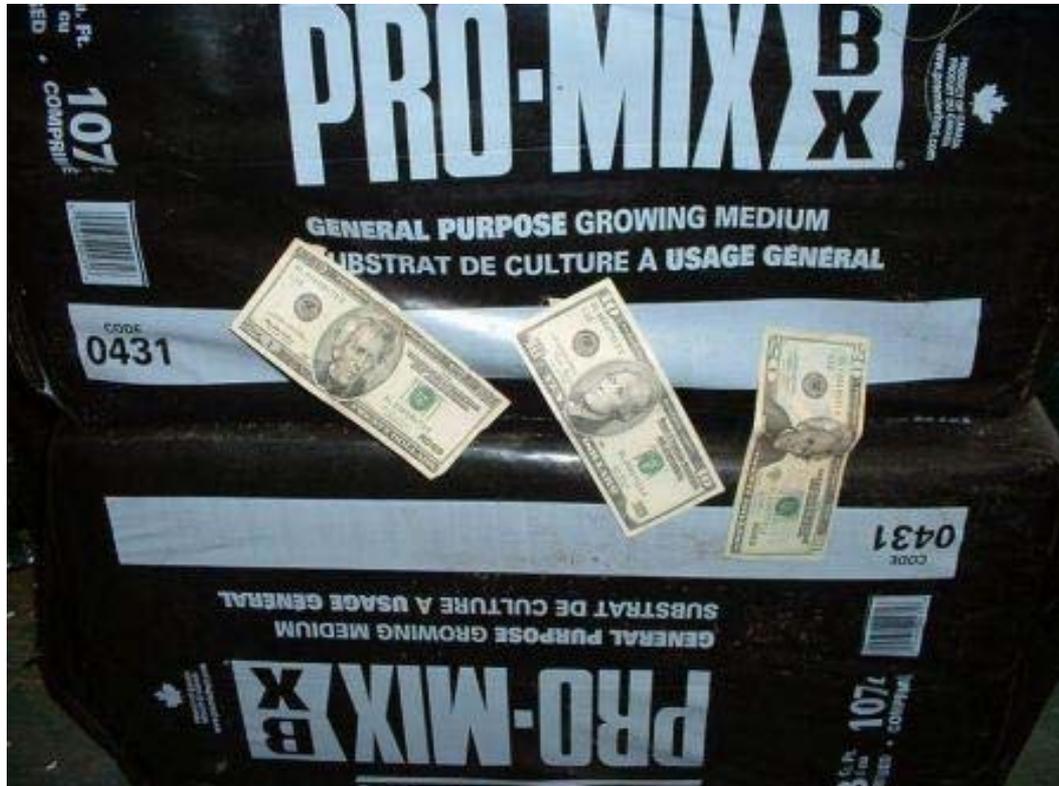


- **Hawaii grows less than 1% of the potatoes which it consumes.**
- **Reasons include:**
 - soil diseases**
 - nematodes**
 - high rainfall**
 - lack of soil**

There is a market in Hawaii for clean seed potatoes, and also gourmet potatoes for expensive restaurants.

The farm value for such potatoes would exceed \$2 per kg. This might warrant growing by a hydroponic method.

- **Highly sophisticated hydroponic systems are too challenging for many growers.**
- **Conventional sub-irrigated pot techniques require too much growing medium which is very expensive in Hawaii.**



Growing medium costs money

Around US\$.0.20/liter

Purpose of these studies

Develop a passive hydroponic growing method

Minimize amount of growing medium

Find inexpensive growing medium

Determine optimum seed tuber size

Generate information on potato cultivars

To determine the effect of potato seed piece size on yield.

Seed piece size

4 \pm 0.5 g

20 \pm 3.5 g

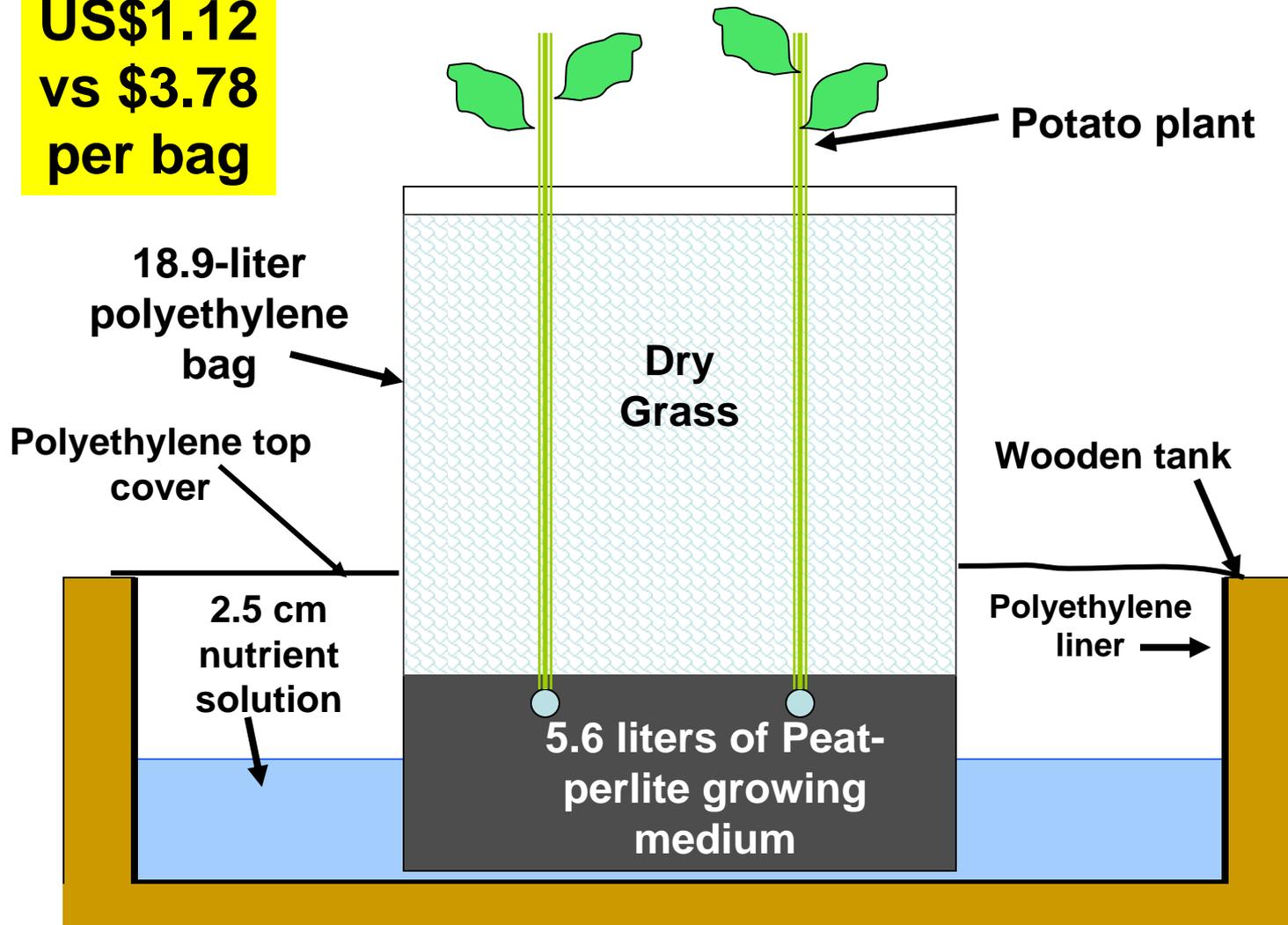
52 \pm 7 g

Method: Sub-irrigated 18.9-liter bags with 5.6 liters of growing medium plus dry grass.



A sub-irrigation method

**US\$1.12
vs \$3.78
per bag**



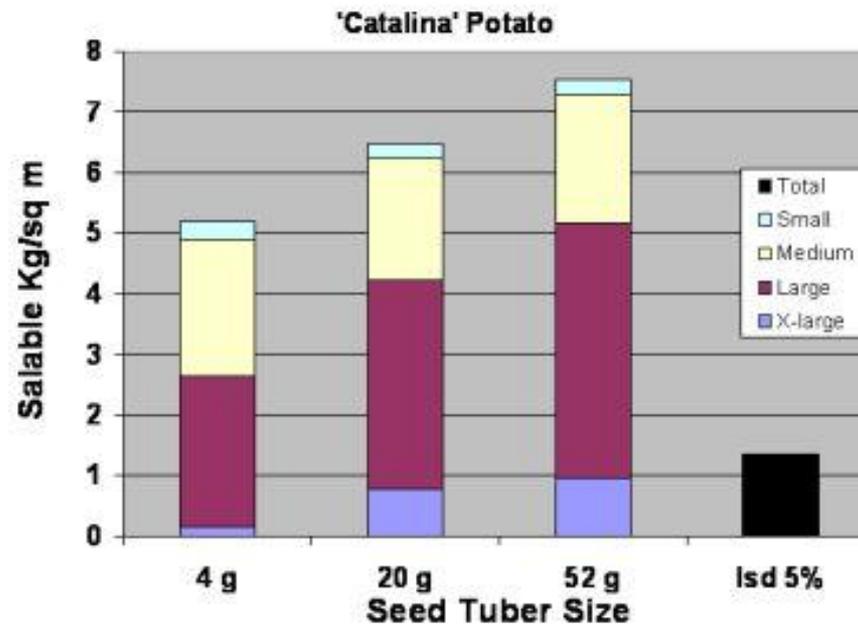
Nutrient solution level
EC = 1.5 to 2.0 mS



Partially filled
with 5.6 liters of
peat-perlite and

Filled with
'hillings' of dry
grass as season
progressed

Sept. 2, 2002 - Jan. 22, 2003; 114 days



Yields are expressed in kg/square m
of tank (not counting aiseways)

**The 52 gram seed pieces
produced greater yields than
the 4 or 20 gram seed pieces**

**Seed Tubers
per Bag**

=====

2

6

**Salable
kg/m²**

=====

6.74 ns

6.16 ns

**There was no difference in salable yield
from planting 2 or 6 seed tubers per bag.**

Growing medium cost

US\$1.01 per kg of potatoes

This is too high.

***Each bag with 5.6 liters of growing medium @
US\$0.20 cost about \$1.12 for 2 potato seed
pieces or about \$0.19 per sq m of tank.***

To determine the effect of 4 cultivars on yield

All Blue

Catalina

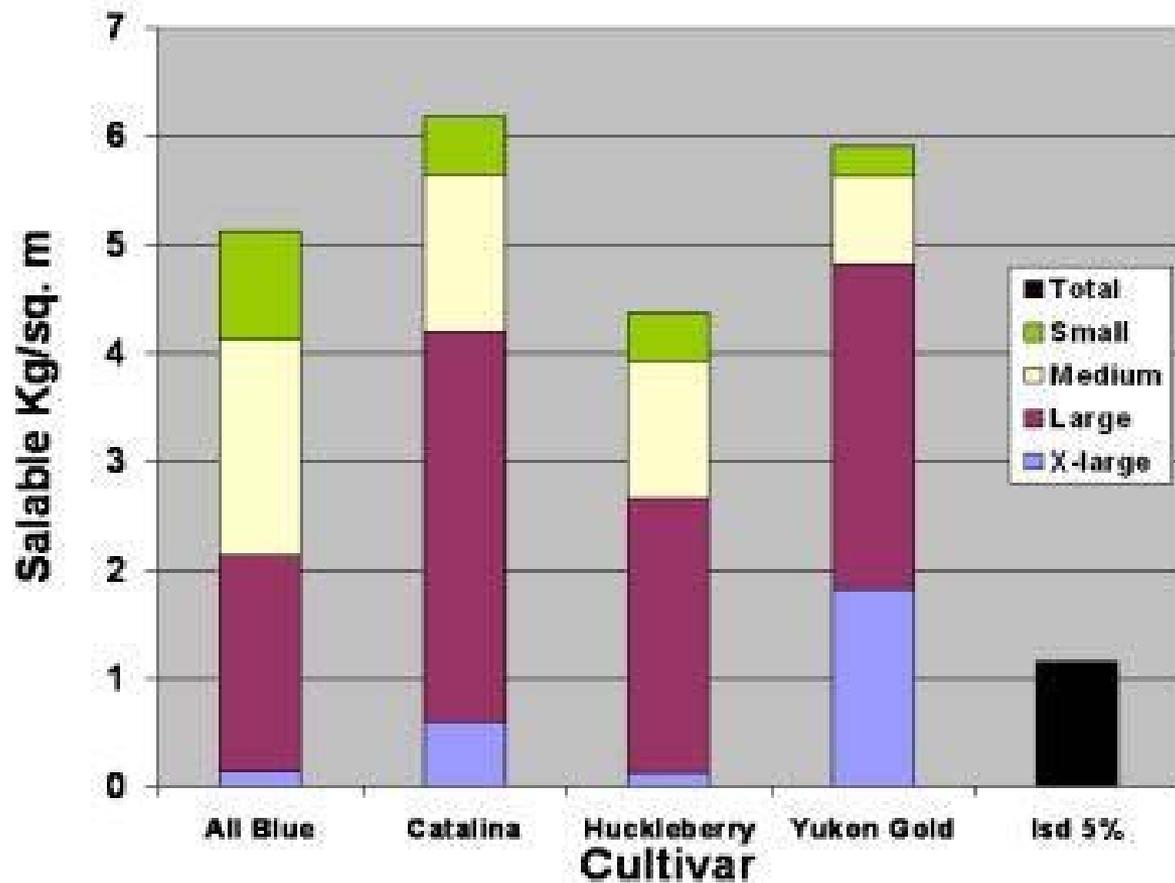
Huckleberry

Yukon Gold

**Method: Sub-irrigated 18.9-liter bags with
5.7 liters of growing medium plus dry grass**







Apr. 17 - Aug. 1, 2003; 106 days

***Huckleberry* yielded lower than**

All Blue, Catalina or Yukon Gold

Growing medium cost

US\$ 1.19/kg of potatoes

This is too high.

To compare 3 growing methods

A.) 11.4-liter polyethylene bag

B.) 18.9-liter polyethylene bag

2 seed tubers/bag

4 liters of peat-perlite per bag (= 2 liters/seed piece)

hill with dry grass

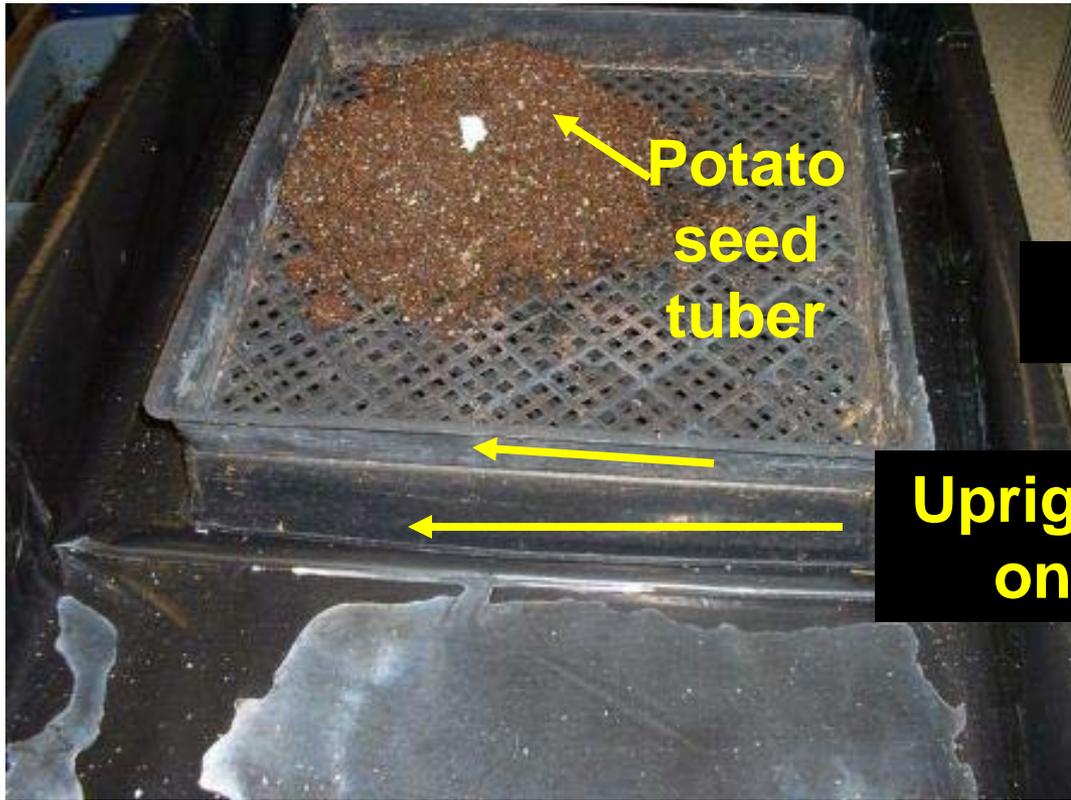
C.) Nursery trays elevated 5 cm

3 seed tubers

6 liters of peat-perlite (= 2 liters/seed piece)

hill with dry grass





**'Hill' with
dry grass**

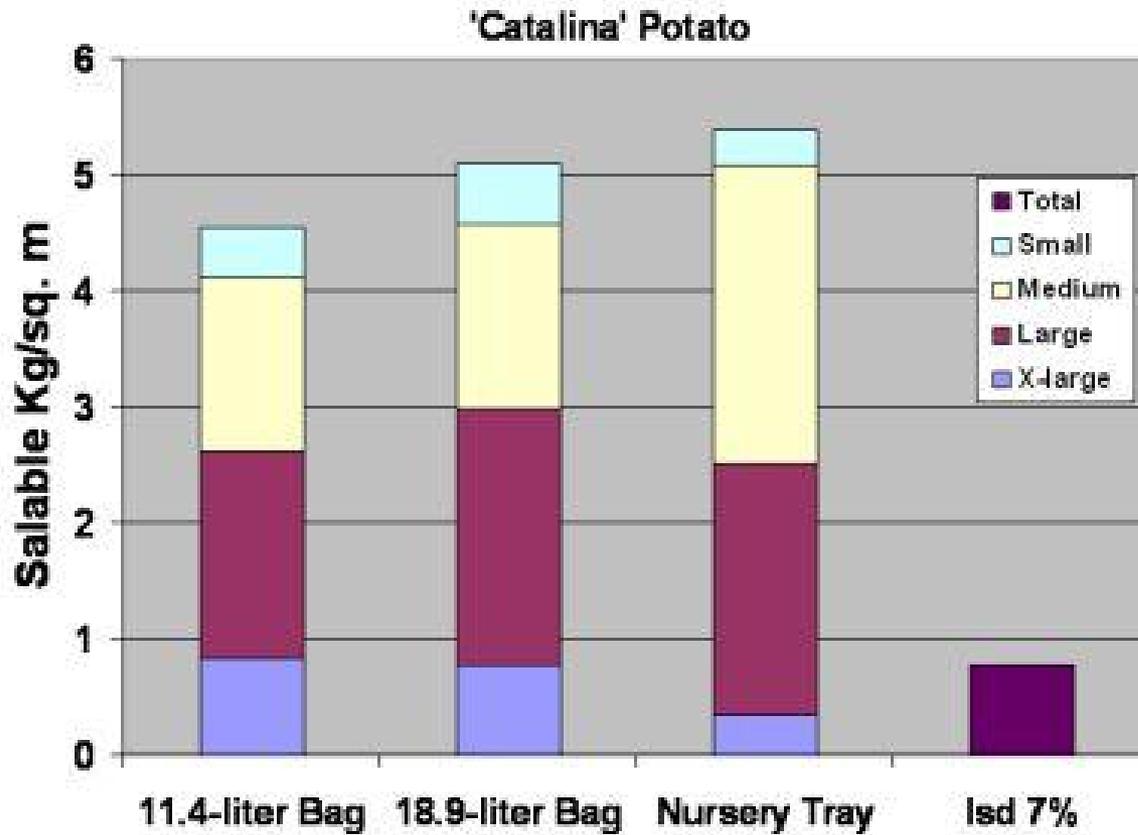
**Potato
seed
tuber**

**2 liters of medium in nursery tray
per seed tuber**

**Upright nursery tray sitting
on upside -down tray**

2.5 to 5 cm Nutrient solution (1.5 mS)

Feb 26 – June 7, 2002; 101 days



**There was a greater total salable potato yield
with the elevated nursery tray method
than with the 11.4-liter bag.**

***Yields for the 18.9-liter bag and the tray were
similar.***

**Although only 2 liters of growing medium
was used per plant,
@ US\$ 0.20/liter of growing medium
the cost was US\$ 0.86/kg of potatoes.**

**Let's look at more ways to reduce growing medium
cost.**

To reduce growing medium

18.9-liter bags with 2 liters growing medium per plant

10 cm pots

Wrap in newspaper

No growing medium



Grow in 10-cm slit-sided pots
filled with peat-perlite



10 cm pot



Pots were covered with
dry grass



70% savings of
growing medium
as compared to
18.9-liter bag
method





Wrap in
newspaper

No growing medium!



Place on tray

Capillary action wets the
newspaper

Cover with dry grass





Newspaper method eliminates requirement for growing medium, but requires some skill and is time-consuming



Pre-sprout in a tray of growing medium and add a small amount of medium on nursery tray



Upright tray on upside-down tray

**4 liters of
growing
medium**

**Bag is unrolled and
dry grass is added**





Growing in
18.9-liter bag
of peat-perlite

The influence of 4 sub-irrigated methods on total salable yield of 3 potato cultivars.

<i>Treatment</i>	<i>Salable kg/m²</i>
18.9-liter bag	6.06 B
10-cm pot	5.65 B
Wrap in Newspaper	5.32 B
No Growing Medium	1.02 A

Dec. 3, 2003 – Apr. 12, 2004 ; 122 days

Growing medium cost

	US\$/kg
18.9-liter bag	0.74
10-cm pot	0.24
Wrap in newspaper	0
No growing medium	0



Wrap in newspaper + dry grass

18.9-liter bag with peat-perlite + dry grass

Yields from the 18.9-liter bags, the 10 cm pots and the wrap in newspaper treatments were similar.

As compared to the 18.9-liter bags with 2 liters of growing medium per seed piece-

The *10 cm pots* saved 70% of the growing medium (\$0.24/kg) and the *wrap in newspaper* treatment saved 100% of the growing medium.

The no medium treatment was unsuccessful.

To test 3 growing media in sub-irrigated 11.4-liter pots filled with 4.5 liters of growing medium and with upside-down 3-liter pots to conserve growing medium

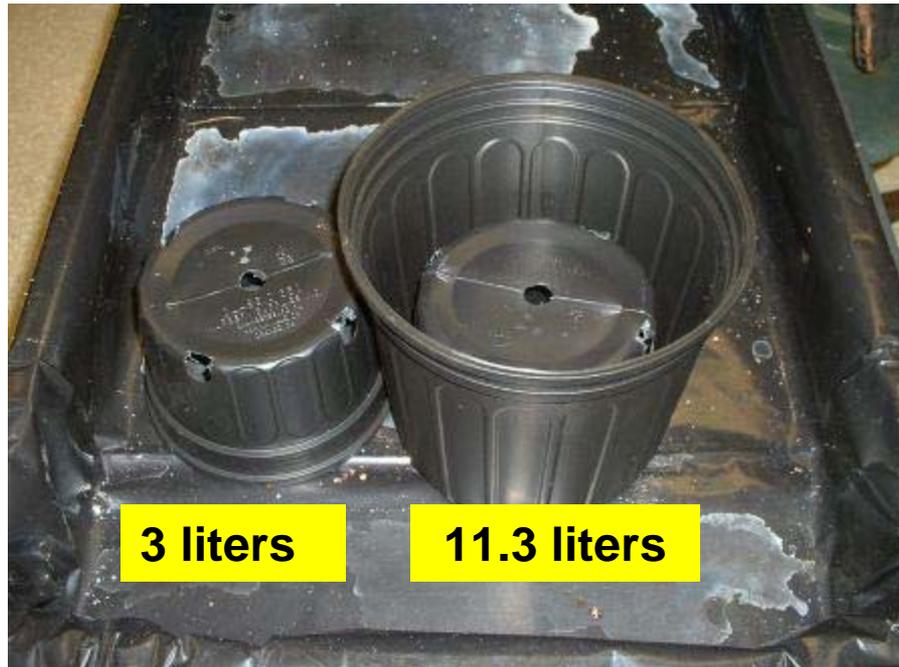


Three growing media were tested:

Peat-perlite (Expensive)

Dried soil (Inexpensive)

Wood chips (Inexpensive)



Upside-down pot in a pot

**Sub-irrigates
through holes in
bottom of pot**



Peat-perlite





**Semi-decayed wood
chips**





Soil

2.5 to 5 cm of nutrient solution

Soil

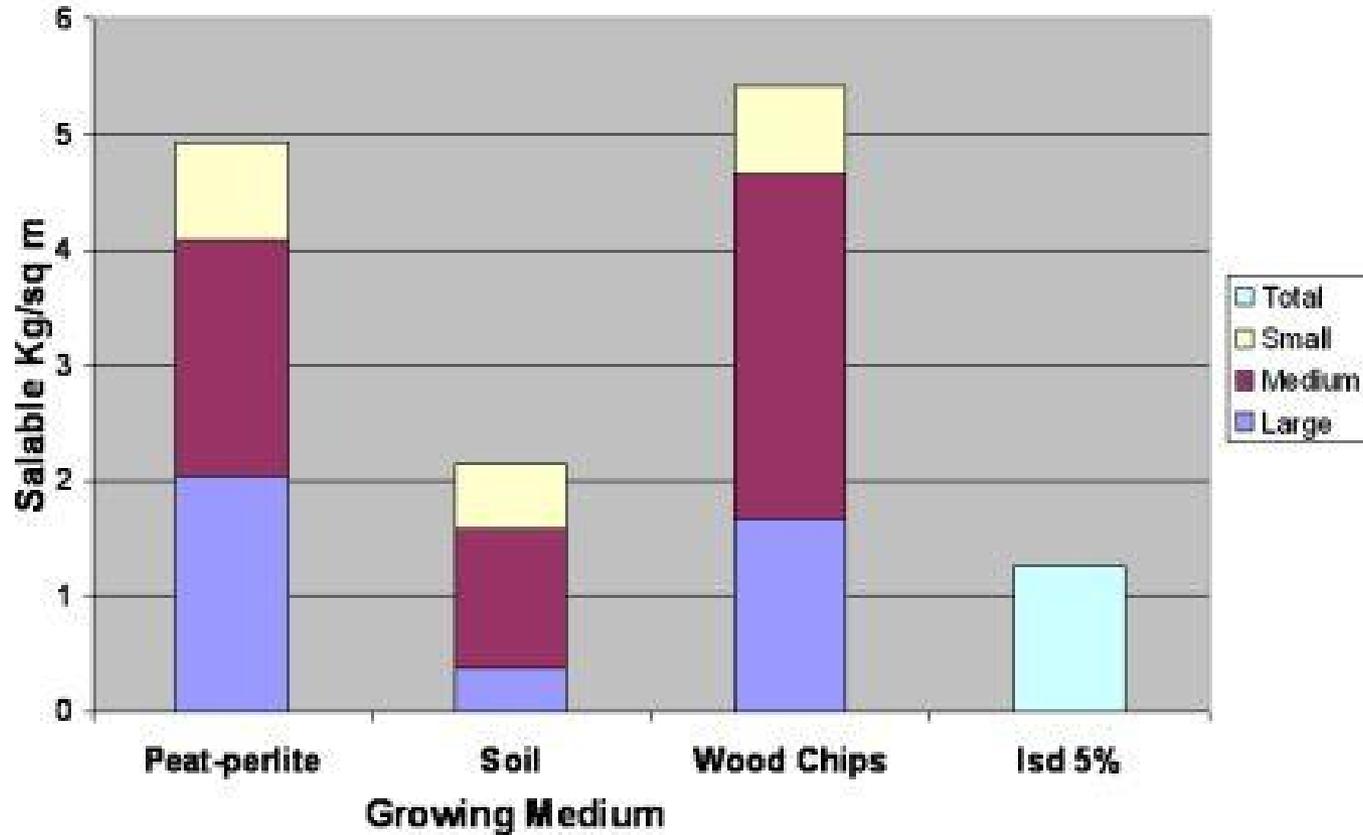




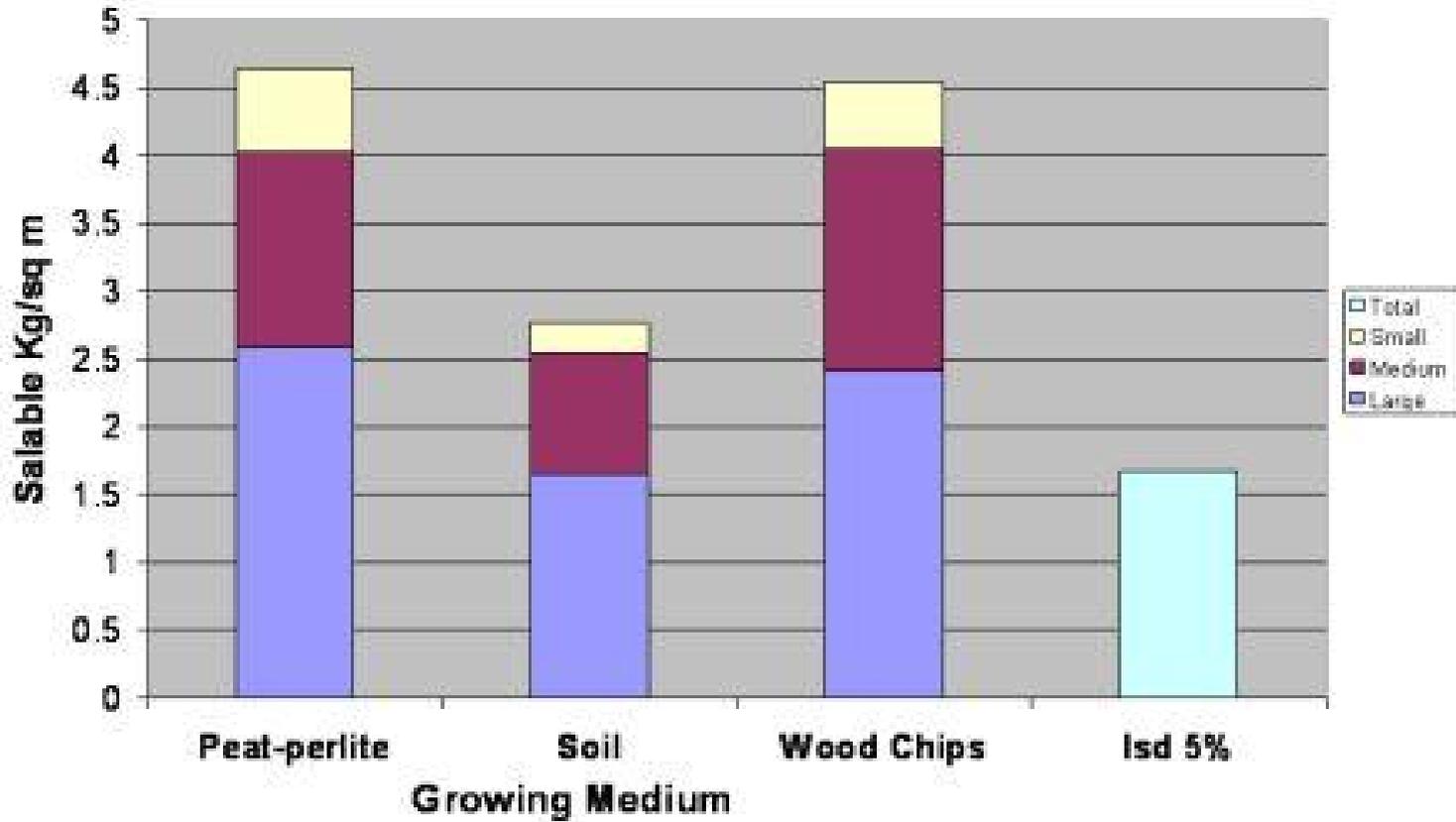
May 10 – Sept. 2, 2005; 115 days

All Blue

'All Blue' Potato



Yukon Gold



Potatoes growing in wood chips grew as well as those in peat-perlite, but yields were much lower in the soil medium.

To test 3 methods of growing potatoes with a wood chip growing medium

Three seed pieces are planted in trays (36 x 36 x 12.7 cm) resting on 5 cm high upside down trays.



Growing medium consists of wood chips which are semi-decayed with a pH of 4.5. (Dry grass is added to all pots)

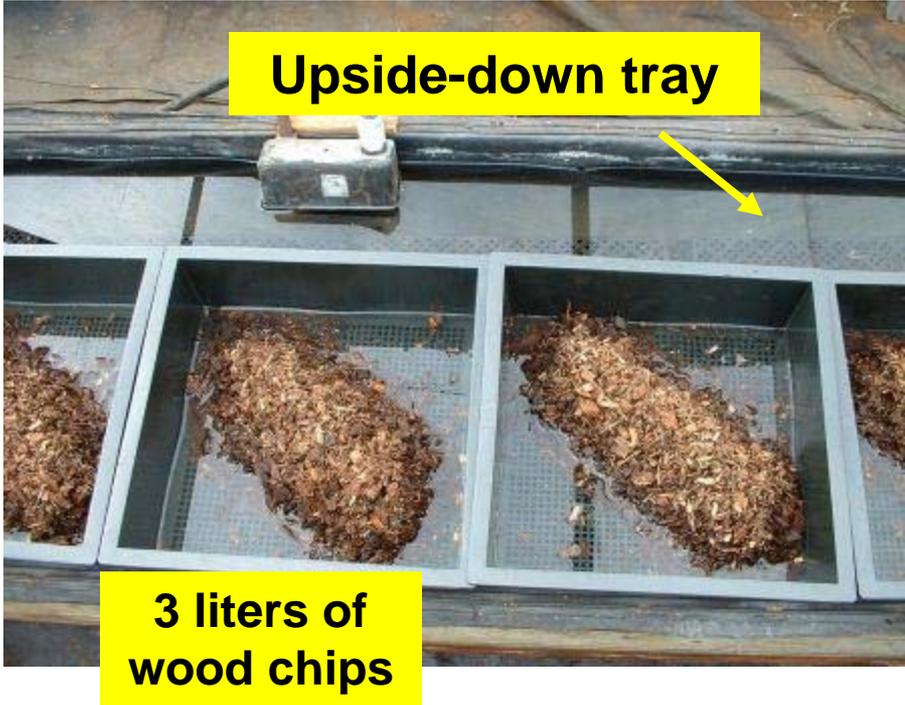
Treatments are:

3 liters/tray

8 liters/tray

4 liters/tray plus 2 upside-down pots with slit sides.







3 liters of wood chips





**4 liters of
wood chips**

**The pots take up
space, thus
reducing the need
for growing
medium**



**Dry grass was placed
over the wood chips**

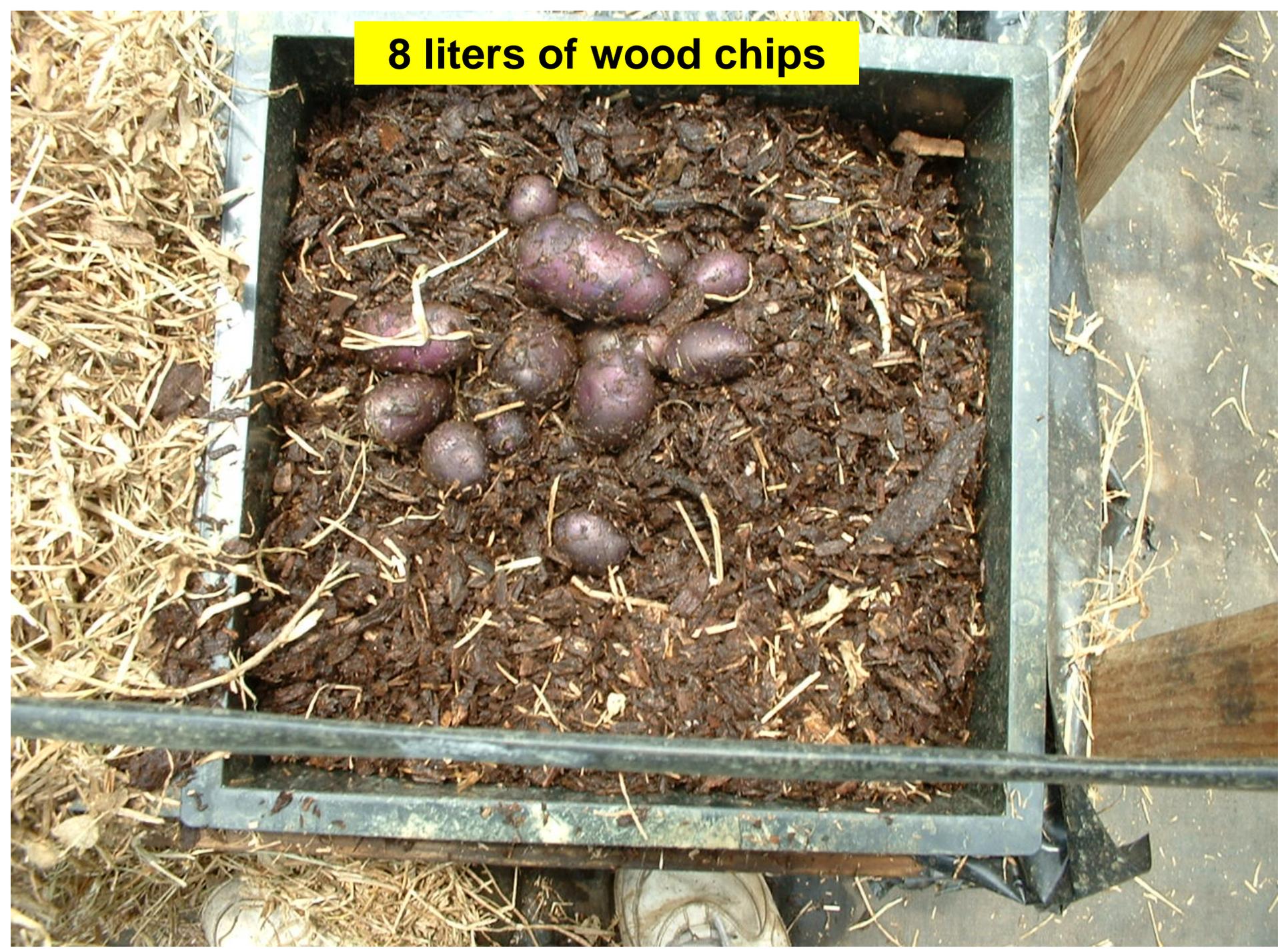
**4 liters of wood chips
plus upside-down pots**



A rectangular tray filled with wood chips, with a yellow text box overlaid. The tray is placed on a dark surface, possibly a table or floor. The wood chips are brown and vary in size. The text box is yellow with black text.

8 liters of wood chips

8 liters of wood chips



Average Yields of *All Blue* and *Yukon Gold* potatoes

(Jan. 25 – May 15, 2006; 110 days)

Kg salable potatoes

Per square m of tank

3 liters of wood chips/tray	3.00 ns
4 liters + upside-down pots	2.77 ns
8 liters of wood chips/tray	3.17 ns

Yields were rather low.

There was no differences amongst treatments

To grow potatoes with 1 liter of growing medium per plant and test 2 versions of the inexpensive wood chip medium against peat-perlite medium

Plant 3 seed pieces in 36 x 36 x 12.7 cm trays resting on 5 cm upside-down trays. There were 3 liters of growing medium per tray.



Growing medium treatments

Semi-decayed wood chips

Younger, undecayed wood chips from top of pile

Peat:perlite 1:1



Undecayed wood chips



Hill with dry grass



Yukon Gold

(Aug. 17 – Dec. 22, 2006; 127 days)

**Total salable kg/square m
of tank**

Semi-decayed wood chips	4.3
Undecayed wood chips	3.1
Peat-perlite	5.2

Peat-perlite growing medium is superior and semi-decayed wood chips were better than undecayed wood chips

To Test 3 growing methods

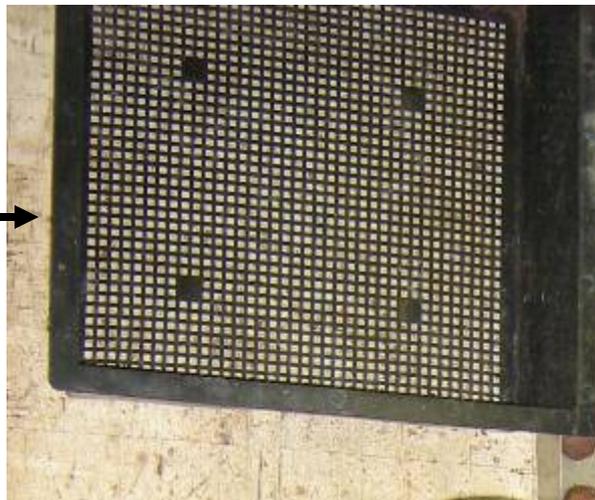
Tray, 36 x 36 x 12.7 cm resting on upside-down nursery tray with 2 liters of growing medium per tray (0.5 liter/tuber) and hilled with dry grass

Upside-down 3 liter pots in upright 11.3 liter pots with 500 ml of growing medium/pot and filled with dry grass

Paper toweling wick over upside-down nursery trays and extending into nutrient solution



36 x 36 x 12.7 cm tray
with perforated bottom



Tank

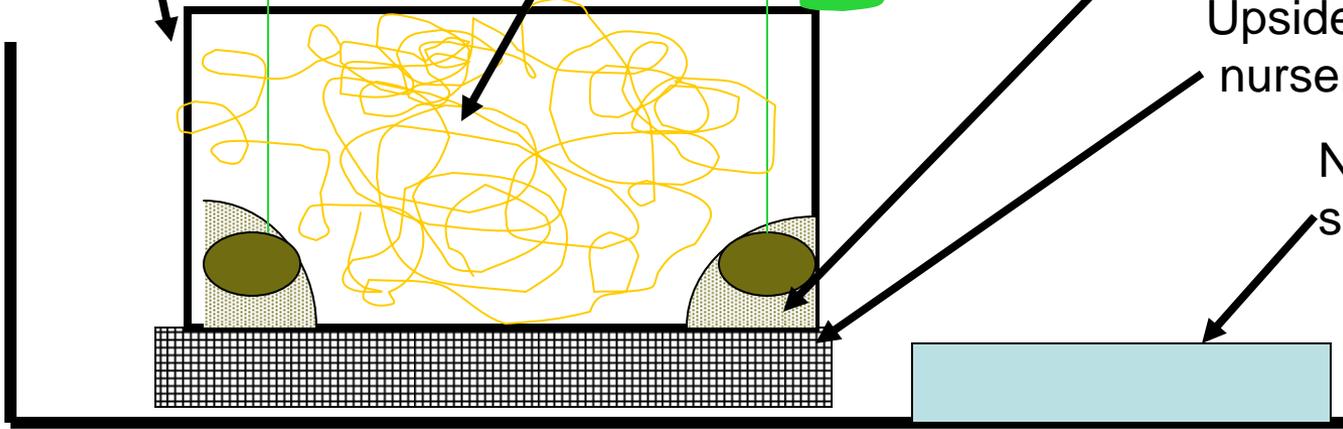


Dry
grass

500 ml
Growing medium

Upside-down
nursery tray

Nutrient
solution





11-liter pot

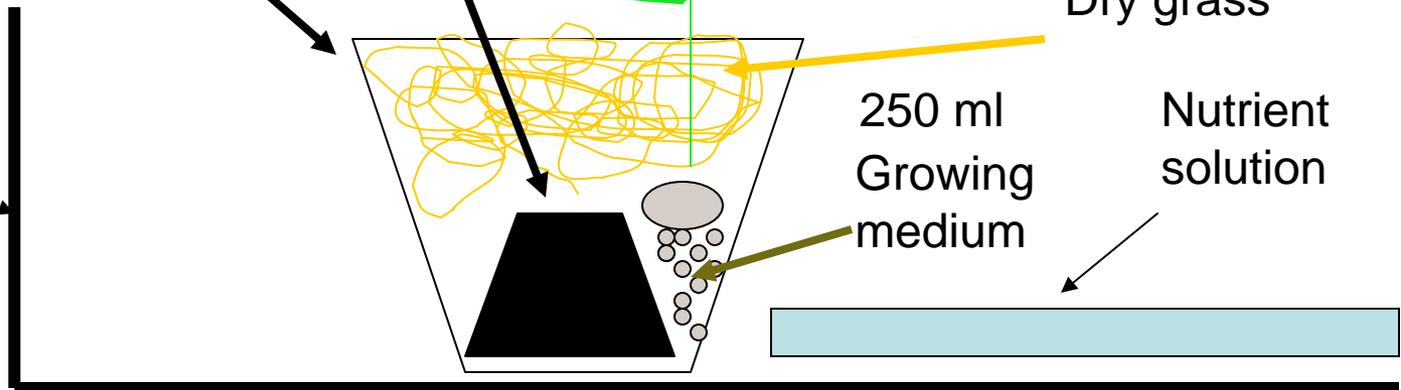
Upside-down 3-liter pot

Dry grass

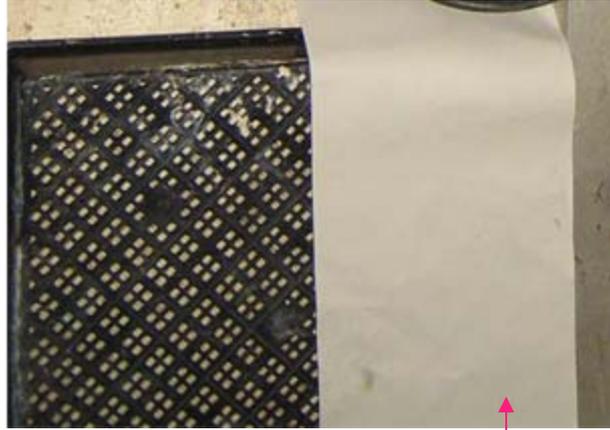
250 ml
Growing
medium

Nutrient
solution

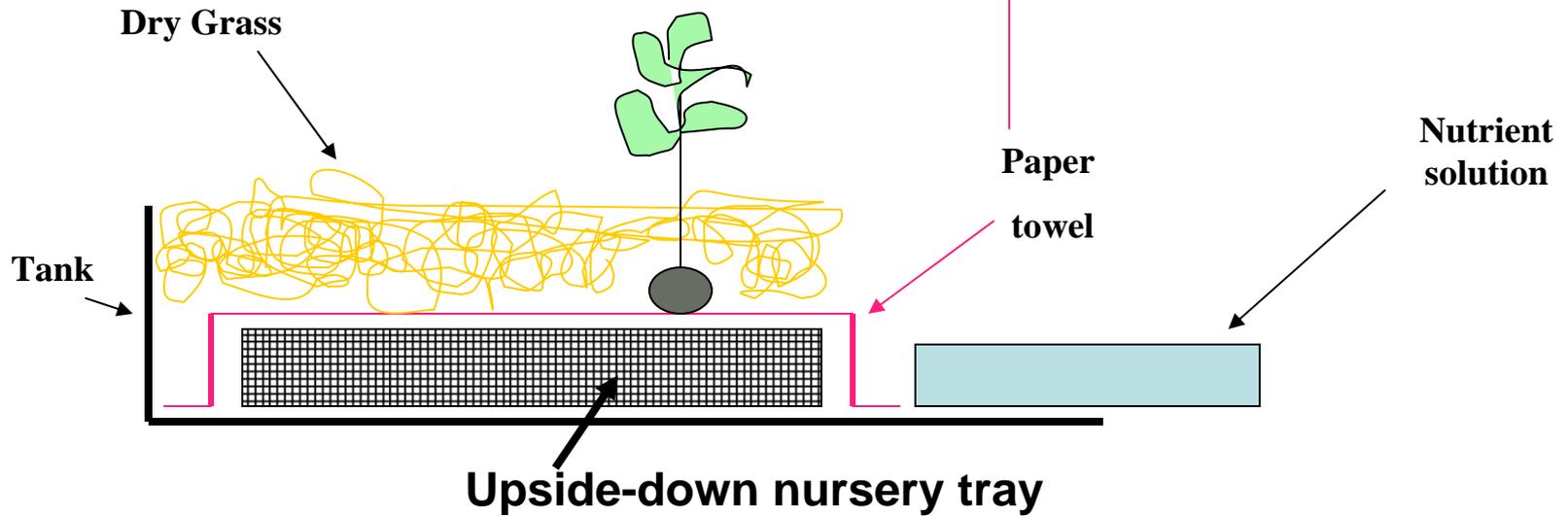
Tank



Upside-down nursery tray →



**No
growing
medium**

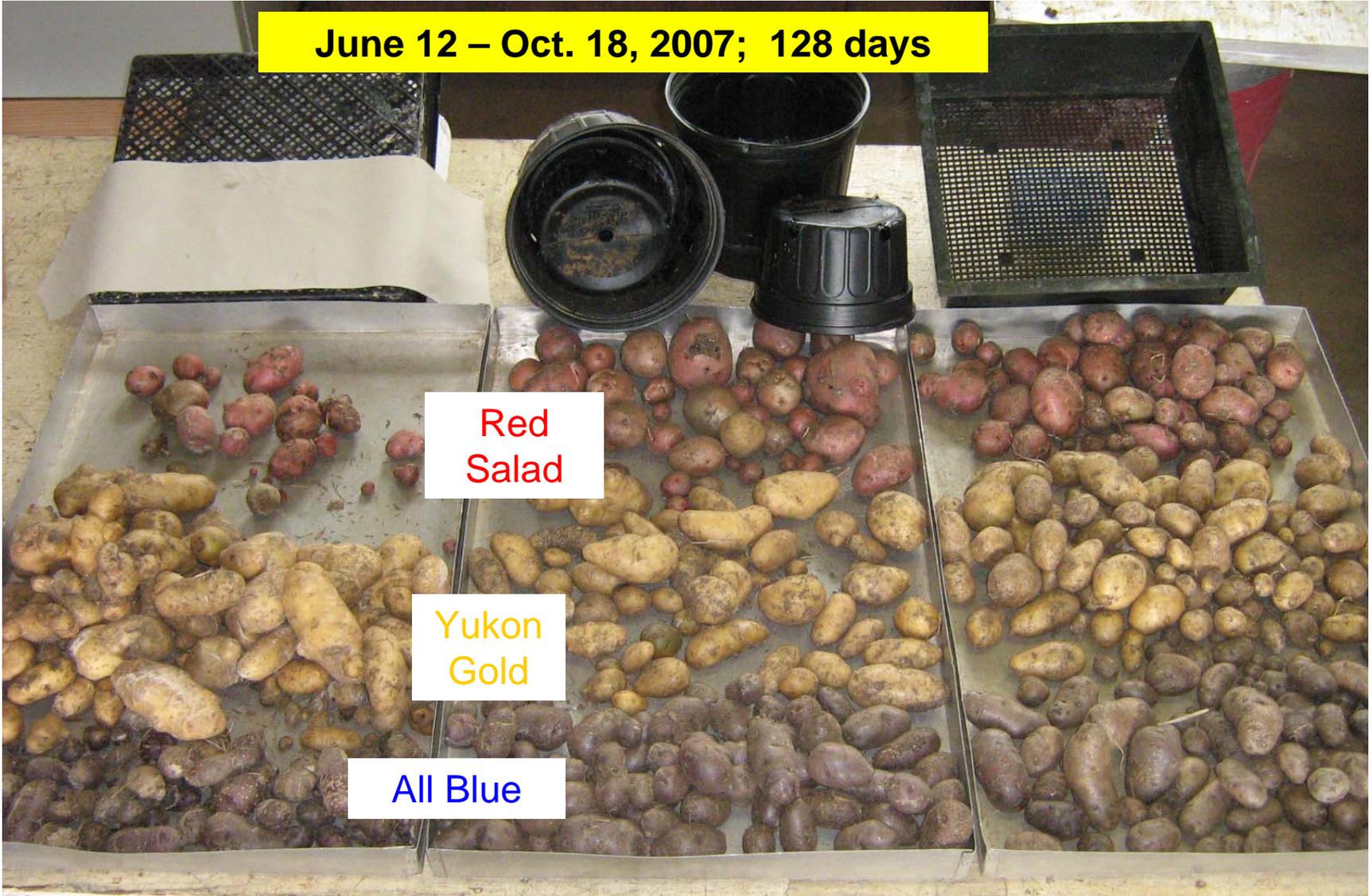


June 12 – Oct. 18, 2007; 128 days

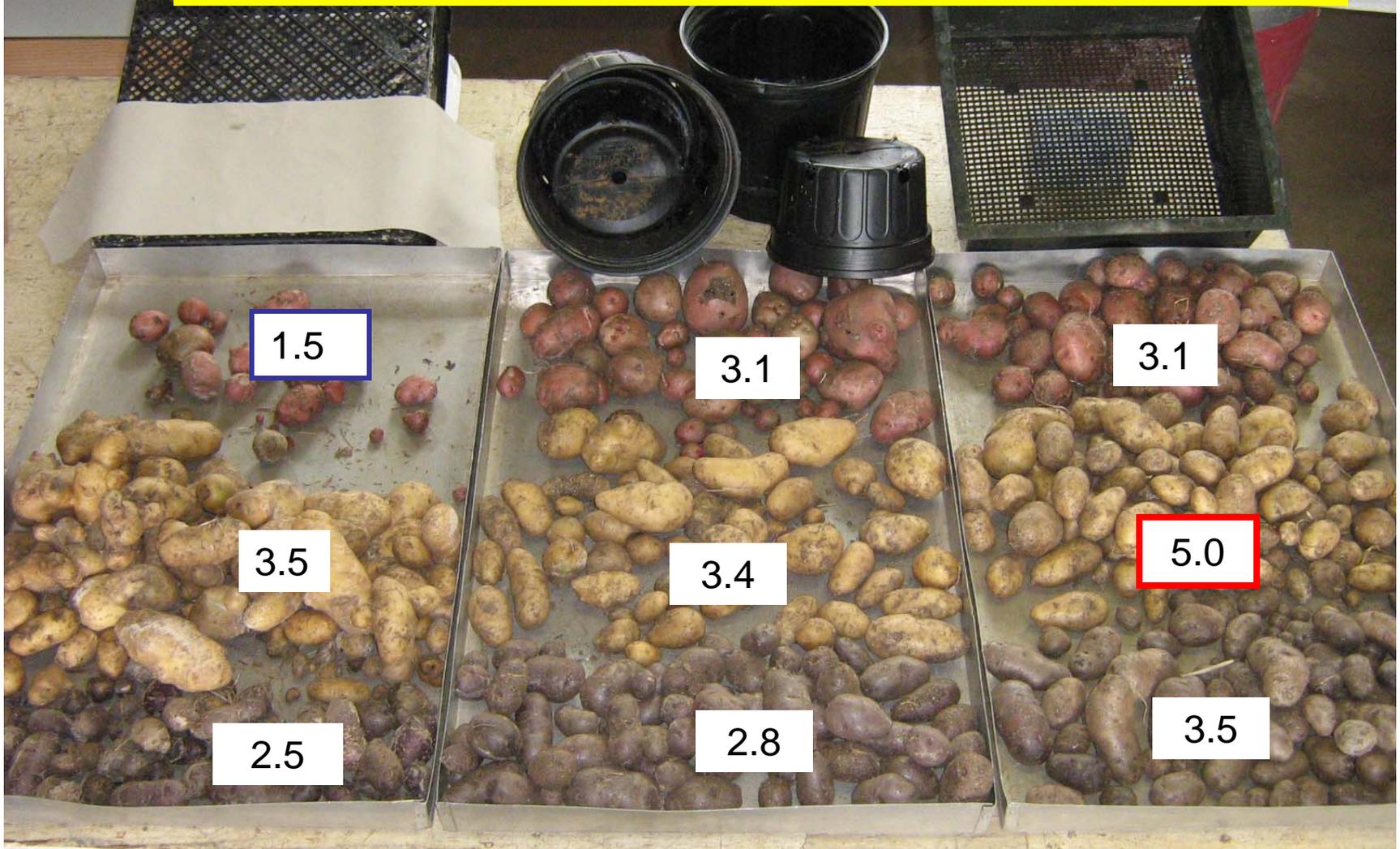
Red
Salad

Yukon
Gold

All Blue



Kg/sq. m of tank of small, medium and large potatoes



1.5

3.5

2.5

3.1

3.4

2.8

3.1

5.0

3.5



\$US per kg of potatoes for growing medium @ \$0.21/liter

The tray method gave best yields, but had higher growing medium costs.

These growing medium costs are around half as much as from original bag methods.

Wick method eliminates growing medium costs, but yield was lower than tray method.

Growing medium cost for pot method was lower than tray method because only half as much medium was used.

Conclusions

At an 800 m elevation greenhouse site in Hawaii, various sub-irrigation methods resulted in yields of around 5 kg/square m of tank.

Higher yields were obtained from 52 g seed tubers than 4 or 20 g tubers.

***Huckleberry* yielded lower than *All Blue*, *Catalina* or *Yukon Gold*.**

Growing medium cost was more than US\$1/kg when grown in sub-irrigated bags with 2 to 2.8 liters of medium/plant (+ dry grass).



An elevated nursery tray method provided equal or better yields than than sub-irrigated bag methods.



Growing medium cost in elevated 10-cm pots was \$0.24/kg potatoes, but growth appeared to be restricted.



The wrap in newspaper method provided good yields and there was no growing medium cost, but wrapping was time consuming.



Potatoes grew as well in wood chip medium as peat-perlite in one trial, but not in another trial.



A wick method eliminated growing medium costs, and yield was similar to a pot-in-pot method but lower than an elevated tray method which had growing medium costs of around half as much as from original bag methods.



**More research is needed to develop methods
which don't require growing medium.**

A photograph showing several ginger plants (Zingiber officinale) growing in sub-irrigated bags. The plants are lush green with long, lanceolate leaves. They are planted in a growing medium contained within bags that have a reflective, silver-colored material on the bottom. The plants are arranged in rows, and the background shows a wooden structure and a paved area.

Zingiber officinale Roscoe

**Ginger growing in
sub-irrigated bags
of growing medium**



Mother seed piece

ALOHA

