UM Potato Breeding and Genetics

Jeff Miller, Scientist (Breeding germplasm management, Field, Lab, Storage, Post-harvest analysis, Selection, Seed distribution, Reports & Direct link to Northern Plains growers)

Dr. Sanjay Gupta, Research Fellow (Potato Storage Biochemistry)

Christian A. Thill

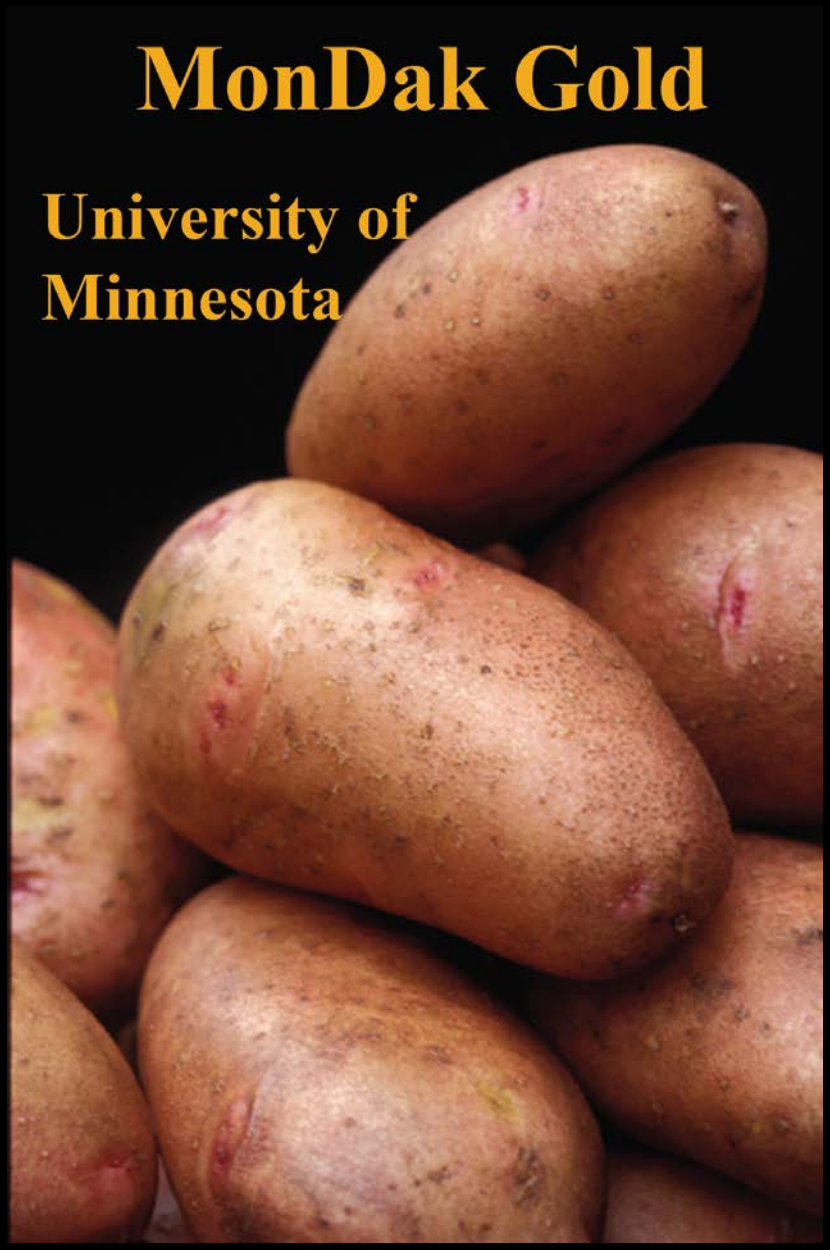
University of Minnesota,
Department of Horticultural Science

FRY PROCESSING SELECTION LOCATIONS

Williston ND

USDA /ARS Potato Research Worksite

Becker, MN;
Edling Farms
Wingard Farms



INVEST IN GOLD

MonDak Gold

(LOW ACRYLAMIDE (< 150ppb, USPB Fry trials), **GOLDEN Fries)**

Incentives for production: The tubers of MonDak Gold have a uniform shape with a smooth skin and light yellow flesh; >92% of the tubers are US No. 1. French fry processing color is excellent from 45F. Tuber set averages 10 tubers/plant with >60% over 6oz. Specific gravity of MonDak Gold ranges 1.080 - 1.085. Smaller tubers may be marketed for fresh market due to their light yellow flesh.

Strengths: MonDak Gold has a smooth red to pink color skin, light yellow flesh, oblong tuber shape, and excellent cooking qualities that make it suitable for French fry processing and tablestock use. MonDak Gold has low acrylamide and frys late from storage. Internal quality is excellent. MonDak Gold is resistant to PVY and PLRV, and has moderate field tolerance to CPB, and Verticillium wilt.

Culinary Quality: MonDak Gold can be used for processing into fries, fresh market baking, mashing, roasting, and microwave cooking.

Seed availability: Virus-free tissue culture plantlets of MonDak Gold are available from the University of Minnesota Potato Breeding program. Tissue culture plantlets are available from the MN. Dept. of Agr. Seed Potato Certification, **www.mnseedpotato.org**

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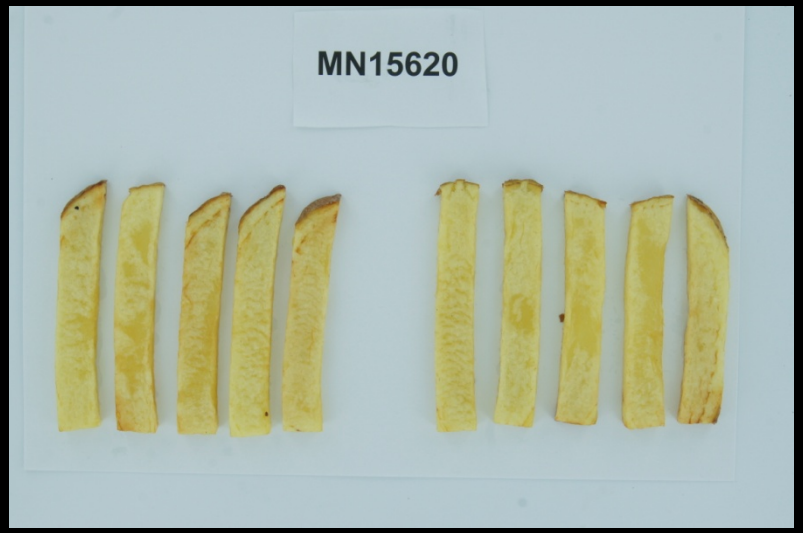
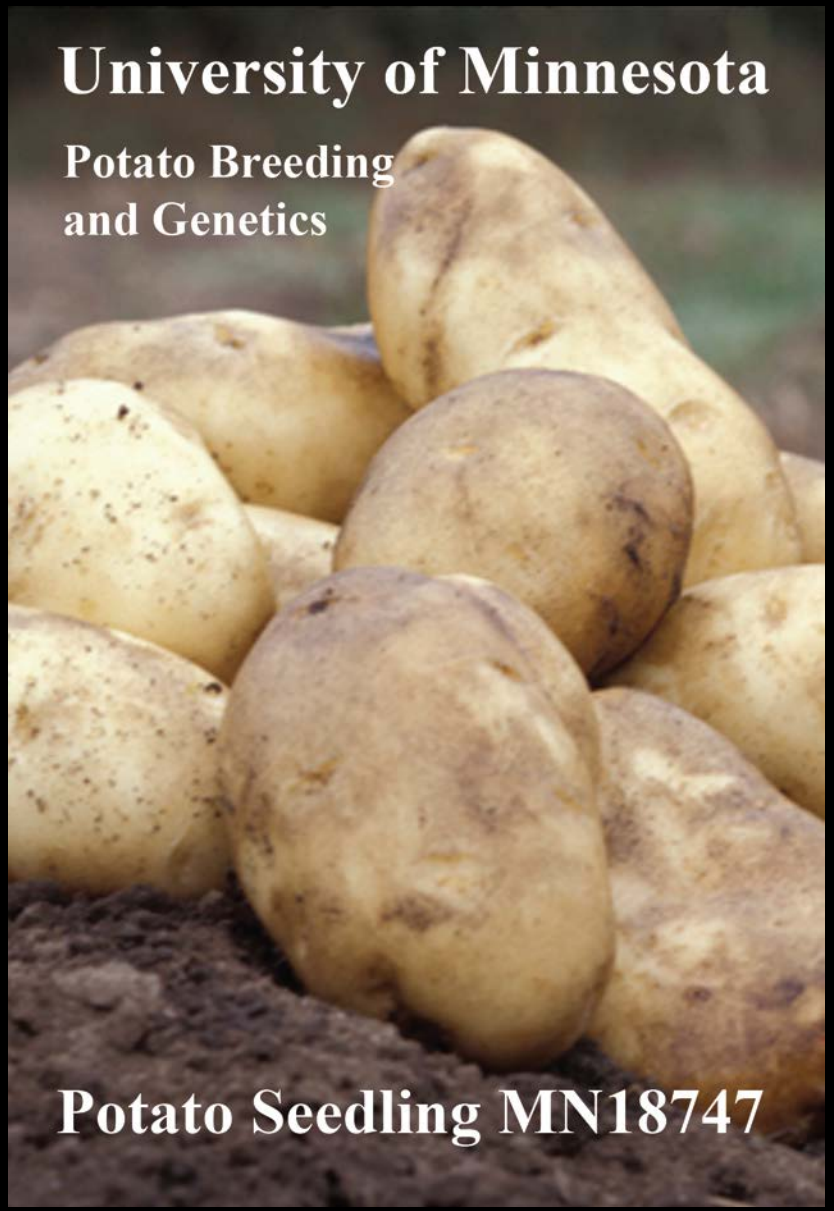
Potato Research Team

This potato research is a collaborative effort of the potato research programs at the University of Minnesota and the NDSU Williston Research Extension Center; with assistance from the Williston Area Ag. Diversification Group, Spud Viking Consulting, and the Northern Plains Potato Growers Association. These organizations work together conducting potato research and varietal testing for developing cultivars for specific markets and adapted to the MonDak and Northern Plains region.

MonDak Gold Semi-Commercial testing @ Williston, ND 10MO@45F





MN18747

Parentage: ND 2264-7 x MN 47.82-6 (MN 14489)
Developers: University of Minnesota, Minnesota Agricultural Experiment Station.
Strengths: MN18747 is a seedling selected by C. Thill having a bright white skin color, white flesh, and blocky to oblong uniform tubers. Its use is for early French fry processing, it has low acrylamide formation, and excellent internal quality. MN18747 expresses normal symptoms of PVY, and is resistant to common scab.
Incentives for production: The tubers of MN18747 have a uniform blocky shape with a smooth bright skin and white flesh. Tuber set averages 7 tubers/plant with >55% early harvest and >80% late harvest over 6oz. Early French fry processing color is excellent as is from 48F storage. Specific gravity of MN18747 is 1.080.

(LOW ACRYLAMIDE (<150ppb USPB national testing), **EARLY)**

Morphological Characteristics:

Plant: Dark green foliage; intermediate to stemmy erect vine and tall in height, large oblong leaflets that provide good bed cover. Vigor is excellent.
Tubers: The tubers are smooth, white color skin, white flesh, and a blocky-oblong uniform tuber shape. MN18747 has excellent internal quality.
Flower: Flowers are red violet with prominent white tips that fade to white.

Agronomic Characteristics:

Foliage: Dark green foliage with large oblong leaflets.
Maturity: Medium to early bulking.
Yield: Tubers bulk early and yield it moderate to high in Minnesota irrigated.
Specific Gravity: Moderate, ranging from 1.077 to 1.081 in Minnesota irrigated.
Storability: Medium dormancy, i.e. slight sprouting at 5 months.
Culinary Quality: MN18747 tubers can be used for fresh market baking, mashing, and microwave cooking and for processing into French fries.
Diseases reaction: Normal symptoms of PVY and PLRV infection, resistant to common scab, susceptibility to CPB, Verticillium wilt, and late blight.
Seed availability: Virus-free tissue culture plantlets of MN18747 are available from the University of Minnesota Potato Breeding program as are small amounts of seed. Tissue culture plantlets are available from the Minnesota Department of Agriculture, Seed Potato Certification, **www.mnseedpotato.org**.

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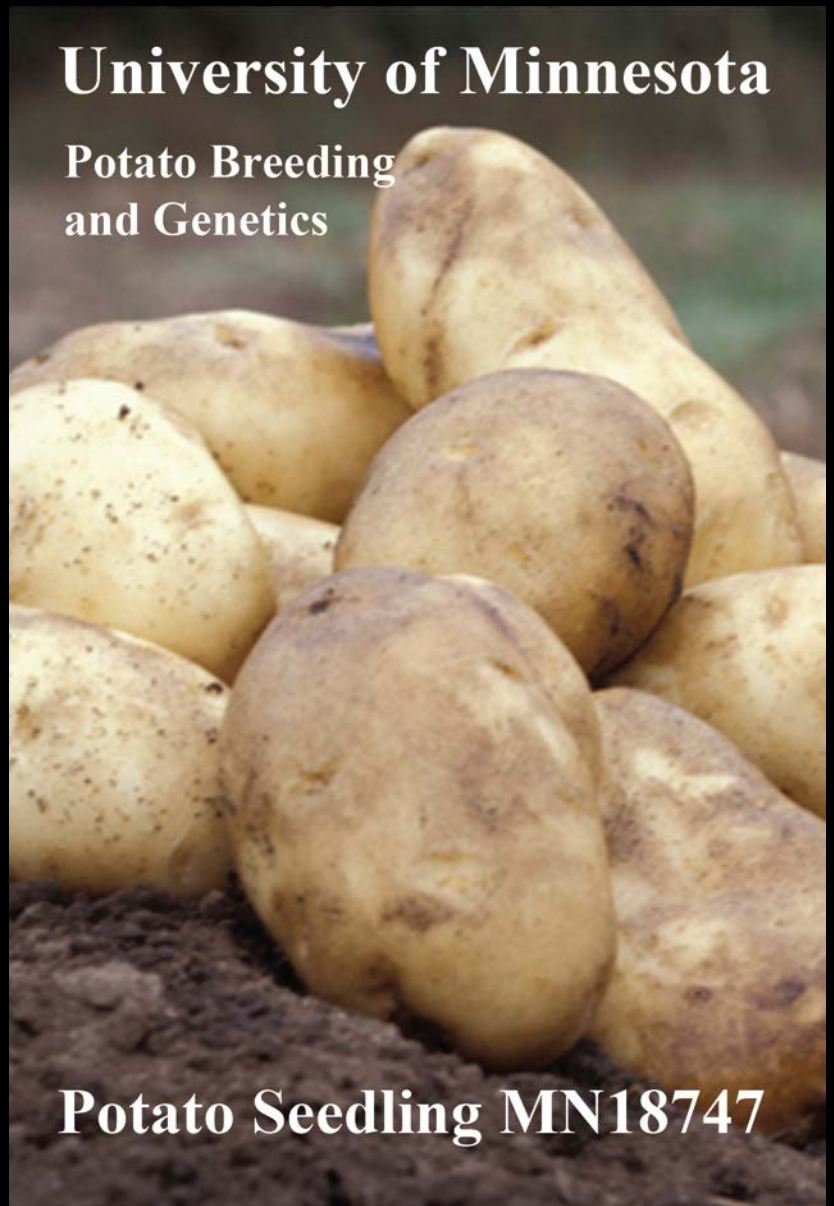
North Central Potato Breeding Team

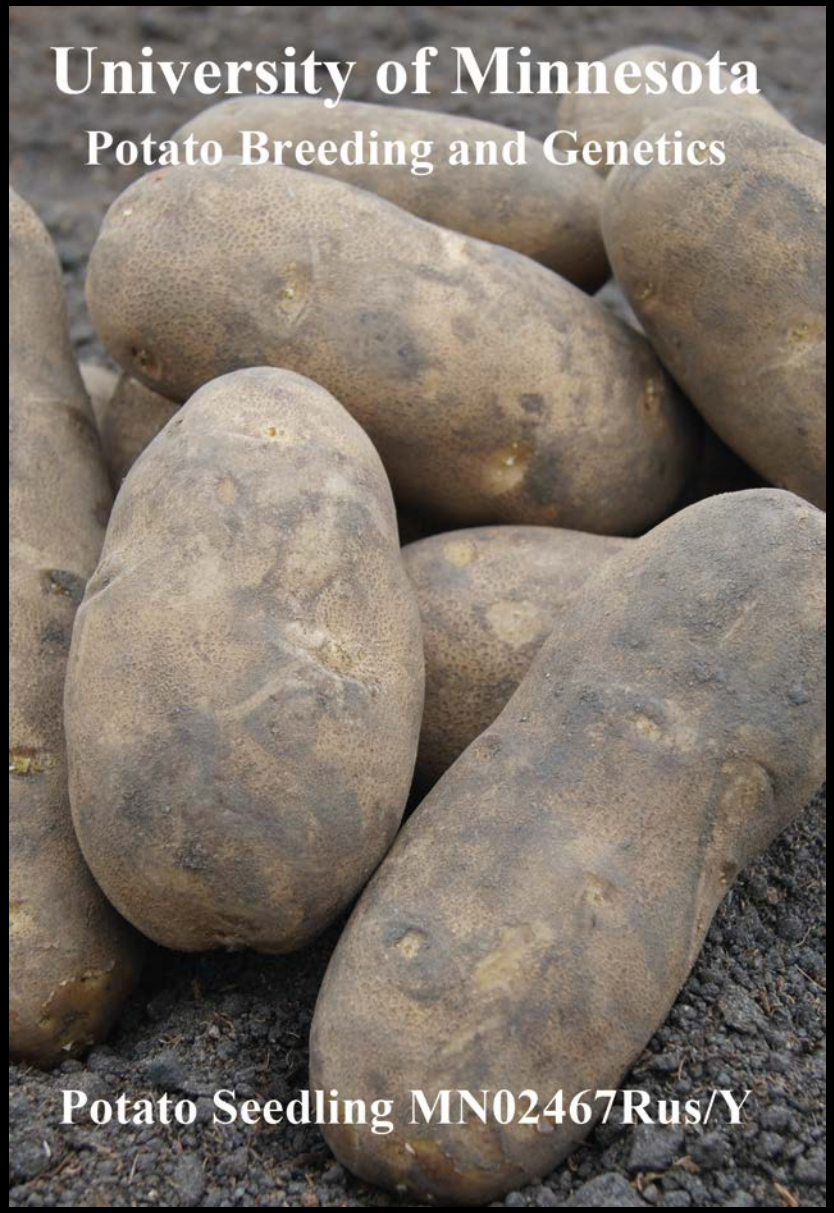
The North Central Potato Breeding Team is a cooperative effort of the potato research programs at Michigan State University, the University of Minnesota, North Dakota State University, and the University of Wisconsin. The four states work together conducting breeding and genetic research, disease and pest resistance screening, develop improved cultivars, and enhance germplasm with the potato industry in the North Central Region. Teams of researchers from the four cooperating institutions apply conventional and molecular breeding strategies to develop and test improved cultivars for specific markets.

MN18747
Our experience to date



Maturity	**Early season**
Yield	**Medium, 95% US#1**
SpGr	**1.078 – 1.080**
Processing	**Early field, short storage @ 45F**

EARLY
(200 seedling transplant yield @ 75 days [PLWR] = 250# N class seed)



MN02467Rus/Y

Parentage: MN Family #51 x (OP)
Developers: University of Minnesota, Minnesota Agricultural Experiment Station.
Strengths: MN02467Rus/Y is a seedling selected by C. Thill having a smooth russet skin, uniform oblong tuber shape with shallow eyes, yellow flesh, and excellent French fry quality. Its use is for both French fry processing and Fresh market.
Incentives for production: The tubers of MN02467Rus/Y have a uniform shape with a russet skin and yellow flesh. Tuber set averages 8 tubers per plant and 64% over 6oz. and >95% of the tubers are US No. 1. MN02467Rus/Y specific gravity ranges from 1.080 – 1.084. Early French fry processing color is excellent as is from 48F storage. Internal quality is good to excellent; some Hollow heart noted.

LOW ACRYLAMIDE (<225ppb, USPB national testing)

Morphological Characteristics:

Plant: Medium to dark green foliage; tall semi-erect vine; intermediate to full canopy with large oblong leaflets providing good bed cover. Vigor is excellent.
Tubers: Russet skin, yellow flesh, oblong uniform tuber shape with shallow eyes, and excellent internal quality. Some hollow heart noted similar to Russet Burbank.
Flower: Red violet with white tips.

Agronomic Characteristics:

Foliage: Medium to dark green foliage with large oblong leaflets.
Maturity: Full season.
Yield: Medium yield, slightly less than Russet Burbank.
Specific gravity: Moderate to high, 1.080 in Minnesota irrigated and 1.084 in Nesson Valley irrigated (Williston, ND).
Storability: Medium long dormancy.
Culinary quality: MN02467Rus/Y tubers can be used for Fresh market baking, and for processing into French fries giving a nice golden colored French fry.
Disease reaction: MN02467Rus/Y expresses normal symptoms of PVY and PLRV, susceptible to common scab and late blight.
Seed availability: Virus-free tissue culture plantlets of MN02467Rus/Y are available from the University of Minnesota Potato Breeding program as are small amounts of seed. Tissue culture plantlets are available from the Minnesota Department of Agriculture, Seed Potato Certification, **www.mnseedpotato.org**.

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MN02467 Strip Trials @ Williston, ND

Maturity	**Full season**
Yield	**Medium to high, 95% US#1**
Specific gravity	**1.080 – 1.086**
Processing	**Early to late *48F**

Advanced processing selections
MN02419

Maturity	**Full season**
Yield	**Medium to high, 95% US#1**
Specific gravity	**1.080 – 1.086**
Processing	**Field and storage @45F**

SELECTIONS

SELECTIONS

FRY PROCESSING SELECTIONS

FRESH RED SELECTION LOCATIONS

Moquist Farms

NPPGA Research Farm

PINE LAKE WILD RICE, GULLY, MN

Williston ND

Becker, MN; Peterson Farms

MN02616R/Y

Parentage: Minnesota Family #149 x OP

Developers: University of Minnesota, Minnesota Agricultural Experiment Station.

Strengths: MN02616R/Y is a seedling selected by C. Thill having a smooth uniform round to oval shape with dark red skin, deep yellow flesh, and excellent internal quality. Its use is for the Fresh market as baked, boiled, salad, fried or grilled.

Incentives for production: The tubers of MN02616R/Y have a uniform round to oval shape with dark red skin and deep yellow flesh. Culinary characteristics are excellent. Tuber set averages 13 tubers/plant and 43% > 6oz. and a large proportion of of the tubers are US No. 1. MN02616R/Y specific gravity ranges from 1.066 - 1.076. Internal quality is excellent.

Excellent culinary quality

Morphological Characteristics:

Plant: Dark green foliage; vine has an erect to spreading growth habit, medium to tall in height; intermediate stemmy to leafy foliage providing full canopy cover over the bed. Vigor is excellent.

Tubers: Dark red skin, deep yellow flesh, round to oval uniform tuber shape with shallow eyes, and excellent internal quality.

Flower: Red violet.

Agronomic Characteristics:

Foliage: Dark green foliage with medium to large leaflets.

Maturity: Medium to full season.

Yield: Medium to high yield.

Specific gravity: Moderate to low.

Storability: Medium dormancy (January - February).

Culinary quality: MN02616R/Y when prepared for Fresh market use as baked, boiled, salad, fried or grilled - its golden flesh makes appealing culinary products.

Disease reaction: MN02616R/Y expresses normal symptoms of PVY and PLRV, susceptible to common scab and late blight.

Seed availability: Virus-free tissue culture plantlets of MN02616R/Y are available from the University of Minnesota Potato Breeding program as are small amounts of seed. Tissue culture plantlets are available from the Minnesota Department of Agriculture, Seed Potato Certification, **www.mnseedpotato.org**.

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RED FAMILY SELECTION @ PLWR

Families = 26

X 200 seedlings/ family

2010 selected = 136 clones

2011 selected = 49 clones

2012 Selected = 17 clones

Advanced red selections

FRESH RED SELECTIONS

CHIP PROCESSING SELECTION LOCATIONS

USDA /ARS Potato Research Worksite

Williston ND

Becker, MN

MN99380-1Y

Parentage: Atlantic x MSA091-1
Developers: University of Minnesota, Minnesota Agricultural Experiment Station.
Strengths: MN99380-1Y is a seedling selected in 1999 having white skin, yellow flesh, smooth uniform tubers, and excellent internal quality. Yield is high. Tubers have moderate specific gravity and good culinary characteristics.
MN99380-1Y has low glucose content and chips acceptably from the field and from cold storage.
Incentives for production: The tubers of MN99380-1Y have a uniform shape with a smooth white skin and yellow flesh. Yield is high with ~ 95% US No.1; and tuber set averages 10 tubers/plant. Attractive chips result after field harvest and late into the storage season.

Morphological Characteristics:

Plant: Light to medium green foliage; semi-erect vine medium in height; closed canopy with small to medium size leaflets.
Tubers: The tubers are smooth and uniform; white skinned, yellow flesh, and round to oval shape. Internal quality is excellent.
Flower: Pale red violet with prominent white tips - fades to white. Male and female fertile; fruit production is evident in the field.

Agronomic Characteristics:

Foliage: Light to medium green.
Maturity: Medium.
Yield: High yield under irrigated conditions.
Specific gravity: Moderate range 1.078 to 1.085.
Storability: Short to medium dormancy.
Diseases reaction: Low incidence of pink rot, susceptible to Verticillium wilt, CPB, slight resistance to common scab and late blight, Hollow heart is rare.
Seed availability: Virus-free tissue culture plantlets of MN99380-1Y are available from the University of Minnesota Potato Breeding program as are small amounts of seed. Tissue culture plantlets are available from the Minnesota Department of Agriculture, Seed Potato Certification, **www.mnseedpotato.org**.

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MN02696

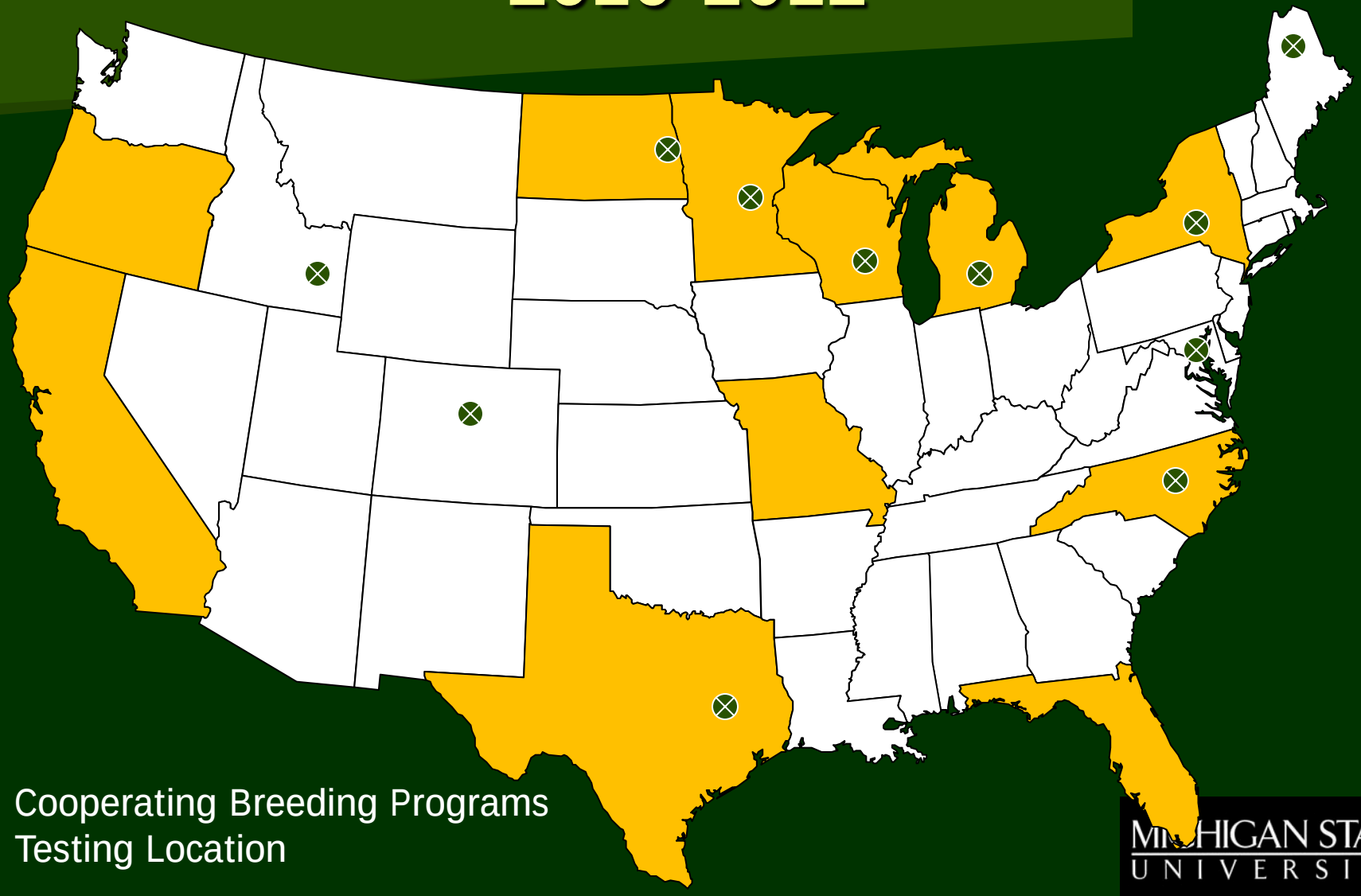




- **Parentage:**
- (OP Seed Chip population)

- A slightly flattened round white chipping potato
- Early - mid maturity
- Gravities ≥ NorValley & Snowden
- Medium yield potential
- Processes directly from 40F

National Chip Processing Trial 2010-2012



MICHIGAN STATE UNIVERSITY

National Chip Processing Trial
Chip Breeding Programs

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MICHIGAN STATE UNIVERSITY

National Chip Processing Trial

- Traits to measure
  - Yield, specific gravity, chip color, defects, breeder merit rating, disease incidence, chip storage in North
- Centralized tissue culture of best lines for timely seed increase
  - Virus clean up if necessary
- Feeder for National SFA Trial and/or Fast-track

MICHIGAN STATE UNIVERSITY


UNIVERSITY OF MINNESOTA
MN04844-07Y
(W2257-2 x Dakota Pearl)

SELECTIONS

	UMORE	Nesson	PLWR	Total
Russet	16	71	100	187
Red	2	6	157	165
Chip	13	1	238	252
Yellow	0	0	40	40
Other		2	4	6
Total	31	80	539	

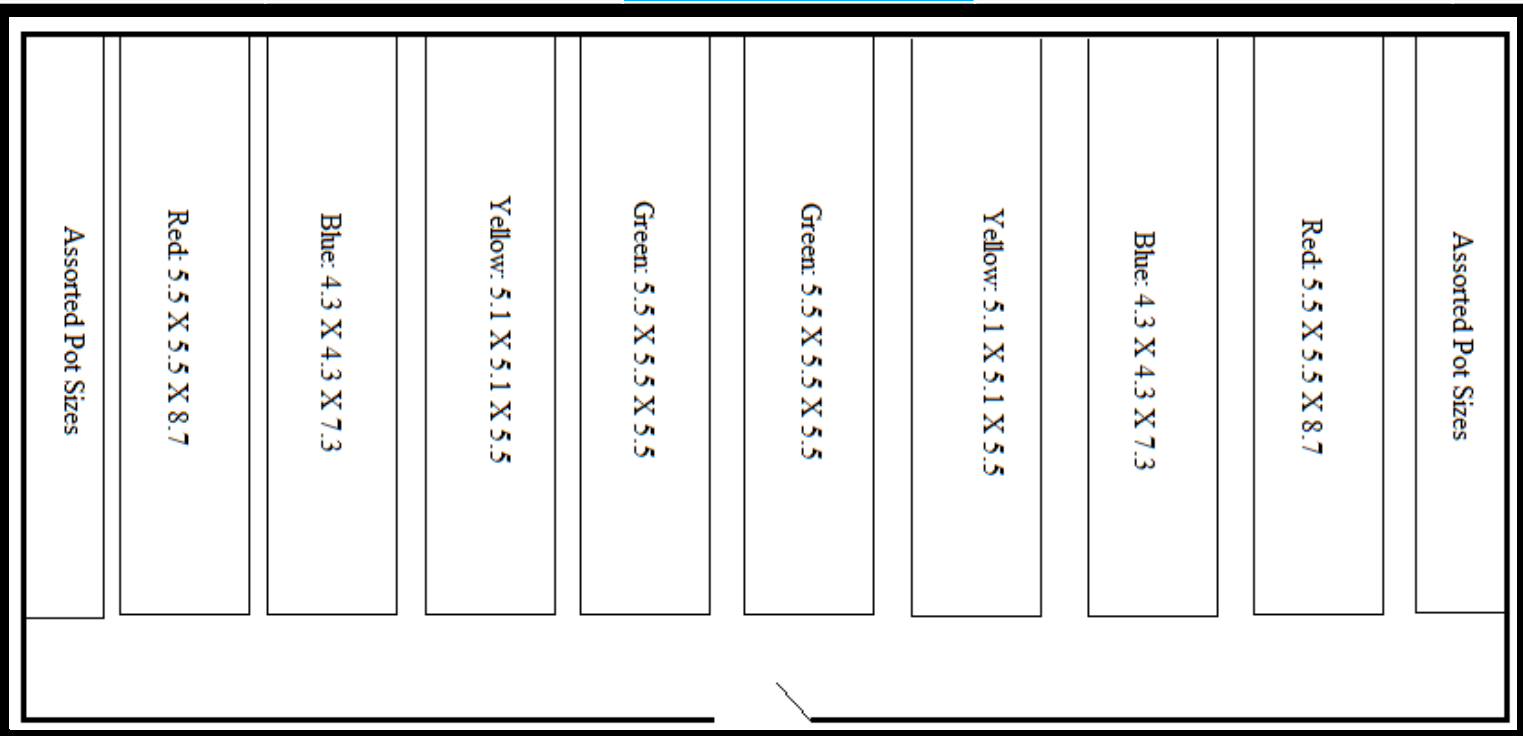
Greenhouse Pot size x pre-nuclear seed production

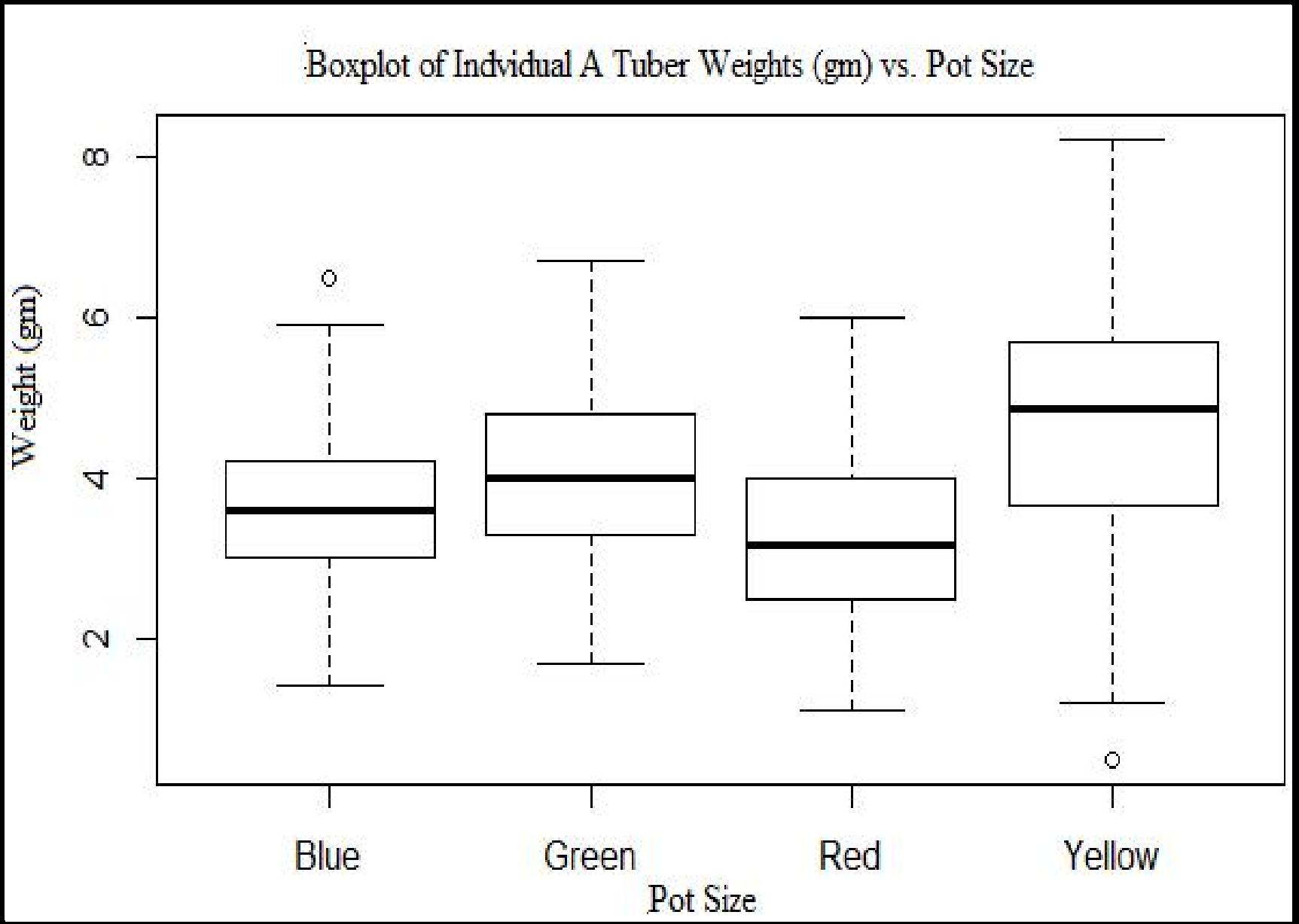
4 Pot sizes

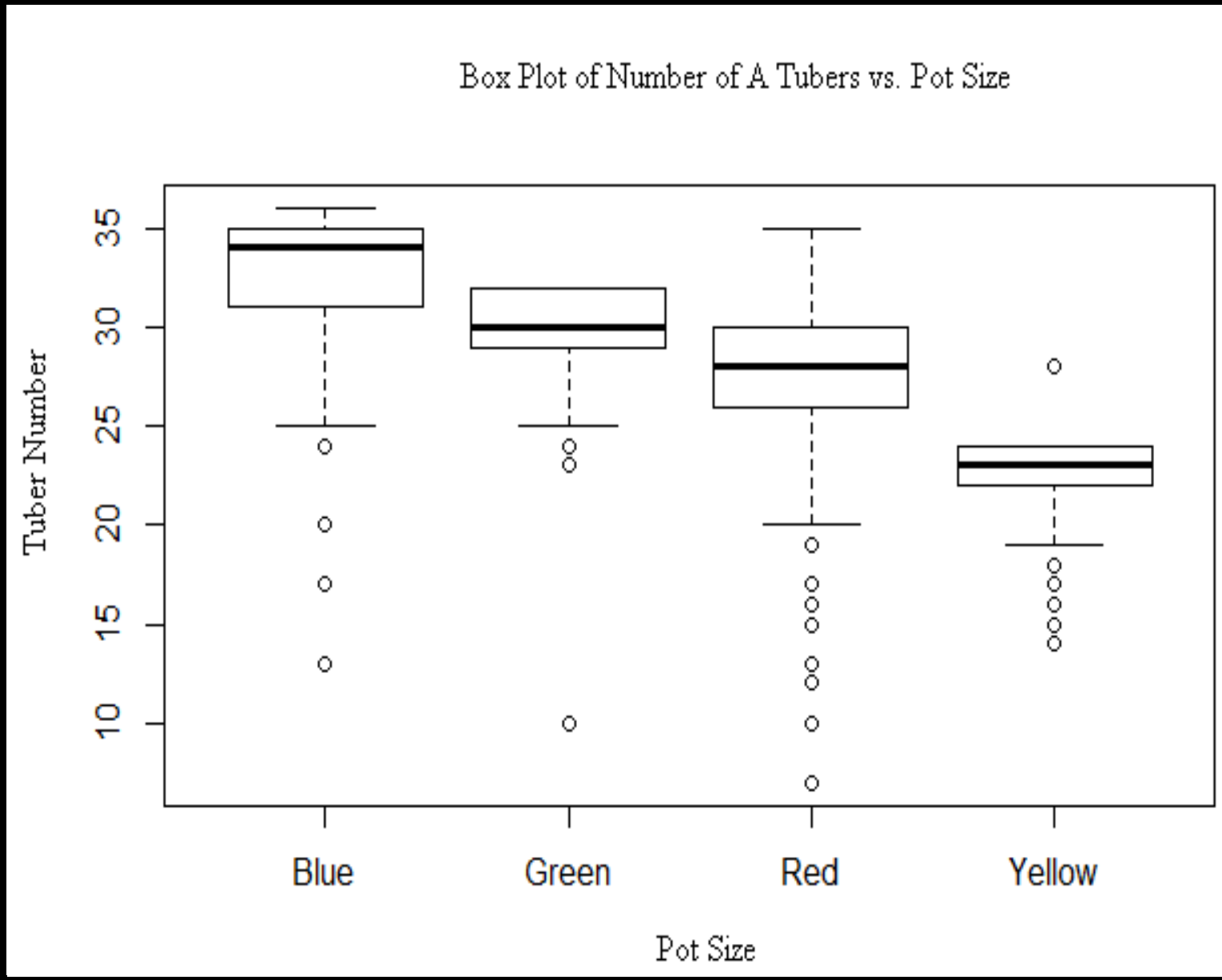
Purpose: To optimize our pre-nuclear production


4x4

Treatment & Cells/Flat	Dimensions (cm)	Identification Color	Area of Flats/Volume of Cells (cm^2/cm^3)	Plant Density (Plants/cm^2)
Treatment 1: 32 cells	5.5 X 5.5 X 5.5	Green	30.25 / 166.375	1.1
Treatment 2: 32 cells	5.5 X 5.5 X 8.7	Red	30.25 / 263.175	1.1
Treatment 3: 24 cells	5.1 X 5.1 X 5.5	Yellow	26.01 / 143.055	.9
Treatment 4: 36 cells	4.3 X 4.3 X 7.3	Blue	18.49 / 134.977	1.9




Boxplot of Indvidual A Tuber Weights (gm) vs. Pot Size
Weight (gm)
2
4
6
8
Blue
Green
Red
Yellow
Pot Size


Box Plot of Number of A Tubers vs. Pot Size
Tuber Number
10
15
20
25
30
35
Blue
Green
Red
Yellow
Pot Size

Common Scab

Materials Evaluated
MN Breeding lines,
NCR lines,
National C. Scab lines,
US Potato Board Chip Breeders Trial lines,
SolCap Trial lines

Breeding lines are evaluated for:
1. Disease incidence (% coverage)
2. Disease severity (surface, raised, and pitted scab; individual or coalesced lesions).

Objective of Study: *Late blight resistance, Thill/ Miller*

1. The primary focus of this research is to develop new potato varieties and parental germplasm resistant to late blight.
2. Breeding lines were evaluated 3x for % late blight infection after inoculation. Selections were made advancing the most resistant lines.

Dr. Sanjay Gupta

- Evaluation and screening of promising clones
- USDA-SCRI initiative to improve nutritional quality of potatoes
- National Acrylamide Task Force
- National French Fry Processing Trial (NFPT)
- USPB trial to evaluate promising potato clones for biochemical markers
- SFA Trial

Dr. Sanjay Gupta

- **Welcome BACK to**

  Minnesota &

- **North Dakota**

Physiology of cold-induced sweetening (CIS) in long term cold stored potatoes

Sanjay K. Gupta

Department of Horticultural Science

University of Minnesota

NPPGA Reporting Conference, Grand Forks, ND.
Feb 19th 2013

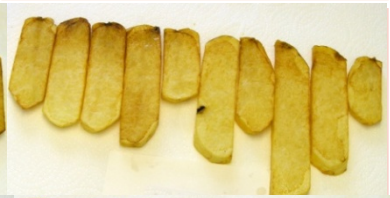
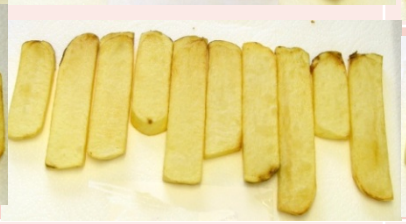
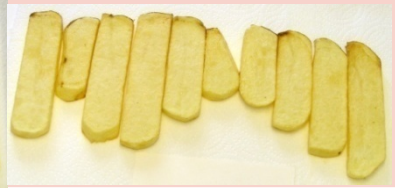
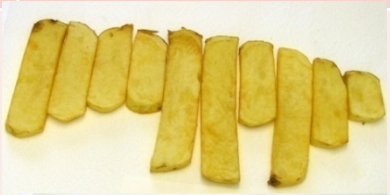
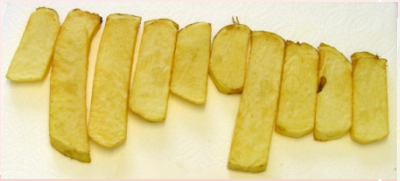
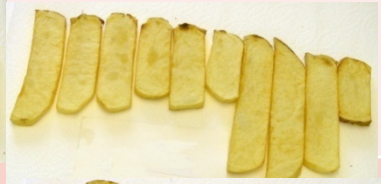
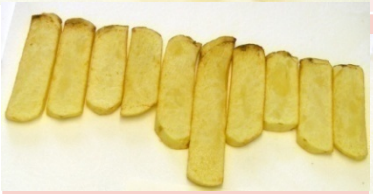
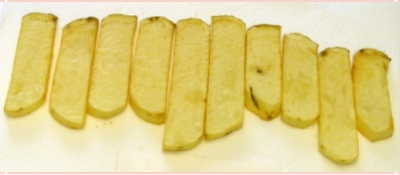
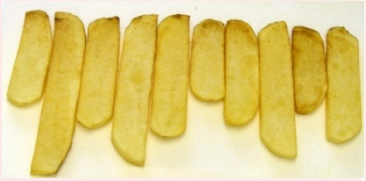
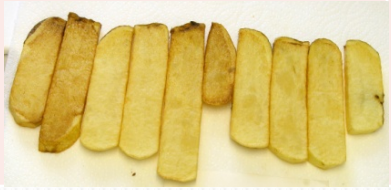
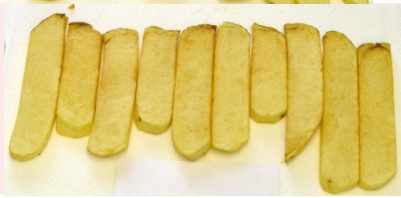
Research Activities

- Physiology and Biochemistry of Cold-Induced Sweetening (CIS)
- Development and evaluation of “New Potato Varieties”
- Nutritional and processing quality changes during long term storages
- Biochemical marker development for potato breeding programs

Major Research Projects

- Evaluation and screening of promising clones for Pacific North-West
- USDA-SCRI initiative to improve nutritional quality of potatoes
- National Acrylamide Task Force
- National French Fry Processing Trial (NFPT)
- USPB trial to evaluate promising potato clones for biochemical markers
- SFA Trial

Fry Color (after 5 months in storage)

	42°F	45°F	48°F
Russet Burbank			
A0008-1TE			
Owyhee Russet			
A97066-42LB			
A98345-1			
Sage Russet			

Physiology of Sugar Accumulation

- **Why** some potato variety accumulate more Reducing Sugars?
- **How**? What is the mechanism

The change is tuber processing quality is mainly due to accumulation of

Reducing sugars

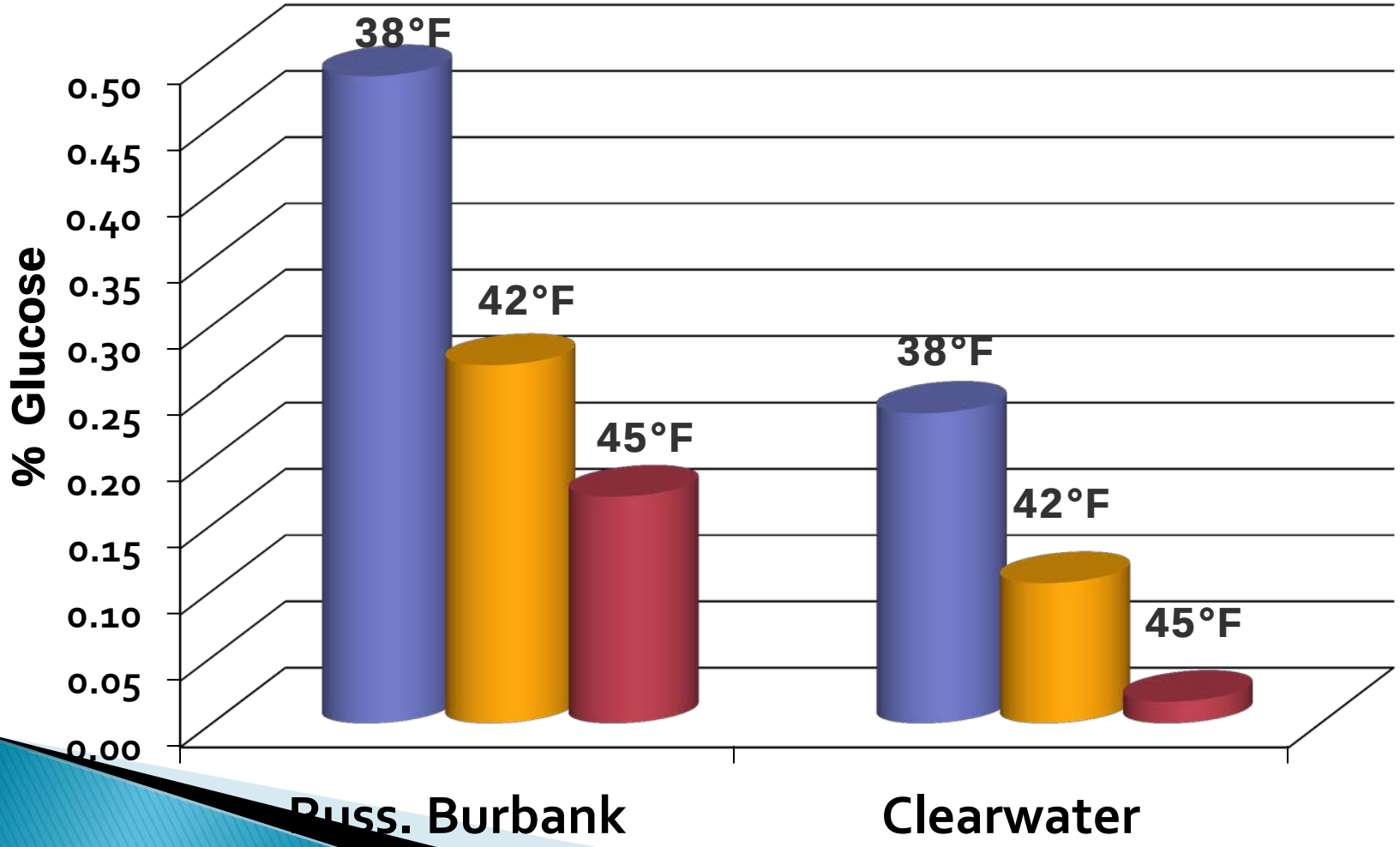
Starch to Sugar Conversion

- Rate of conversion = Rate of utilization by Respiration

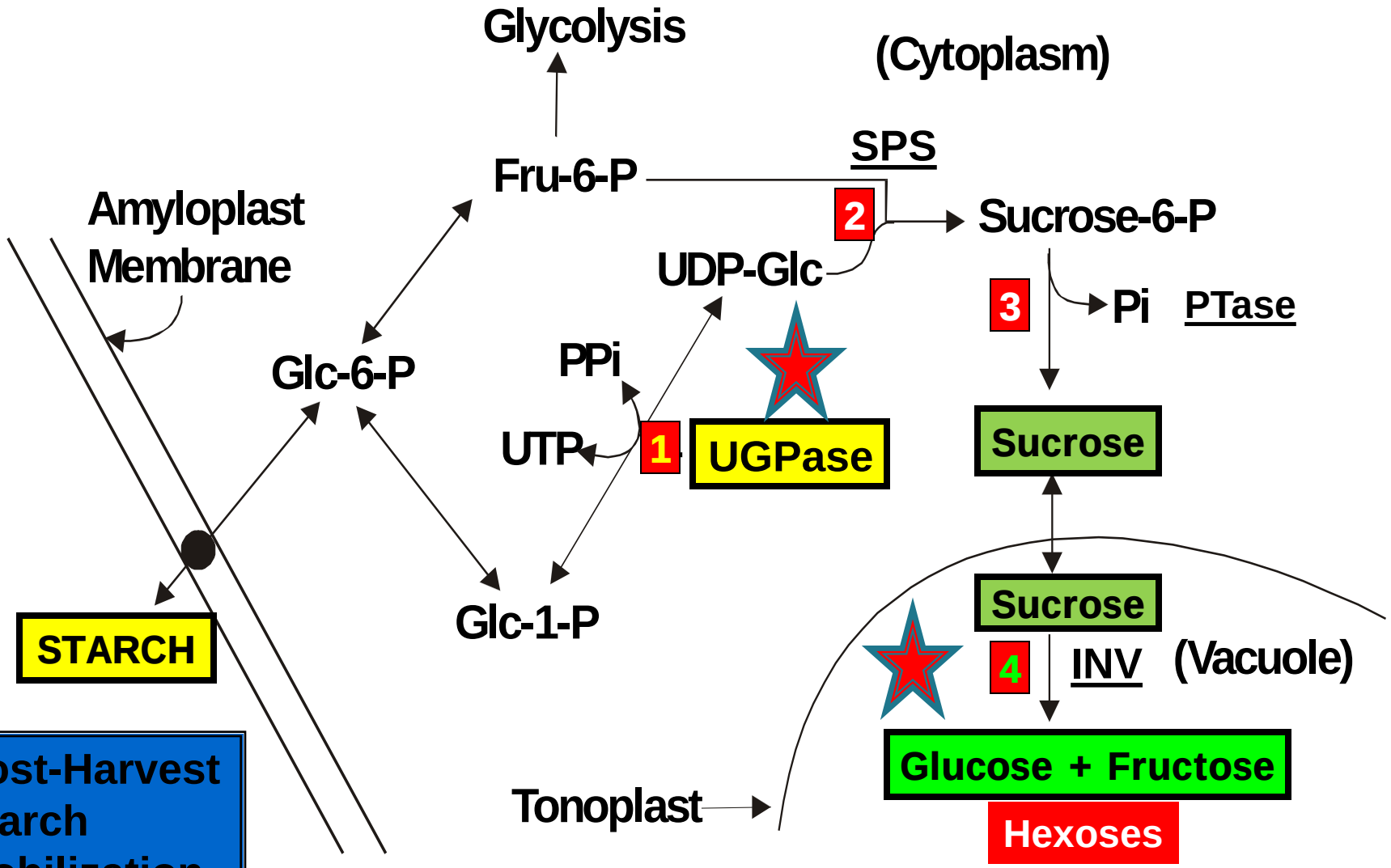
- Rate of conversion > Rate of utilization by Respiration

  Excess sugar gets accumulated in potatoes

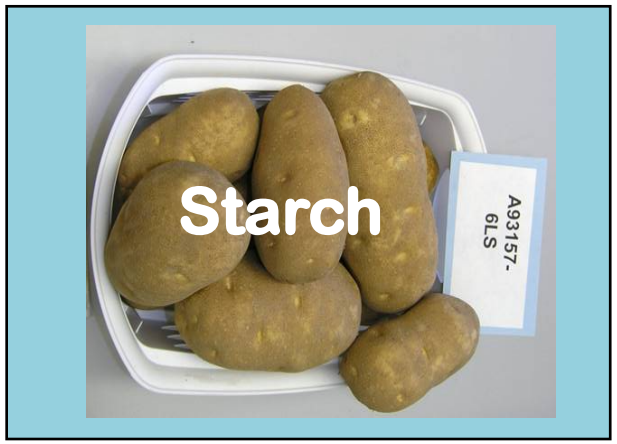
Reducing Sugar Levels After Six Months Storage at 38, 42, 45°F



Biochemical Pathway



Starch Conversion During Storage

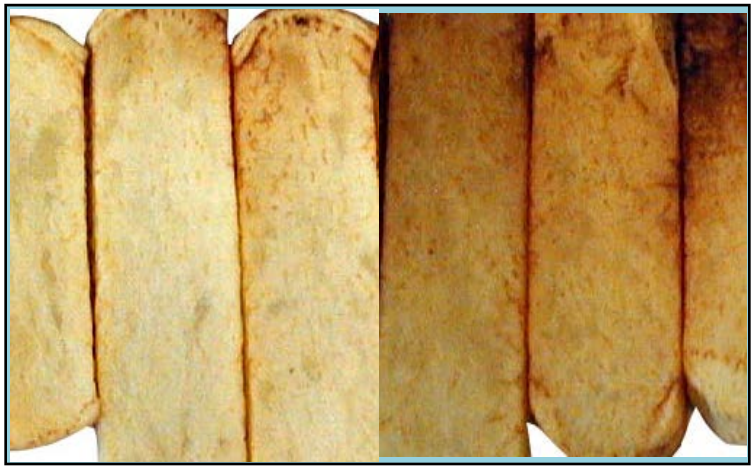


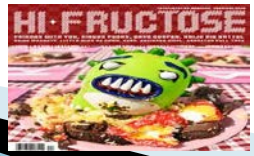
12-Carbon

Sucrose

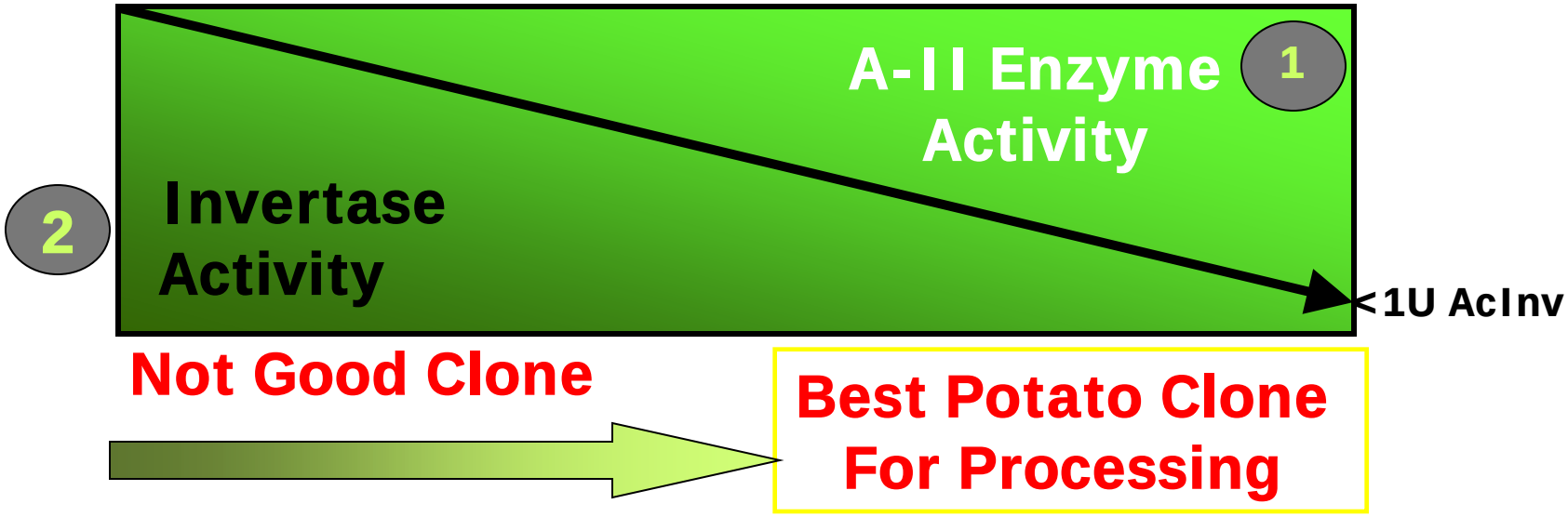
Reducing Sugars

Two 6-Carbon





Two Markers for Selection of Low Sugar Accumulating Potato Clones



Acid Invertase Activity Level and CIS Resistance

Acid Invertase units	Cold-Induced Sweetening (CIS) Resistance
0 - 1	Best resistance (Class A). A+ if the low acid invertase activity without inhibitor protein (i.e. Total acid invertase activity)
1 - 3	Intermediate resistance (Class B)
>3	Very low or no resistance to CIS resistance (Class C)

Class Change During Storage

Class Change	# of clones	Percentage
A to A	55	54
A to B	24	23
A to C	11	11
B to B	2	2
B to C	2	2
C to C	8	8

Predictability 89%

Research Priorities

- Evaluation of promising potato clones for storability and processing quality using biochemical markers.
- Study the genetics of biochemical markers
- Evaluate the promising potato clones for nutritional quality.
- Screening of early generation selection for CIS to develop new varieties.
- Develop new biochemical markers for potato breeding programs.

Seek your input in setting goals

Thank You

Photo by Jeff Miller