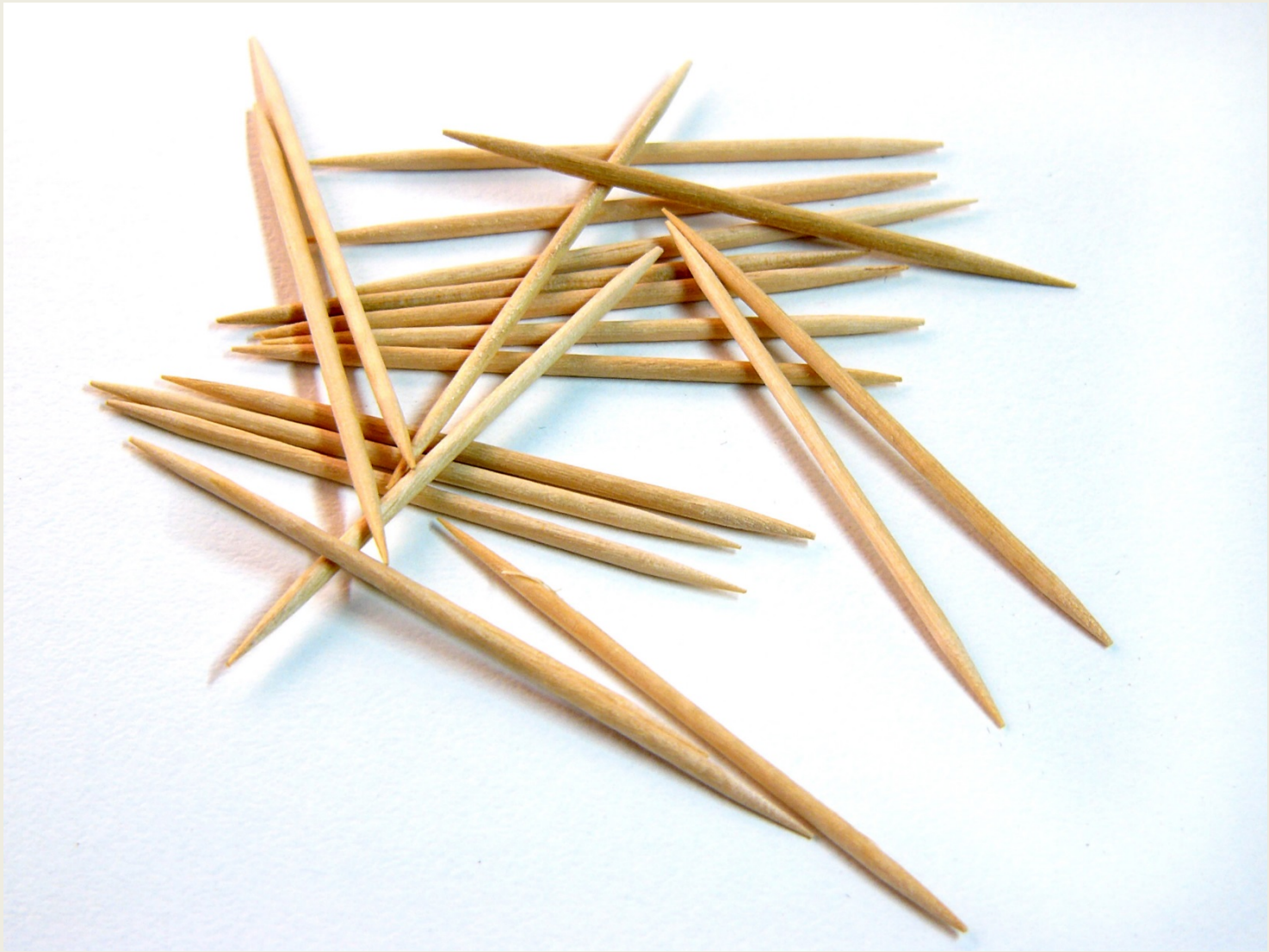
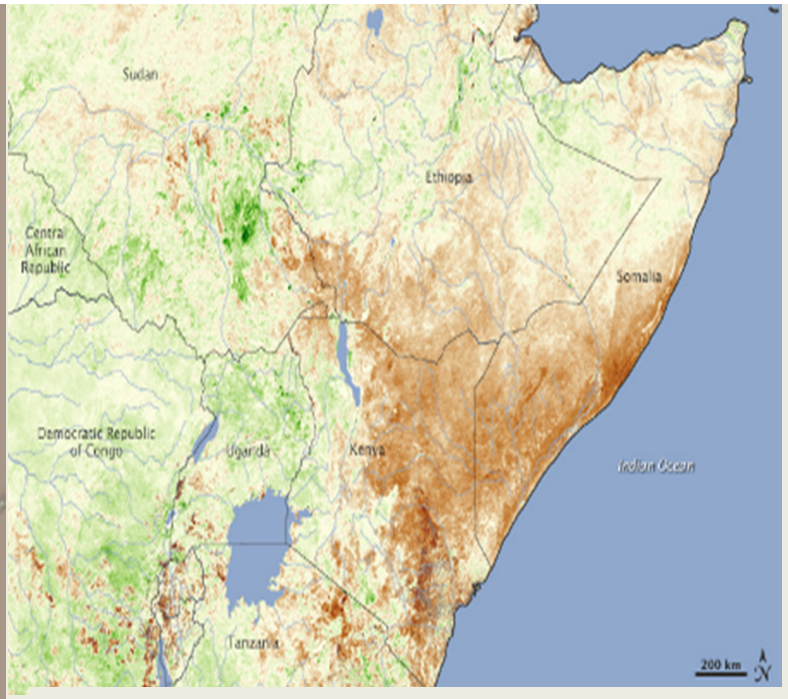
The Toothpick Method
One acre at a time





Problems? Ebola HIV
Drought Malaria
Dengue Fever Water quality
Malnutrition Soil deficiencies
Violence Corruption
Women Disempowered
Extreme Poverty Hunger

Can Biocontrol Fix all THIS?


Want an idea that sells? Think like the customer

The Starfish Foundation (John Sands and the Liberty Initiators Network (Florence Oyosi and farmers)

STRIGA - WORST WEED IN AFRICA

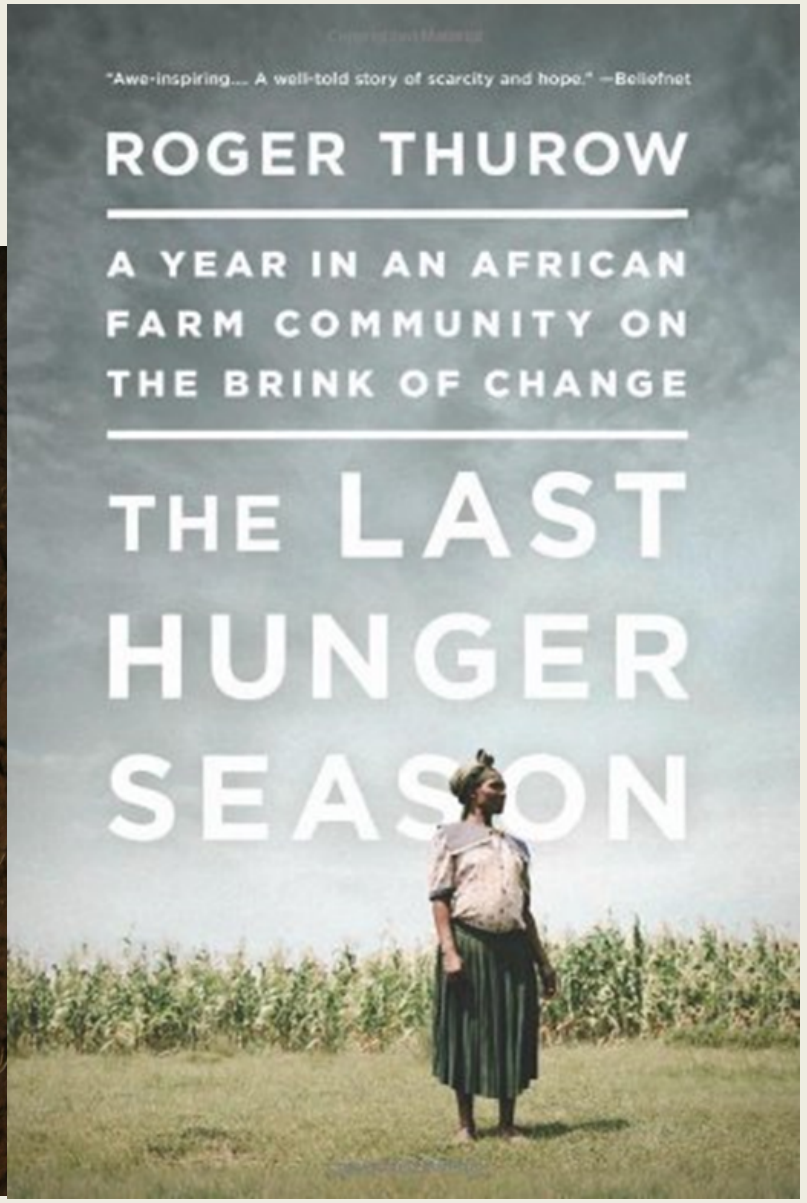
Striga hermonthica

Food production losses due to Striga*

Country	Yield loss (%)*	Yield loss ('000 tons)
Burkina Faso	35-40	710-820
Eritrea	20-60	30-90
Kenya	35-40	50-60
Mali	40	580
Mozambique	35	40
Niger	40-50	930-1,160
Nigeria	35	3,750
Sudan	30	1,230
Tanzania	up to 90	550
Total/mean	39-45	8,110-8,520

8 million tons would feed a lot of people

* Sorghum, millets, and maize (Gressel, 2004)


"Awe-inspiring.... A well-told story of scarcity and hope." —Bellefnet
ROGER THUROW
A YEAR IN AN AFRICAN FARM COMMUNITY ON THE BRINK OF CHANGE
THE LAST HUNGER SEASON

Biocontrol of striga?

It has been tried.

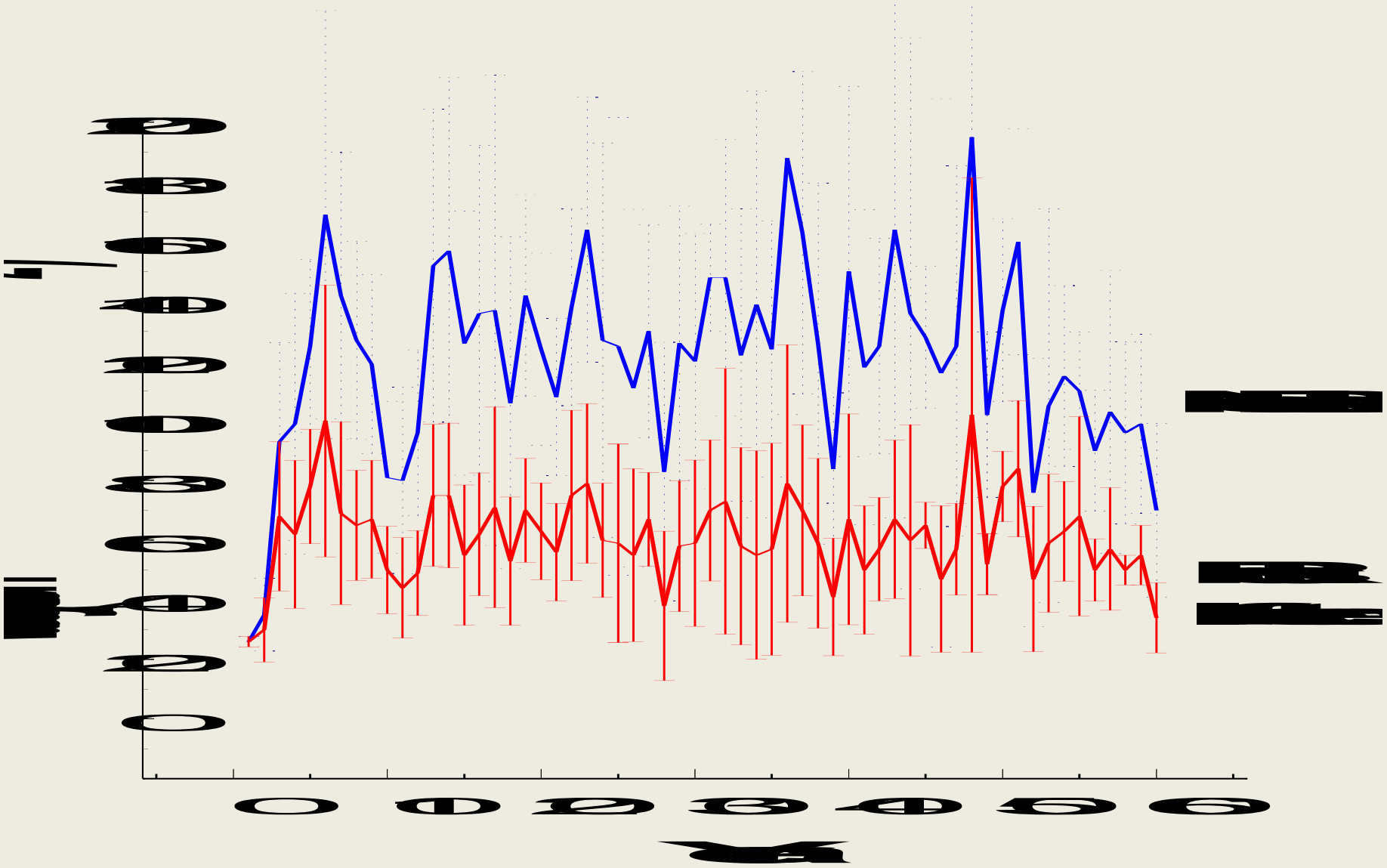
Gates Foundation alone spent $11 million on striga control.

Foxy – Fusarium oxysporum fsp. strigae

A Host-Specific Plant Pathogen with 200 forma speciales, each attacking a different species of plant.

MONTANA
STATE UNIVERSITY
Mountains & Minds

Pathogens are like Goldilocks



Carsten, Maxwell and Sands: San Clemente Island

One Solution

Virulence enhancement of host specific biocontrol agents

Sounds good, maybe.

Can we do it?

How can we do it?

How long does it take?

Is it safe?

Can we get regulatory approval?

Who can afford it?

Will there be resistance as with herbicides?

Which fungi?

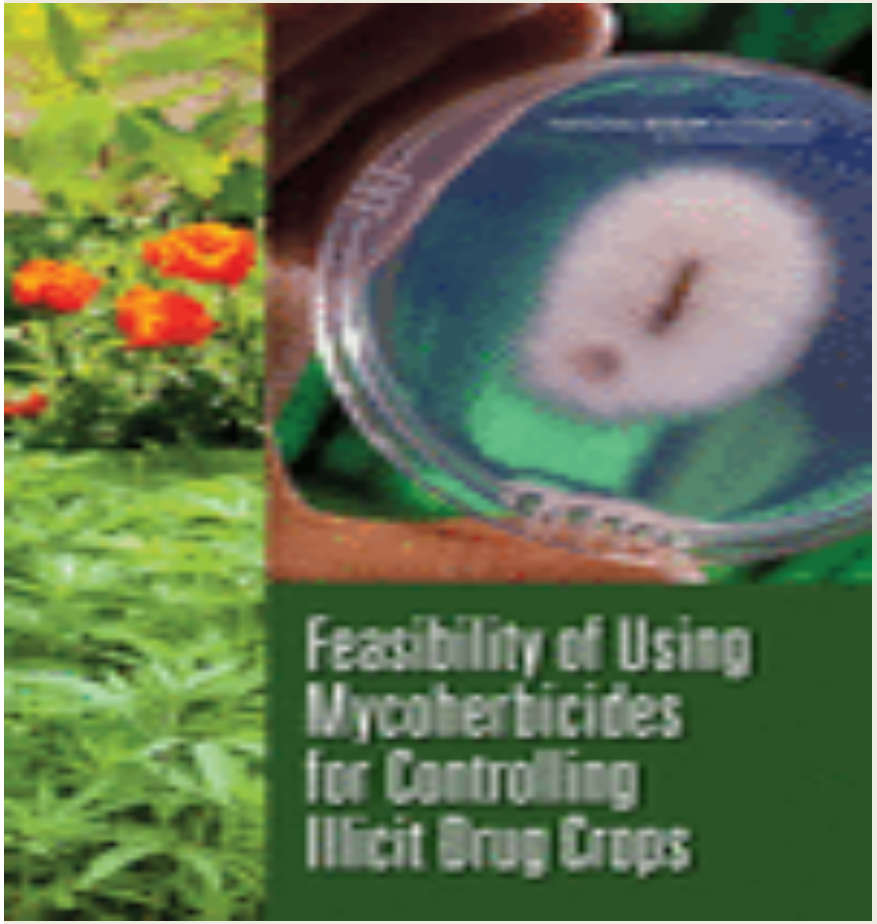
Our History in the 90's

Cocaine, Opium, and Cannabis Biocontrol.

Fusarium oxysporum fs. erythroxylii , papaveri, cannabina

A Technology developed but not implemented.

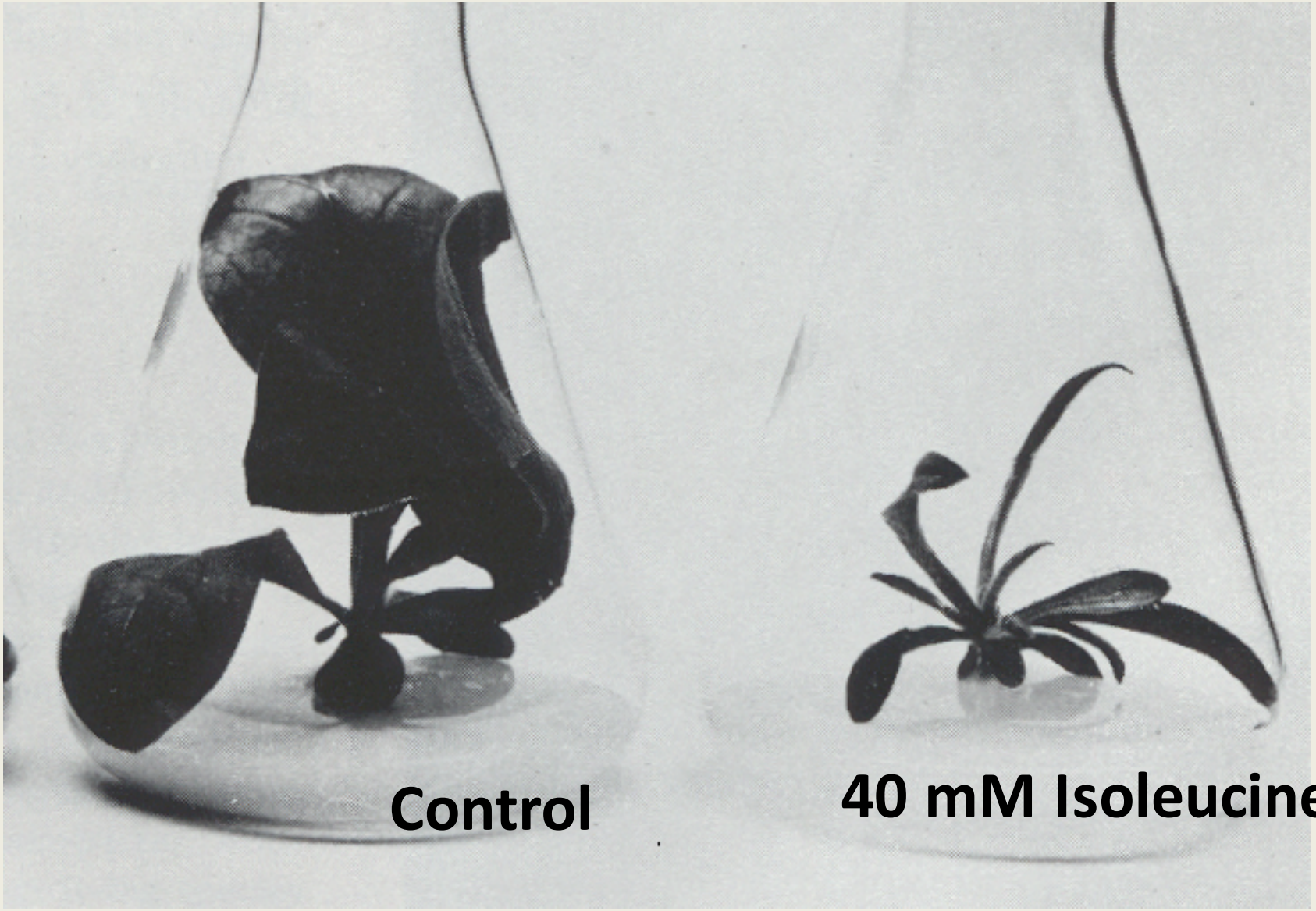
But this is what we learned...



What we learned

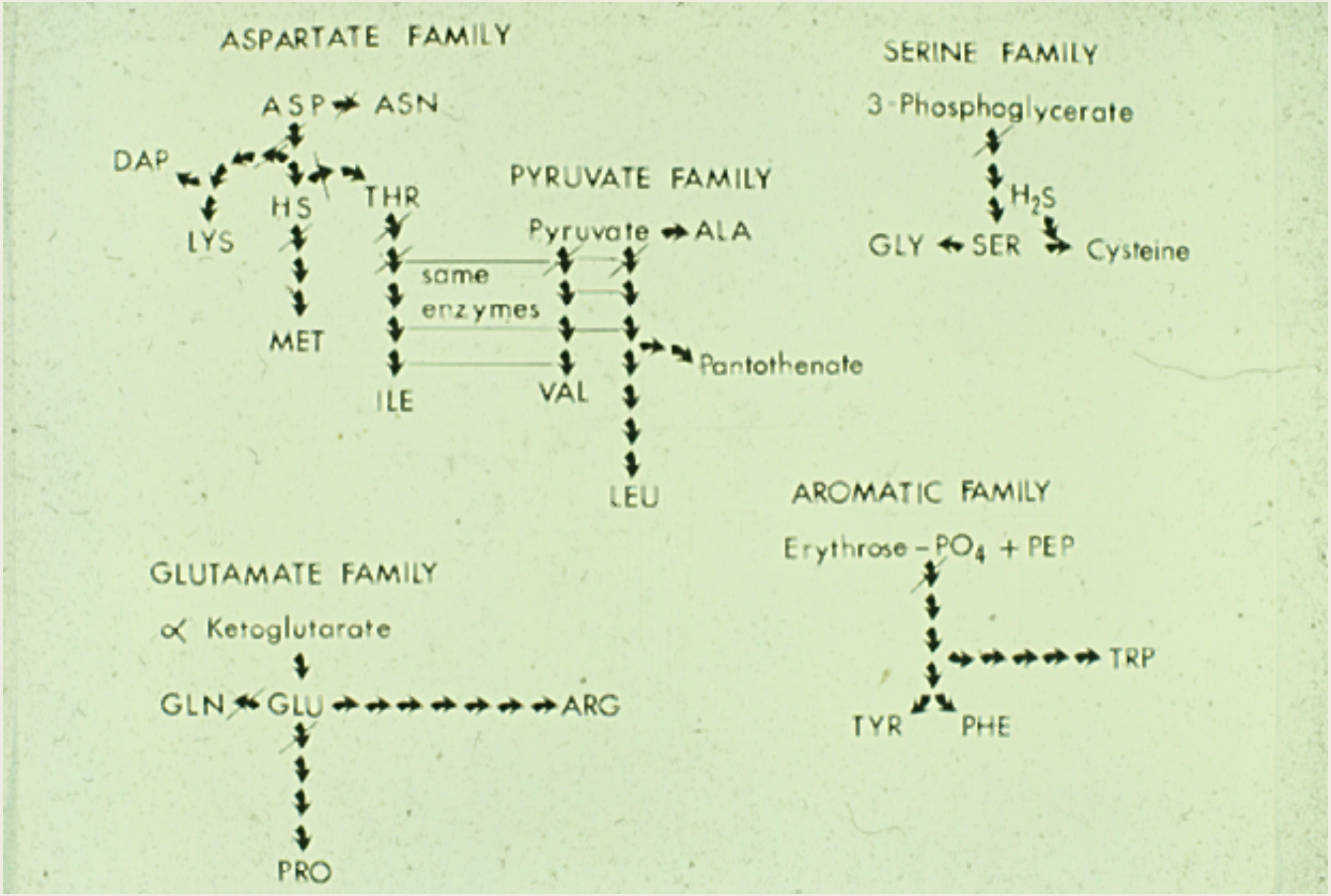
Most pathogens are not as virulent as they could be .
Host specificity is required or the project will be rejected.
Pathogens that produce toxins will be rejected.
Pathogens like Fusarium may be specific to one host but they establish on roots of most plants.
Most fungi can grow on minimal media.
Fusaria can be selected for production of amino acids.
Some amino acids kill plants.
Fungi need a food source if they are going to establish in the soil.
Just because you have efficient biocontrol agents, that does not mean that they will be used.

Frenching Disease of Tobacco

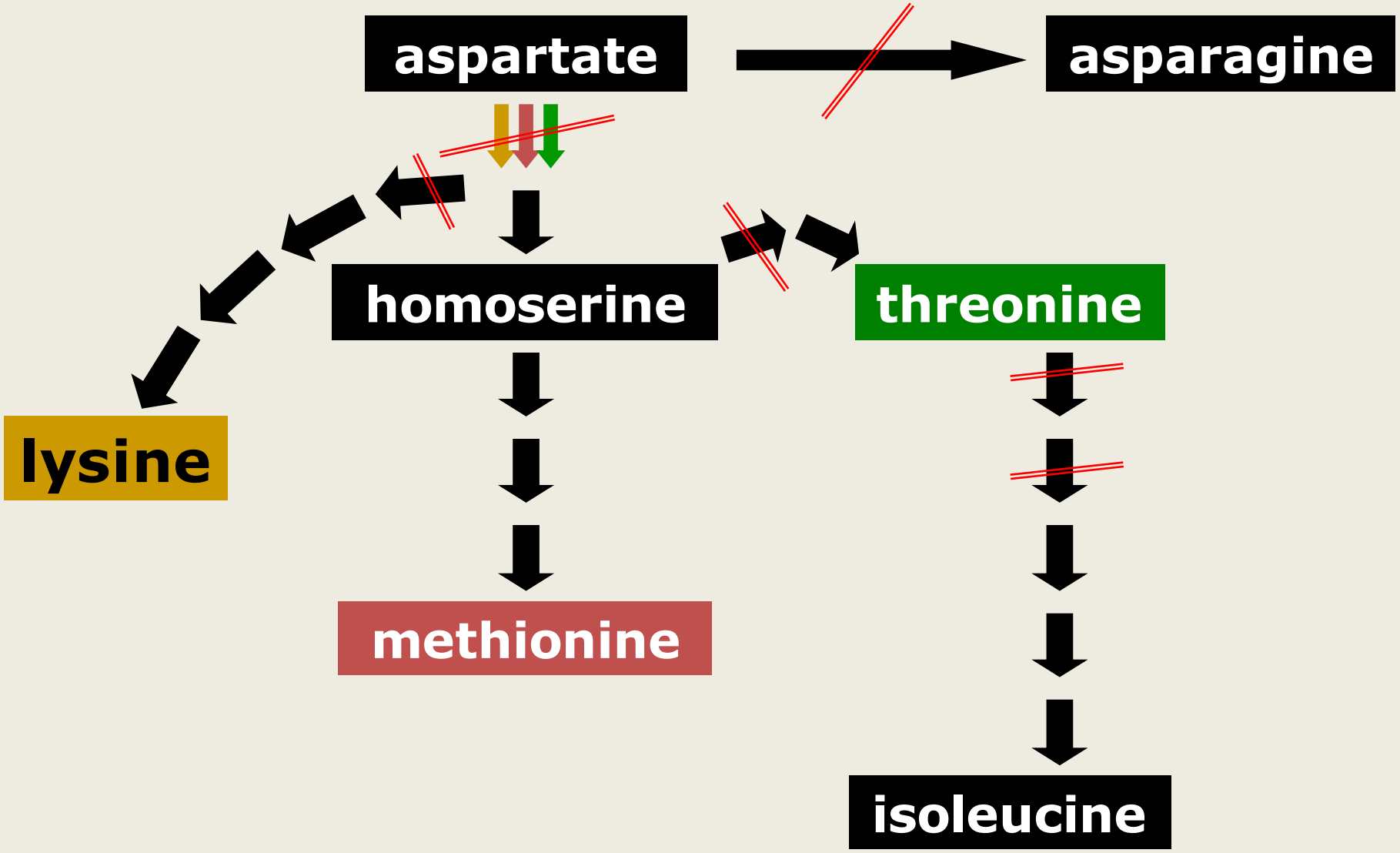


James Oglethorpe 1750 discovered Frenching

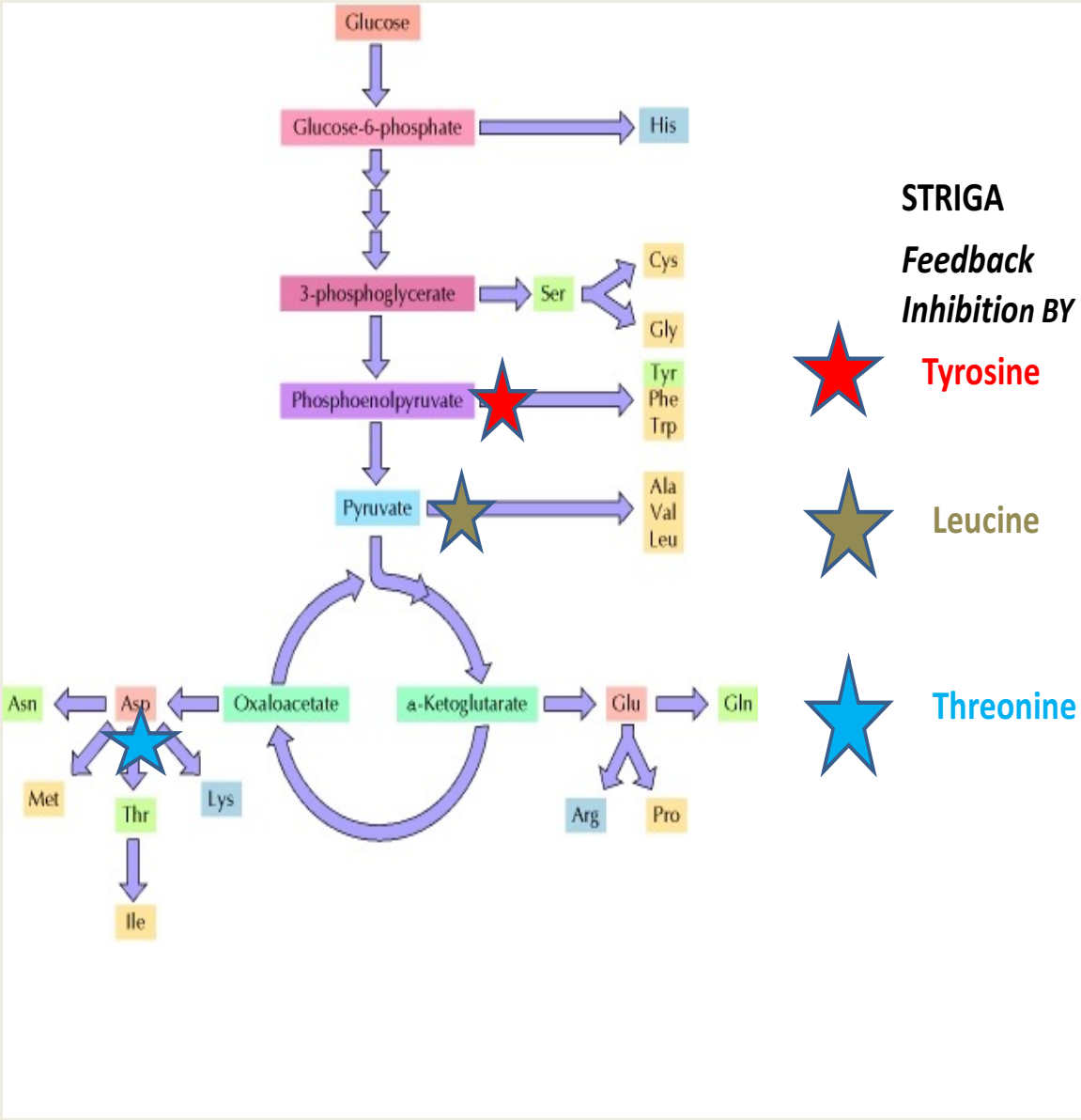
Steinberg 1960 did biochemistry


ASPARTATE FAMILY
ASP
ASN
DAP
LYS
HS
MET
THR
ILE
PYRUVATE FAMILY
Pyruvate
ALA
same
enzymes
VAL
Pantothenate
LEU
SERINE FAMILY
3-Phosphoglycerate
H_2S
GLY
SER
Cysteine
GLUTAMATE FAMILY
∝ Ketoglutarate
GLN
GLU
ARG
PRO
AROMATIC FAMILY
Erythrose – PO_4 + PEP
TRP
TYR
PHE

Aspartate Family of Amino Acid Biosynthesis in Plants



Striga hermonthica



Specific Amino Acids Inhibit Weed Development

Weed	Amino Acid
Field Bindweed	Lysine
Houndstongue	Valine
Spotted Knapweed	Valine, Tryptophan
Leafy Spurge	Lysine, Tryptophan

All plants tested are inhibited by one or more amino acids

Striga hermontheca	Tyrosine, Leucine, Threonine
Orobanche ramosa	Arginine, Methionine, Lysine

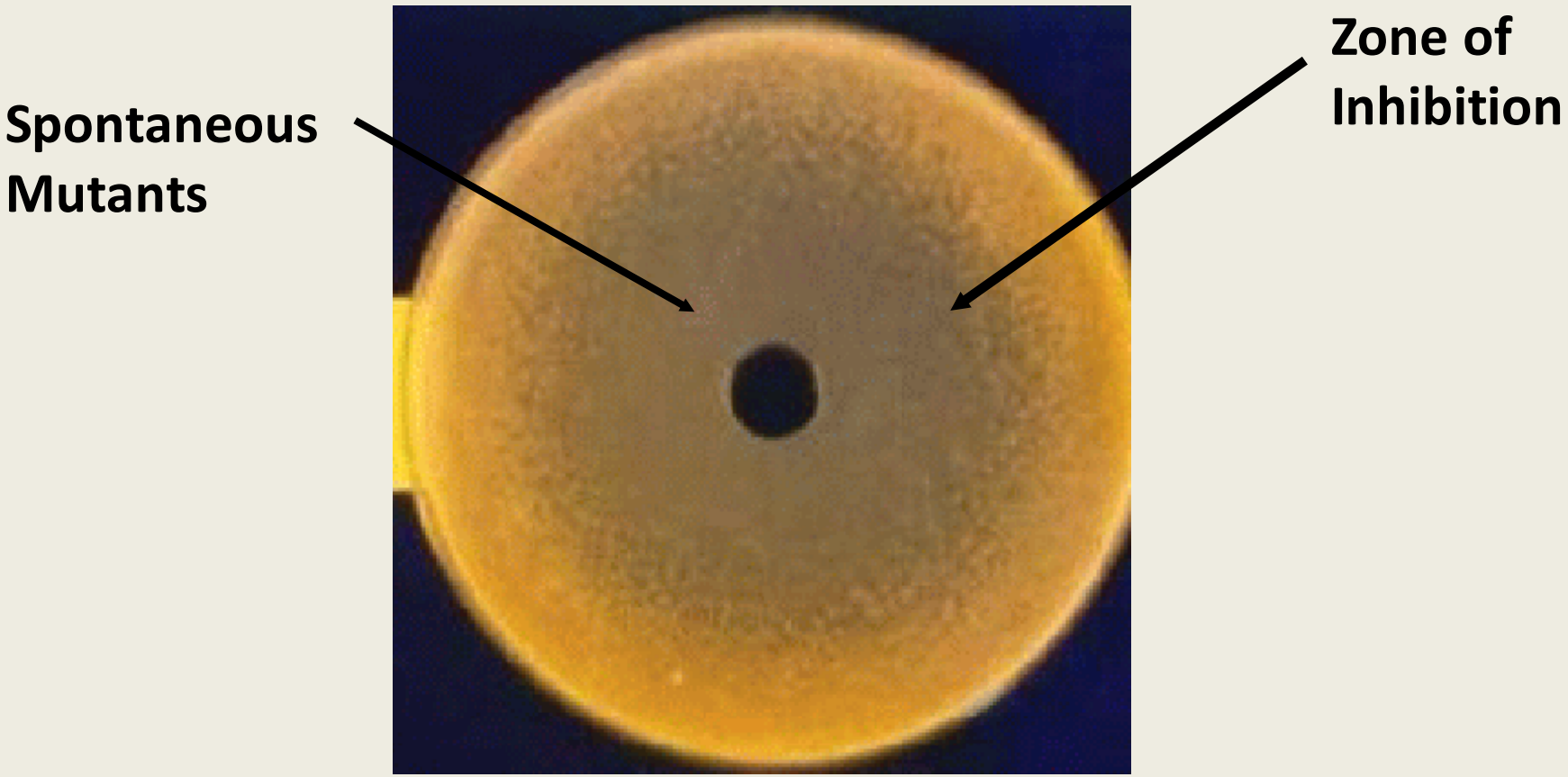
aa's against Rush Skeleton weed

Greenhouse efficacy of *FoxyC* mutants

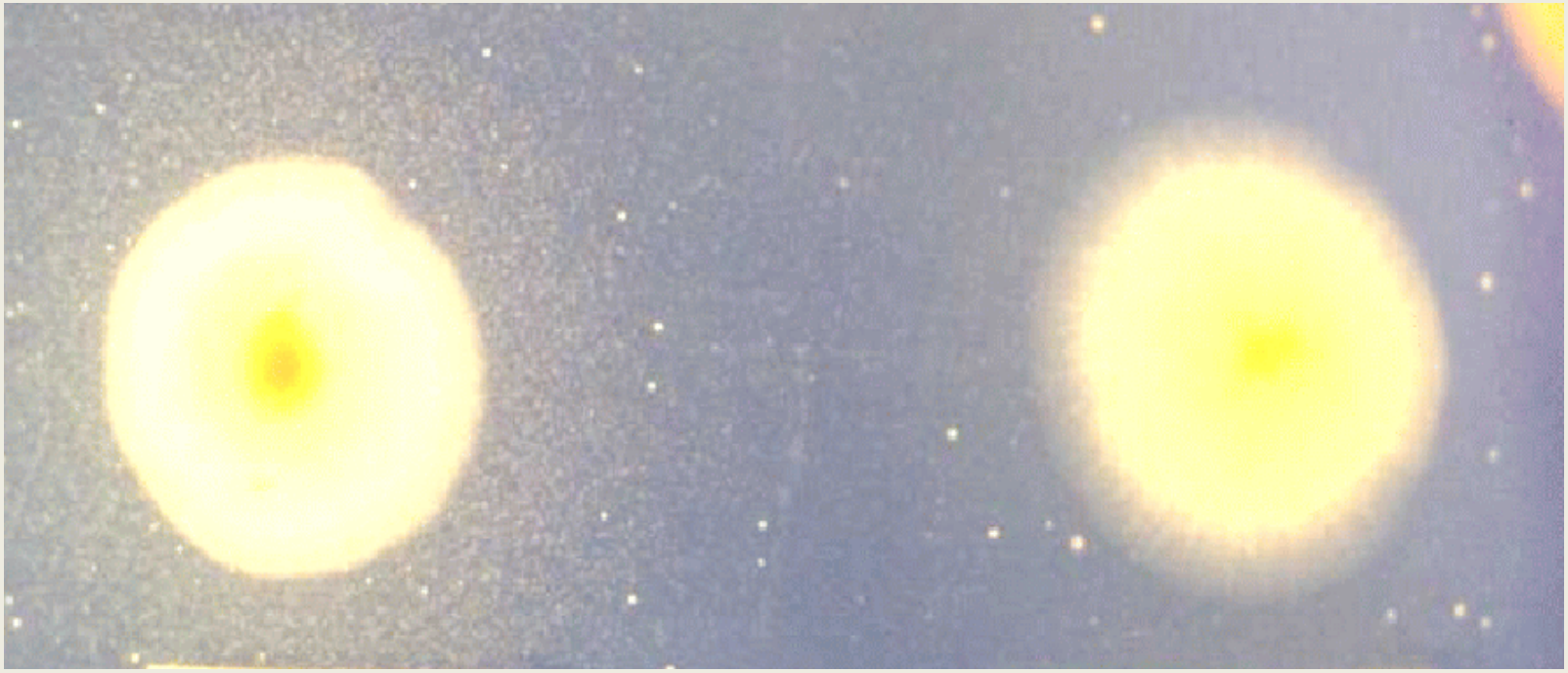
	[valine] (mg/l)	%disease	weeks to kill
wild-type	0	25	6-8
4nv	2.84	70	2-3
6pa	2.48	90	2-3
8pa	9.93	90	2
control	na	0	8


We isolated
fusarium out
of wilting
Striga plants.

Inhibition of *FoxyC* with the valine analog, penicillamine



MICROFACTORIES TO MAKE AA'S



Valine Excretor

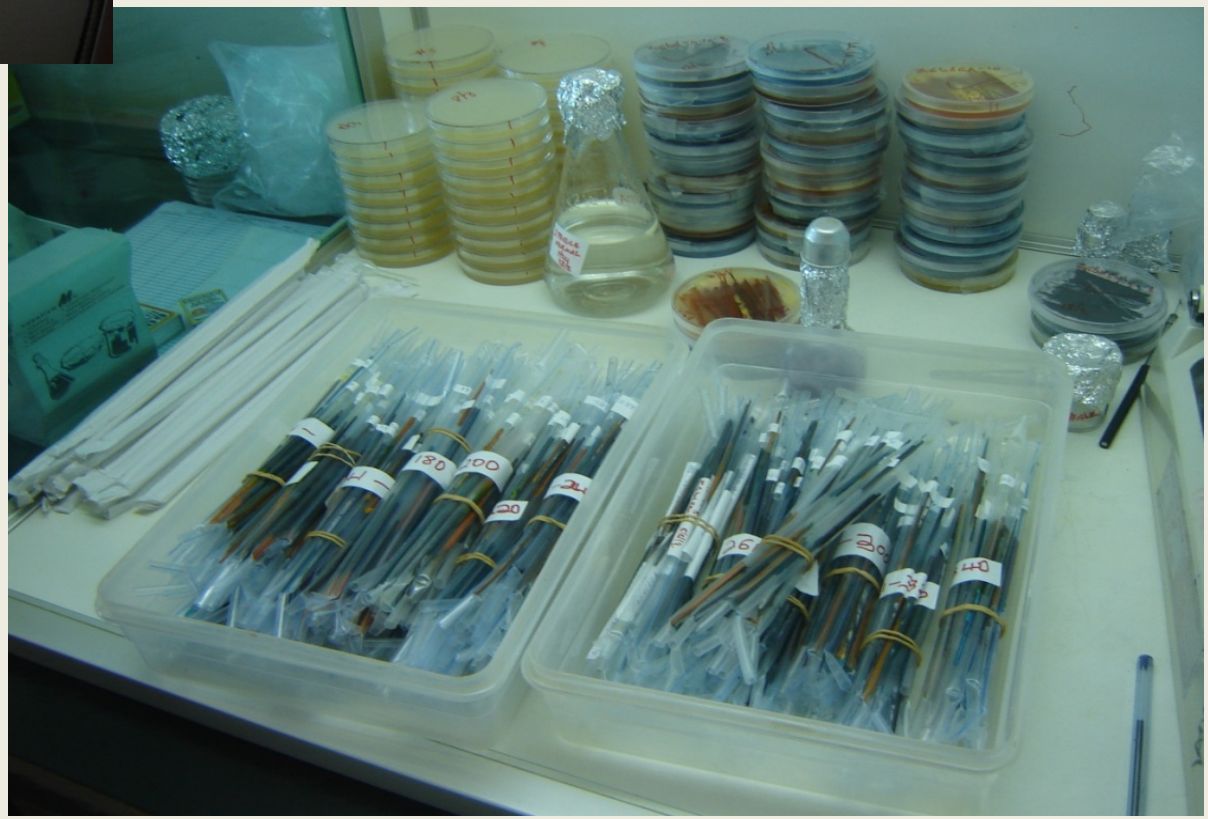
Wild-type pathogen

We Tested for Toxins
Found None

The potential toxin production of the selected *Fusarium oxysporum fsp. strigae* strains lines was analyzed at Virginia Polytech University, Professor David Schmale.
His lab found no traces of any of the 5 common Fusarium elicited toxins:
deoxynivalenol (DON),
3-acetyldeoxynivalenol (3-ADON),
15-acetyldeoxynivalenol (15-ADON),
nivalenol (NIV)
zearalenone (ZEA).

Toothpicks with Foxy prepared for March planting, 500 farms, Western Kenya

Toothpicks were placed in sterile drinking straws. Three toothpicks , one of each foxy strain.



Procedure:

1. Prepare field
2. Add compost
3. Add diammonium phosphate
4. Add Foxy 3 days old in rice to ½ of the plots
5. Add 3 Hybrid Maize seeds
6. Cover and wait for rain
7. Weed twice or three times
8. Harvest 100 days later

Field evaluation of Foxy for management of striga

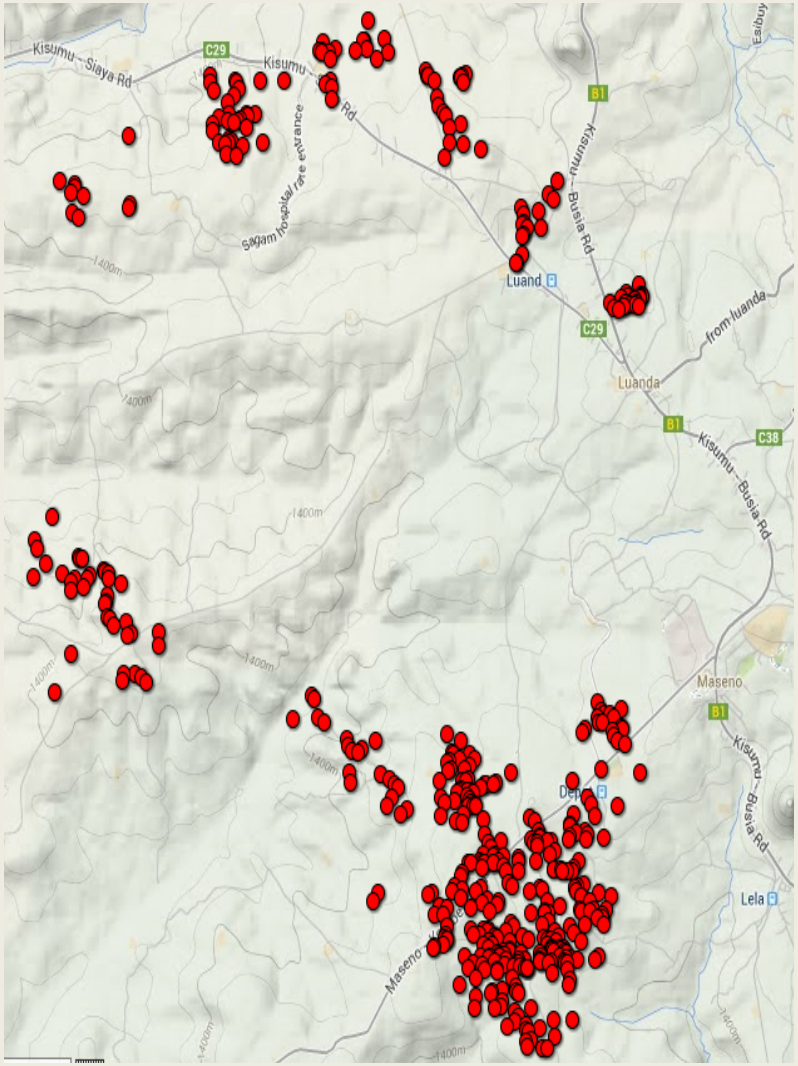
Farmer Practice

Farmer Practice + Foxys

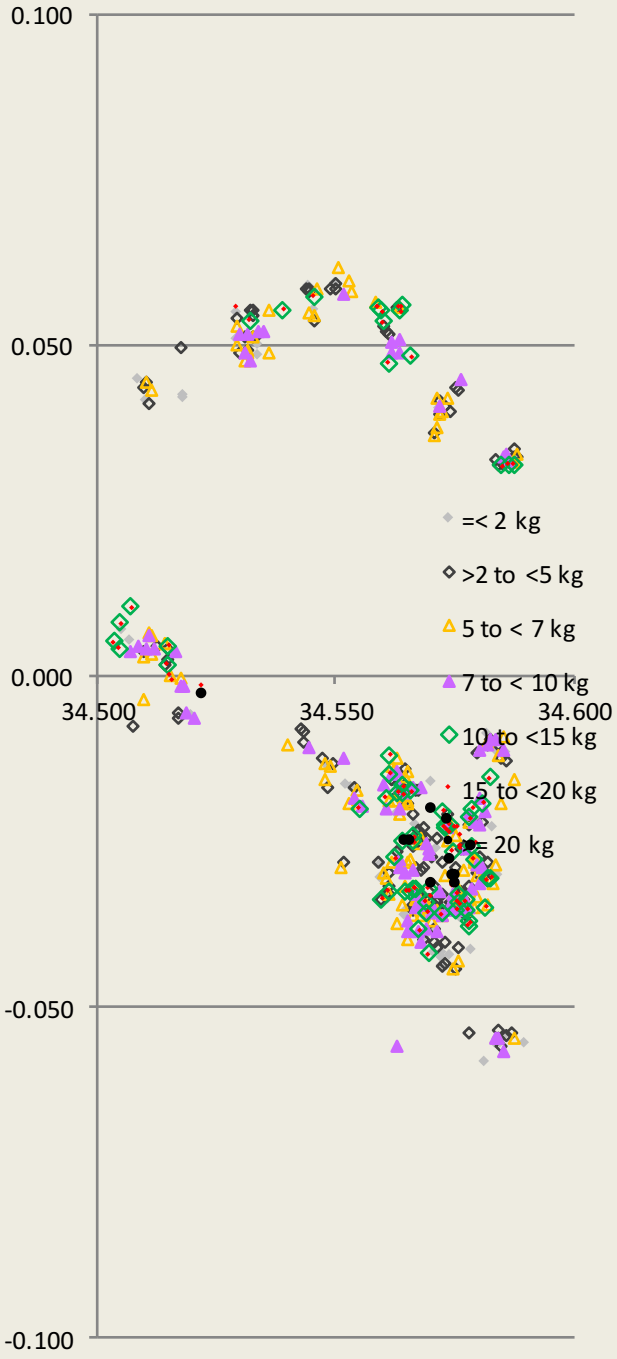
Control

Date: December 20th 2013

NO Input…No Output

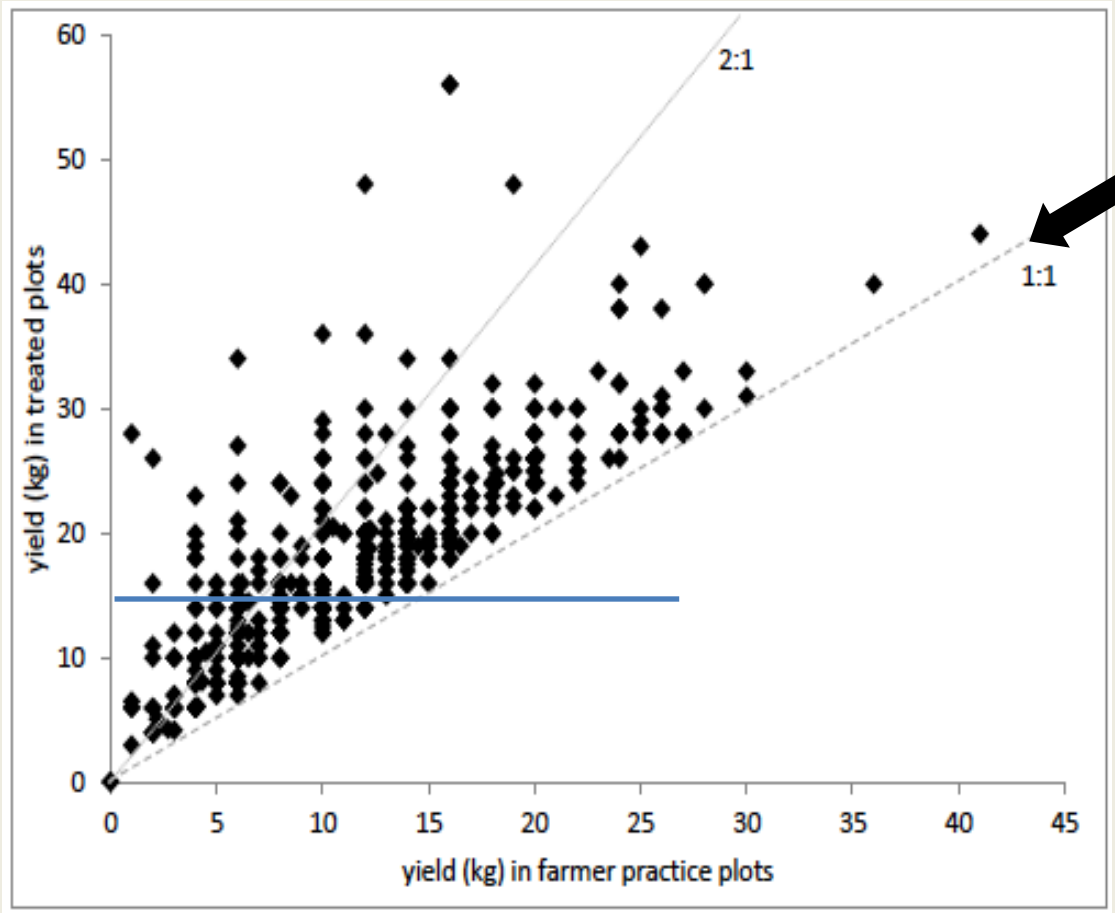


500 Farms in Kenya



2014 First (Long) Season YIELDS

Treated with Foxy T14



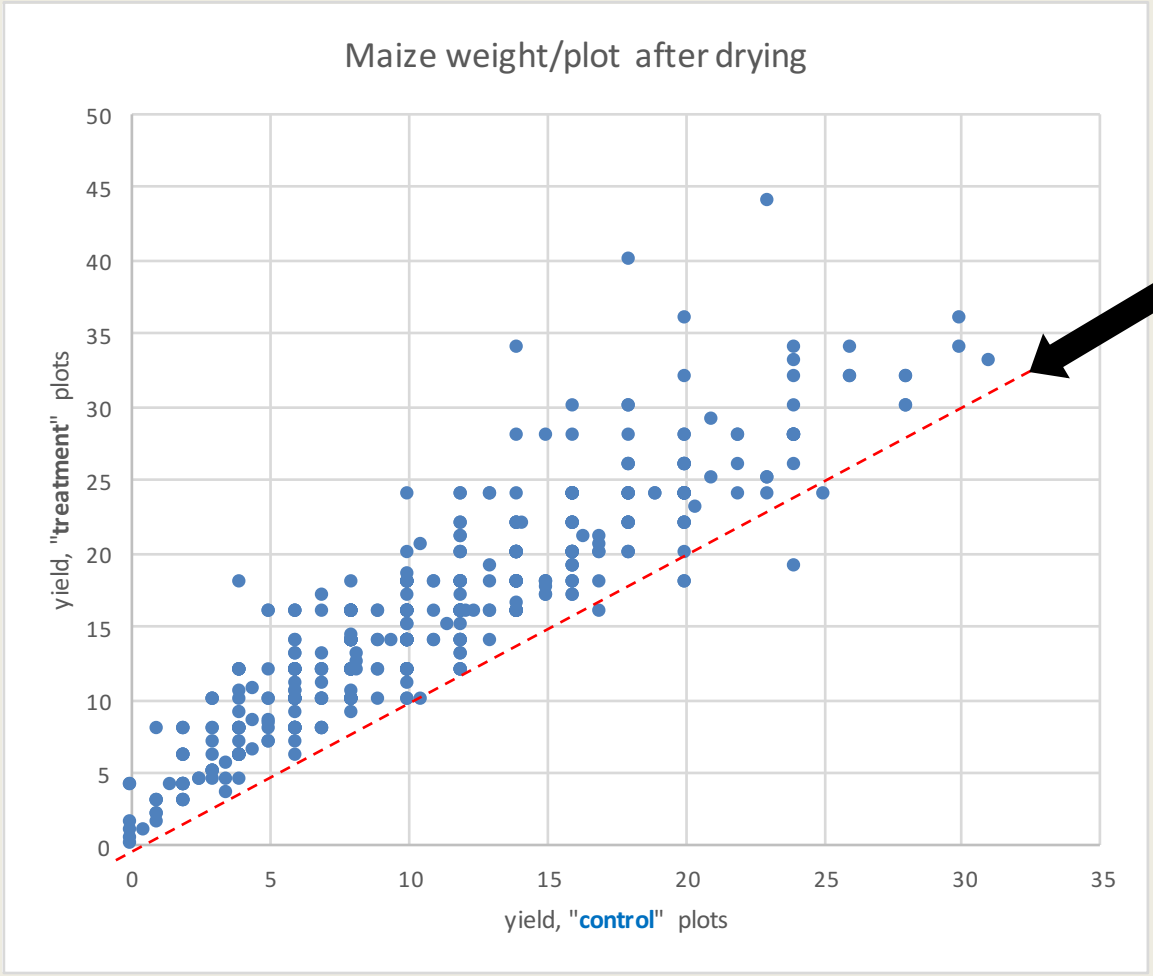
Anything above this line = greater yield in the treated plot

NOT Treated with Foxy T14

Average yield increase: 56.5%

Short Season: Yield Differential

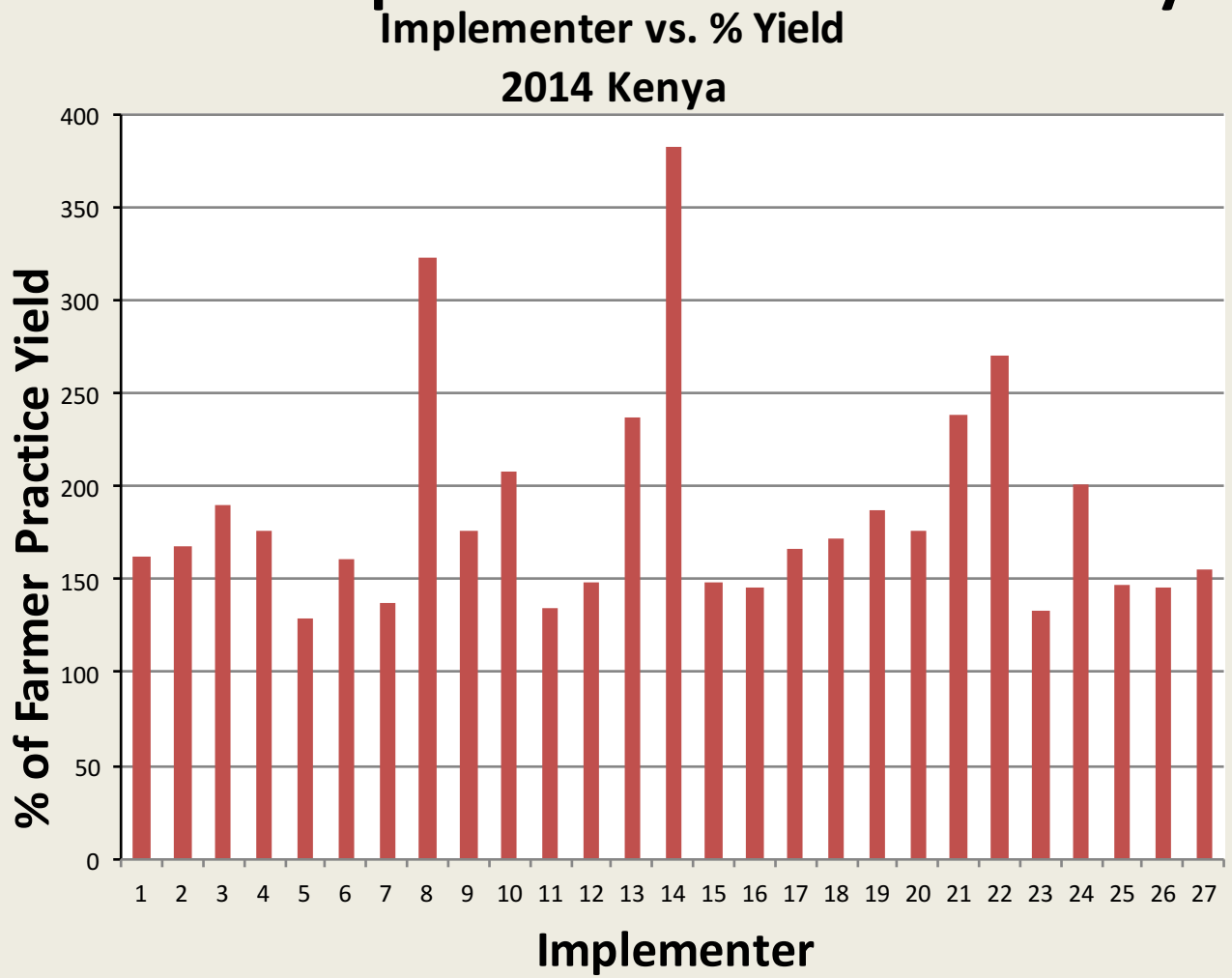
Treated with Foxy T-14



Anything above this line = greater yield in the treated plot

NOT Treated with Foxy T-14

The Data are phenomenal. 508 out of 510 farms showed an increase in yield in plots treated with FOXY vs. plots not treated with Foxy.



Team Striga

- Henry Sila Nzioki, KALRO Kenya, Plant Pathologist
- Florence Oyosi, Liberty Initiators Network, Kenya
- Eylul Kaya, MSU , Selection of foxy, and seed strip
- Alice Pilgeram, MSU fungal genetics, statistics
- Cindy Morris INRA/MSU, statistics
- Maurizio Vurro Italy, Broomrape..
- Eric Newman MSU undergraduate, seed strip
- Sophie Zhu MSU undergraduate, seed strip
- Ed Dratz, Alice Pilgeram, MSU
- Johnny Gressel, Isra