

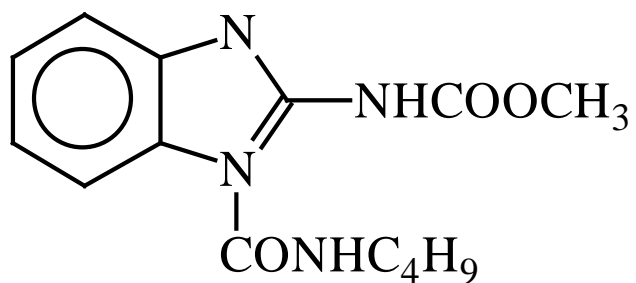
# Strategies for Optimizing Fungicide Usage in Resistance Management

J.M. Vargas, Jr.

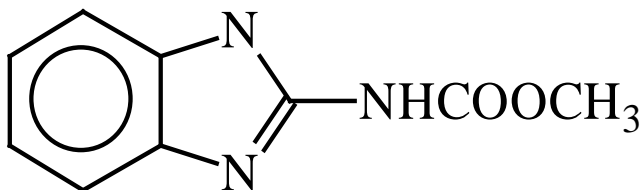
# Generic Groups

- **Benzimidazoles** - Fungo 50, Cleary's 3336, Systec 1998, T-Storm
- **Dicarboximides** - Chipco 26GT, Vorlan, Curalan, Touche
- **DMI Fungicides** - Bayleton, Banner, Rubigan, Eagle, Trinity
- **Acylalanines** - Subdue Maxx
- **Phosphites** – Signature, Magellan, Allude
- **Qo I** - Heritage, Compass, Insignia, Disarm

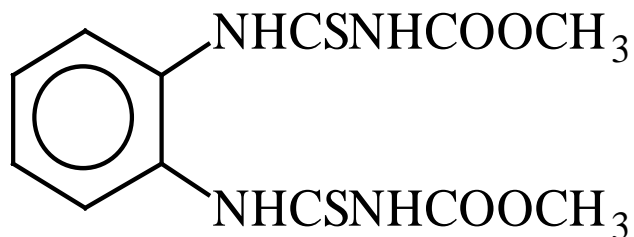
# Chemical structures and breakdown products of benzimidazole systemic fungicides



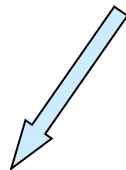
Benomyl



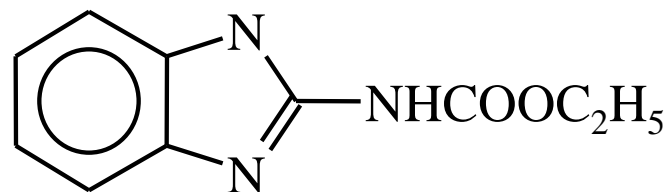
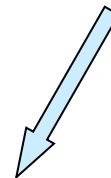
MBC



Thiophanate methyl



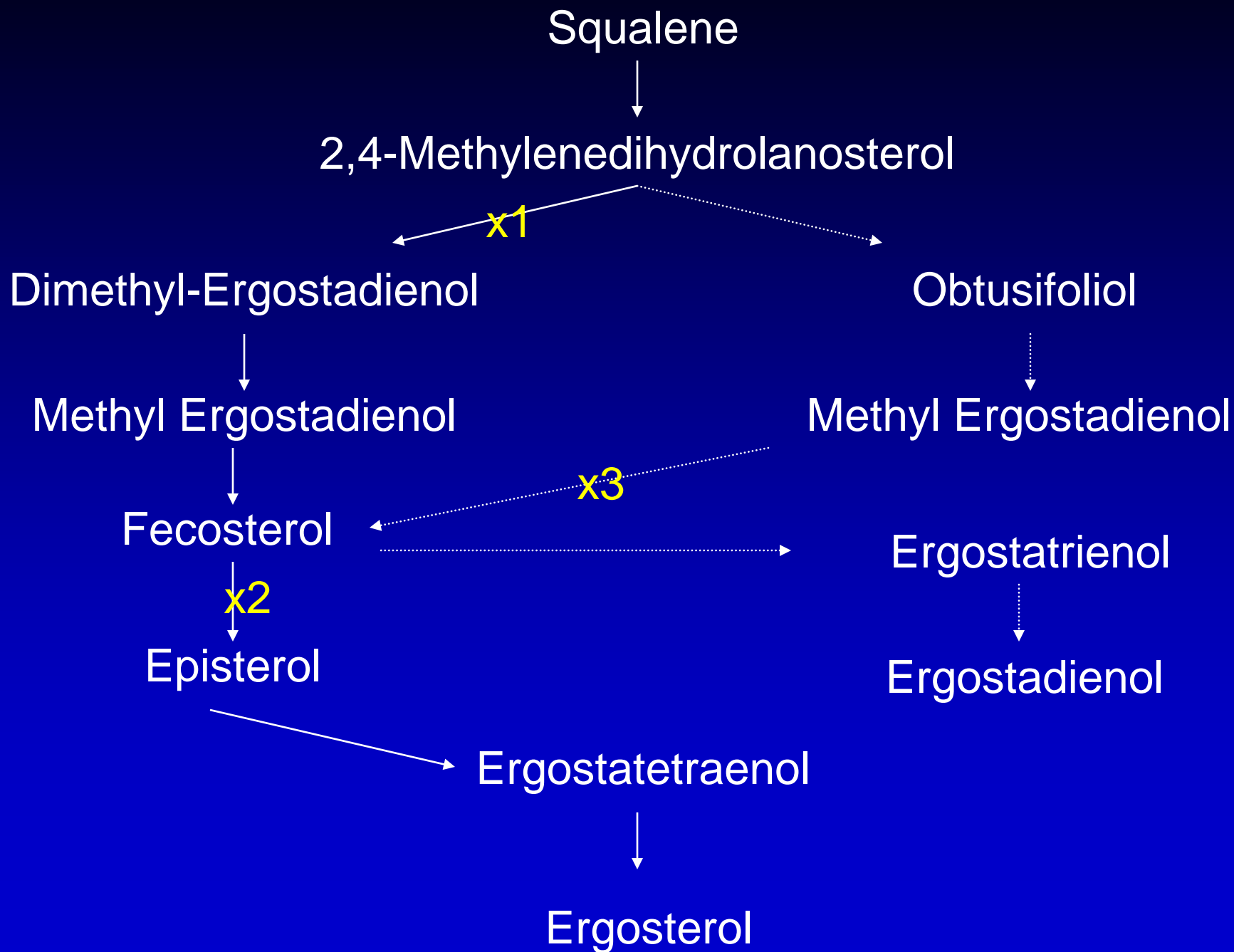
Thiophanate



EBC

# Resistance to DMI Fungicides Appears as:

- 1) Shorter intervals of control
- 2) Low level persistence of disease



# Radial Growth of *S. homoeocarpa* Isolates - 10 ppm

Fungicide	<i>S. homoeocarpa</i> Isolate				
	MI-2	PA-1	PA-2	OH-1	SS-1
Bayleton	20	10	21	11	0
Rubigan	17	15	20	9	0
Banner	0	0	0	0	0
Sentinel	0	0	0	0	0
Chipco 26019	0	0	25	10	0
Tersan 1991	40	40	40	40	0
Control	40	40	40	40	40

# Radial Growth of *S. homoeocarpa* Isolates at 10 ppm

Fungicide Class	<i>S. homoeocarpa</i> Isolate		
	PA-2	OH-1	SS-1
DMI	21	11	0
DMI	20	9	0
Dicarboximide	25	10	0
Benzimidazole	40	40	0
Untreated	40	40	40

# DMI Resistant Dollar Spot (15 days after second treatment) 1991

Fungicide	Rate/1000ft <sup>2</sup>	Disease
Bayleton	1 oz	9
Rubigan	1.75 oz	9
Banner	1 oz	9
Tersan 1991	1 oz	9
Check	--	9
Dyrene	4 oz	0
Daconil	6 oz	0

0 = no disease      9 = severe disease



# 1993 Resistant Dollar Spot Study

## Rating Date: 9/22/93

Treatment	Rate/1000 ft <sup>2</sup>	Mean* (DMR)
Bayleton (10 days)	4 oz	0 a
Bayleton (10 days)	2 oz	0.3 ab
Bayleton (10 days)	1 oz	0.7 a-c
Bayleton (21 days)	4 oz	1.7 a-e
Control	--	2.7 c-f
Bayleton (21 days)	1 oz	3.3 e-g
Bayleton (21 days)	2 oz	3.3 e-g

\* Mean of 3 replications

# Degree of Resistance and Persistence Among the SS Fungicides

Fungicide Class	Degree of Resistance	Persistence
Benzimidazoles	High	Yes
Dicarboximides	Low	No
DMI's	Low	Yes
Acylalanines	High	Yes
Organic Phosphates	Low	No

# Where resistance to site specific fungicides has occurred:

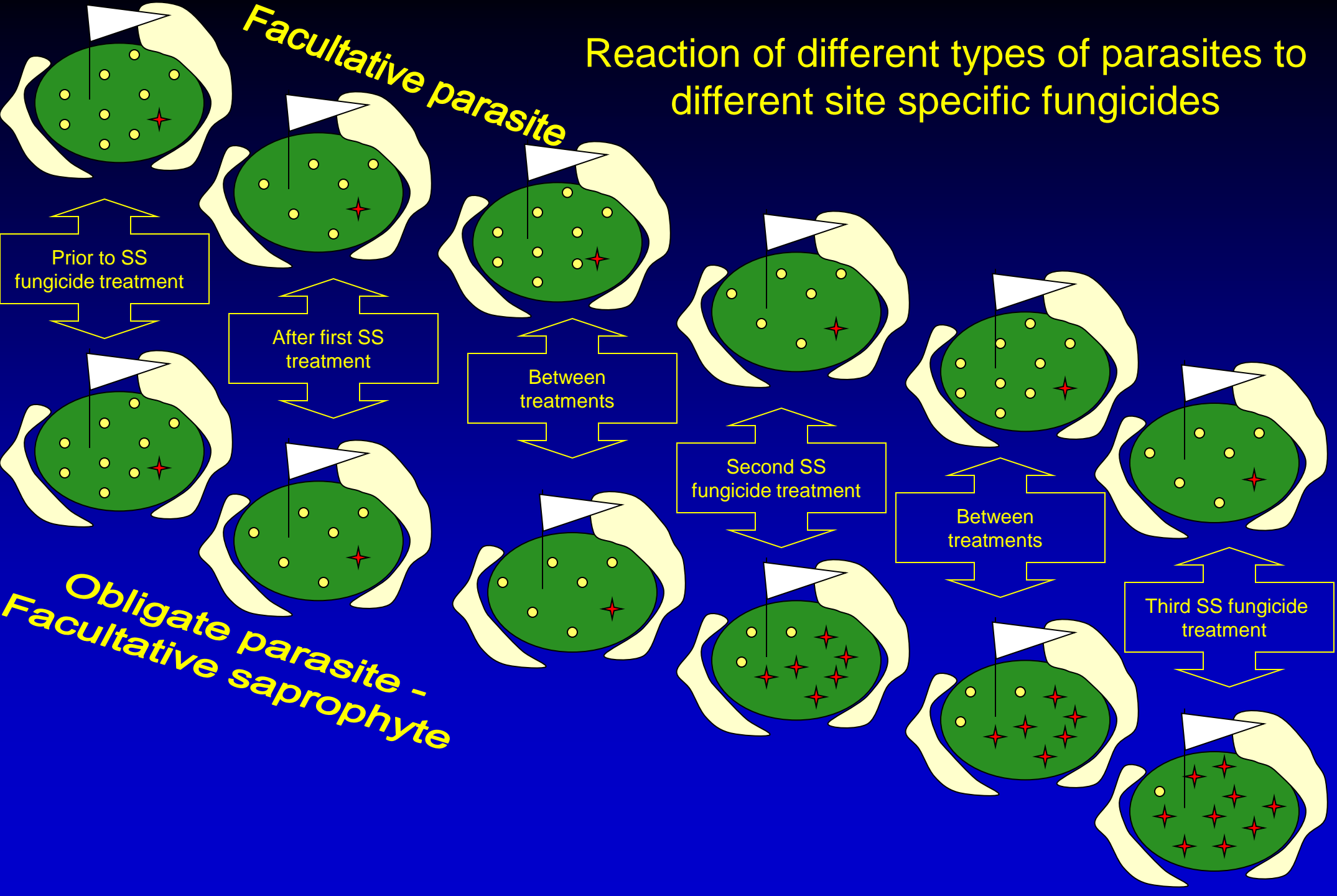
- Obligate parasites -frequently
- Facultative saprophytes -frequently
- Facultative parasites -infrequently

# Disease classification Based on the Type of Parasitism Exhibited by the Fungus

Obligate Parasites	Facultative Saprophytes	Facultative Parasites
*Rusts	*Dollar spot	Brown patch
*Powdery mildew	*Microdochium Patch	Anthracnose
Yellow tufts	*Phytophthora	Pythium blight
	Stripe smut	

\*Those diseases to which widespread resistance to SS fungicides has occurred whether in turf or another crop.

# Reaction of different types of parasites to different site specific fungicides



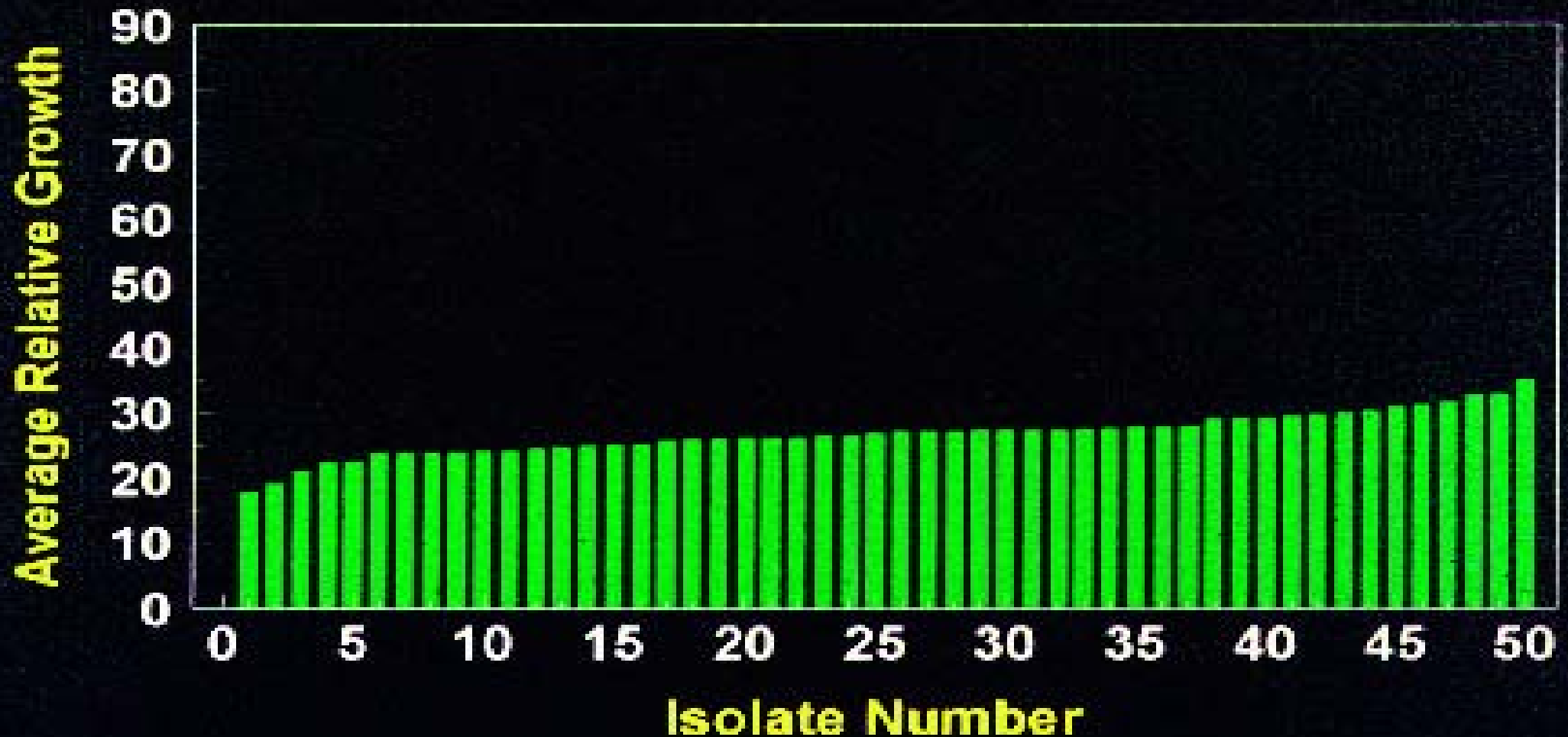
# To delay or prevent resistance:

- 1) Lowest effective rate
- 2) Longest possible intervals

# Resistance develops faster

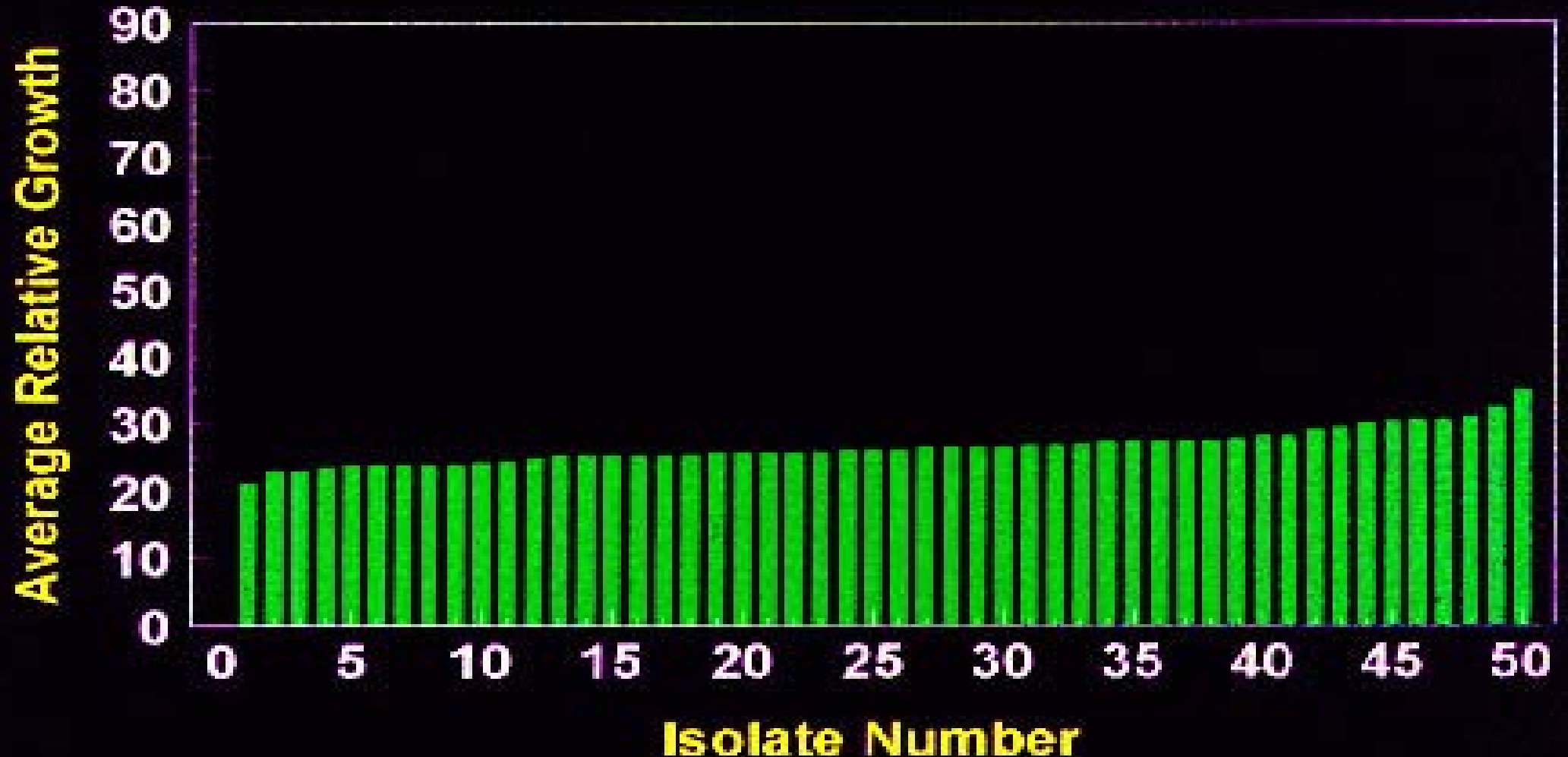
- 1) Higher rates
- 2) Shorter intervals

# MI-9 (S) - Bayleton Amended (0.5 $\mu\text{g/ml}$ ) Plate Study

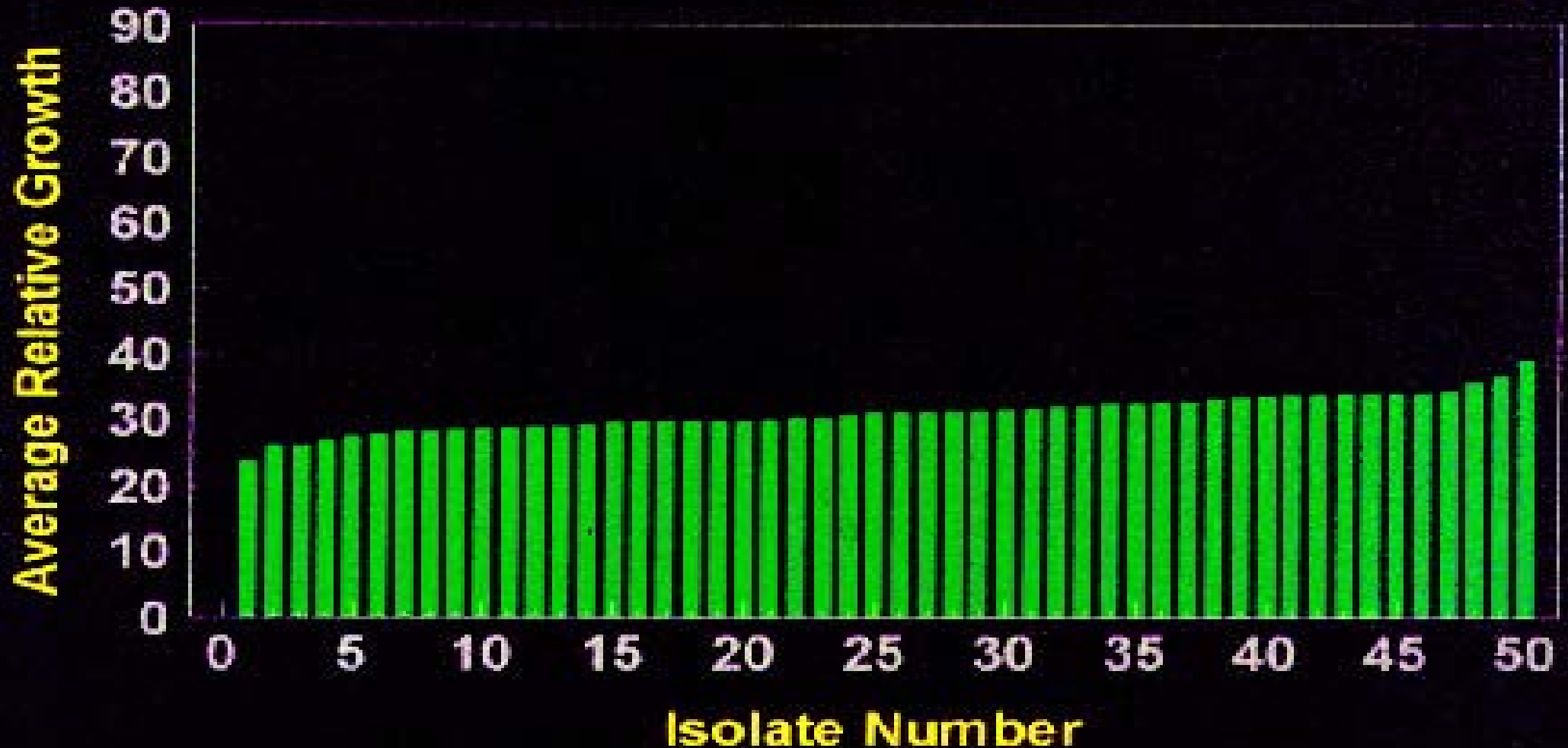




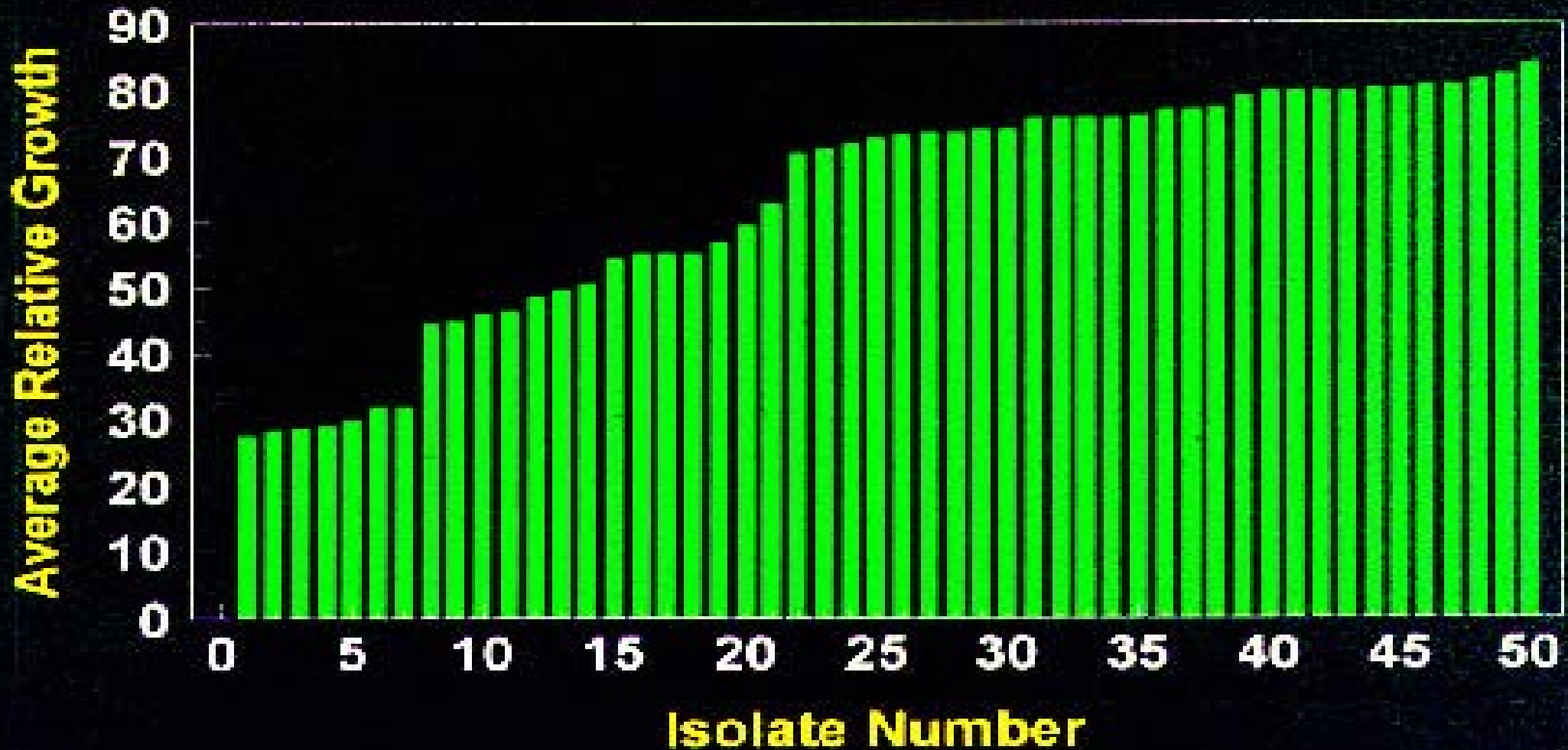
# MI-10 (S) - Bayleton Amended (0.5 $\mu\text{g/ml}$ ) Plate Study



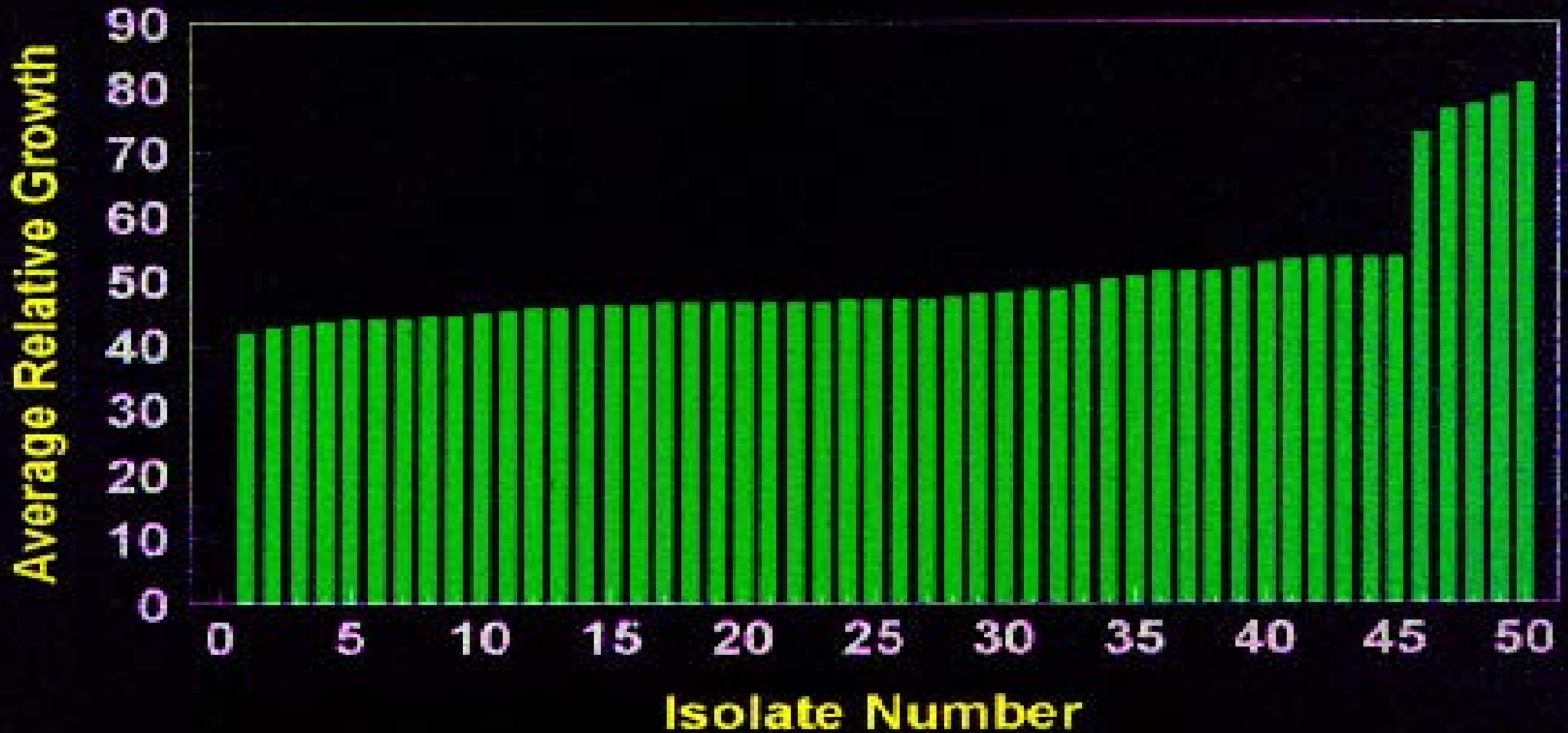
# MI-11 (S) - Bayleton Amended (0.5 $\mu\text{g/ml}$ ) Plate Study



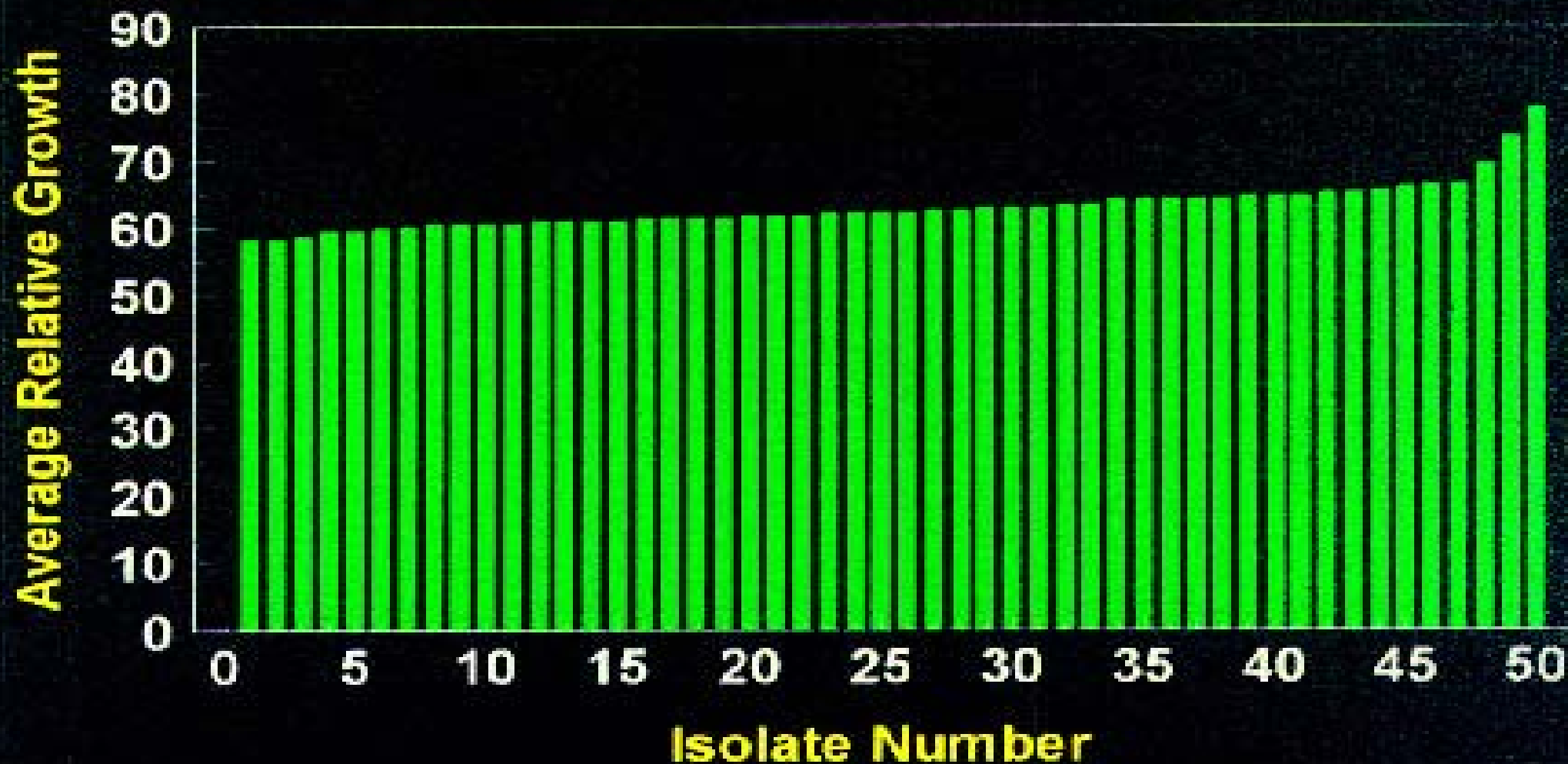
# MI-8 (R) - Bayleton Amended (0.5 $\mu\text{g/ml}$ ) Plate Study



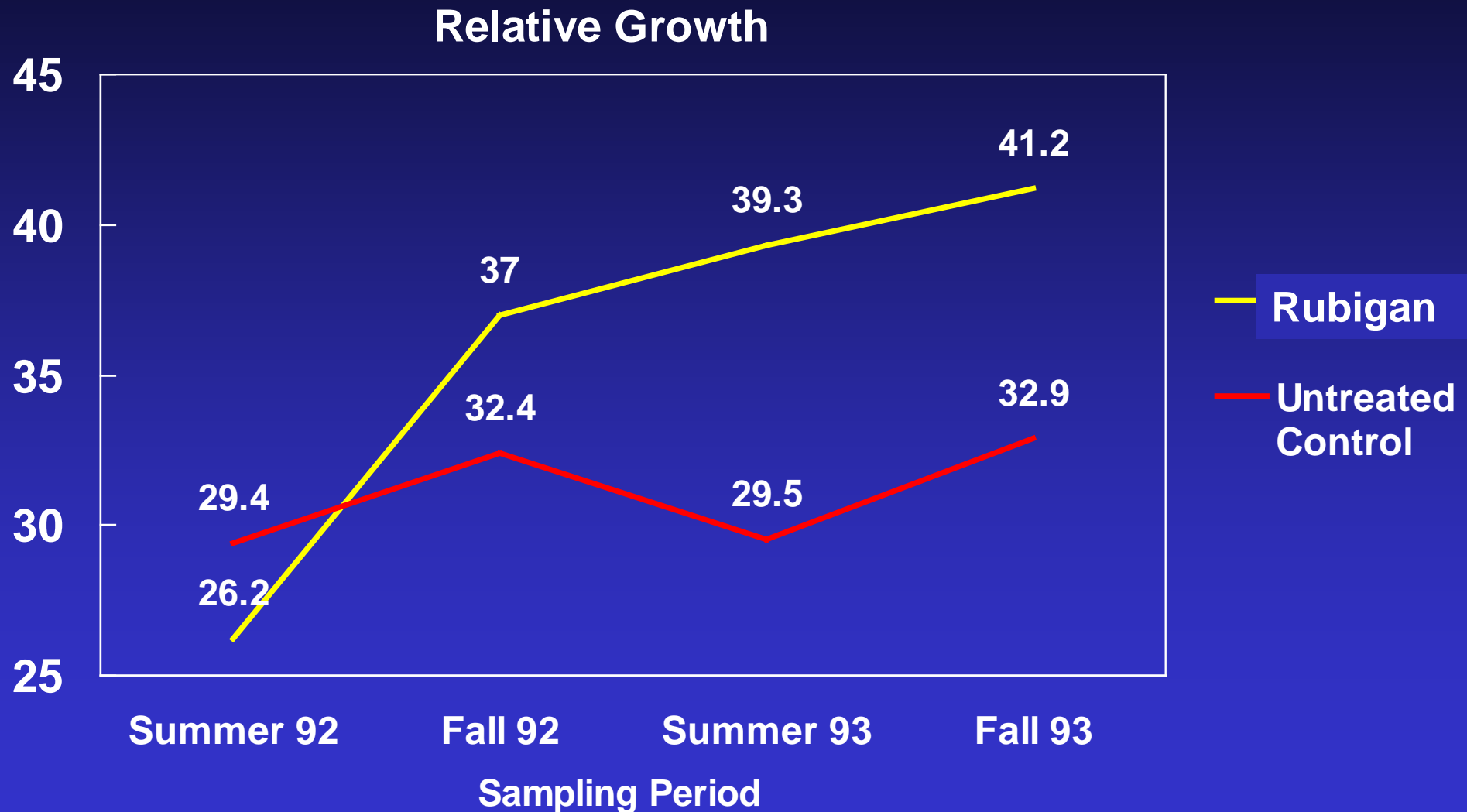
# OH-2 (R) - Bayleton Amended (0.5 $\mu\text{g/ml}$ ) Plate Study



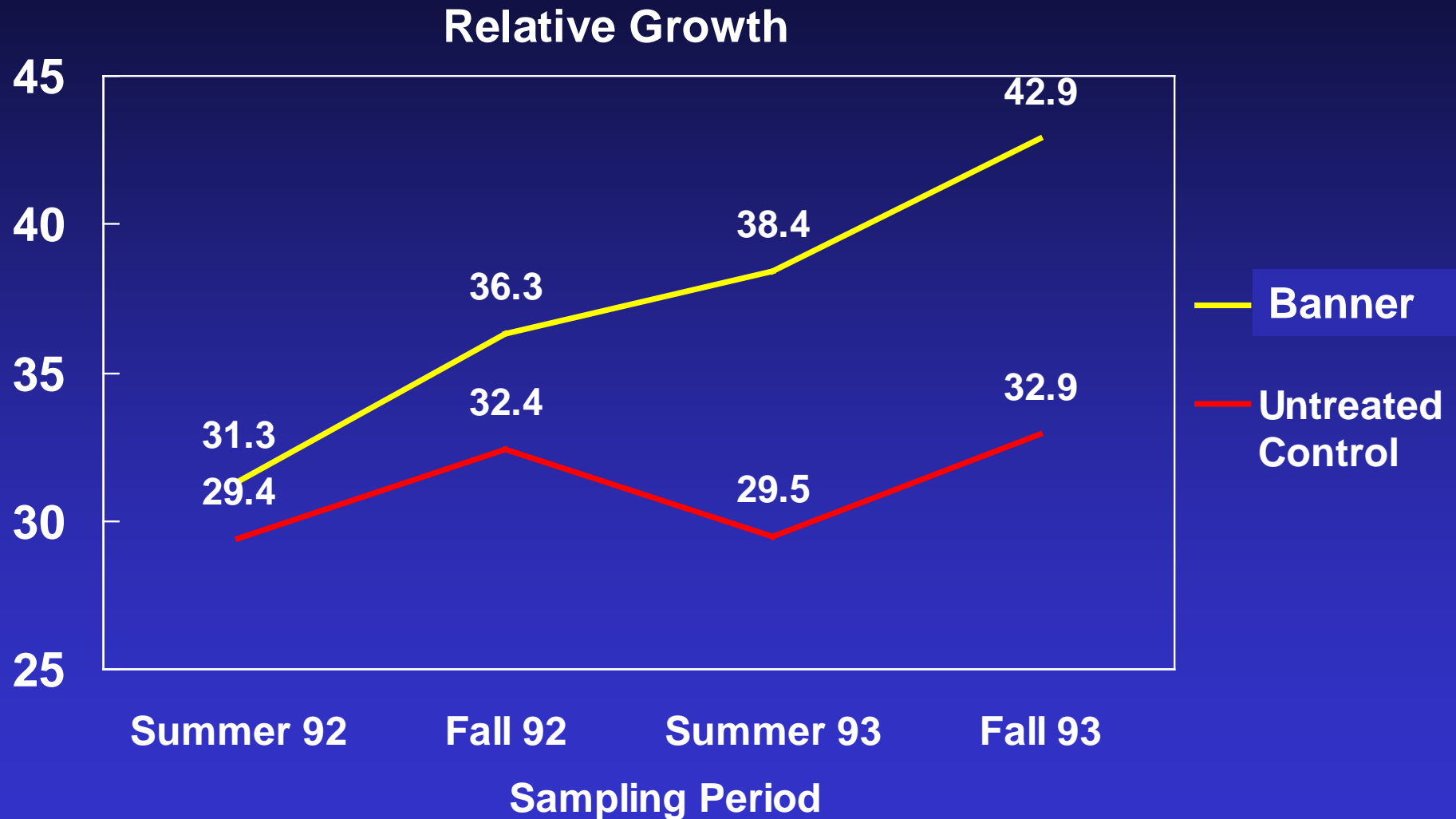
# MI-7 (R) - Bayleton Amended (0.5 $\mu\text{g/ml}$ ) Plate Study



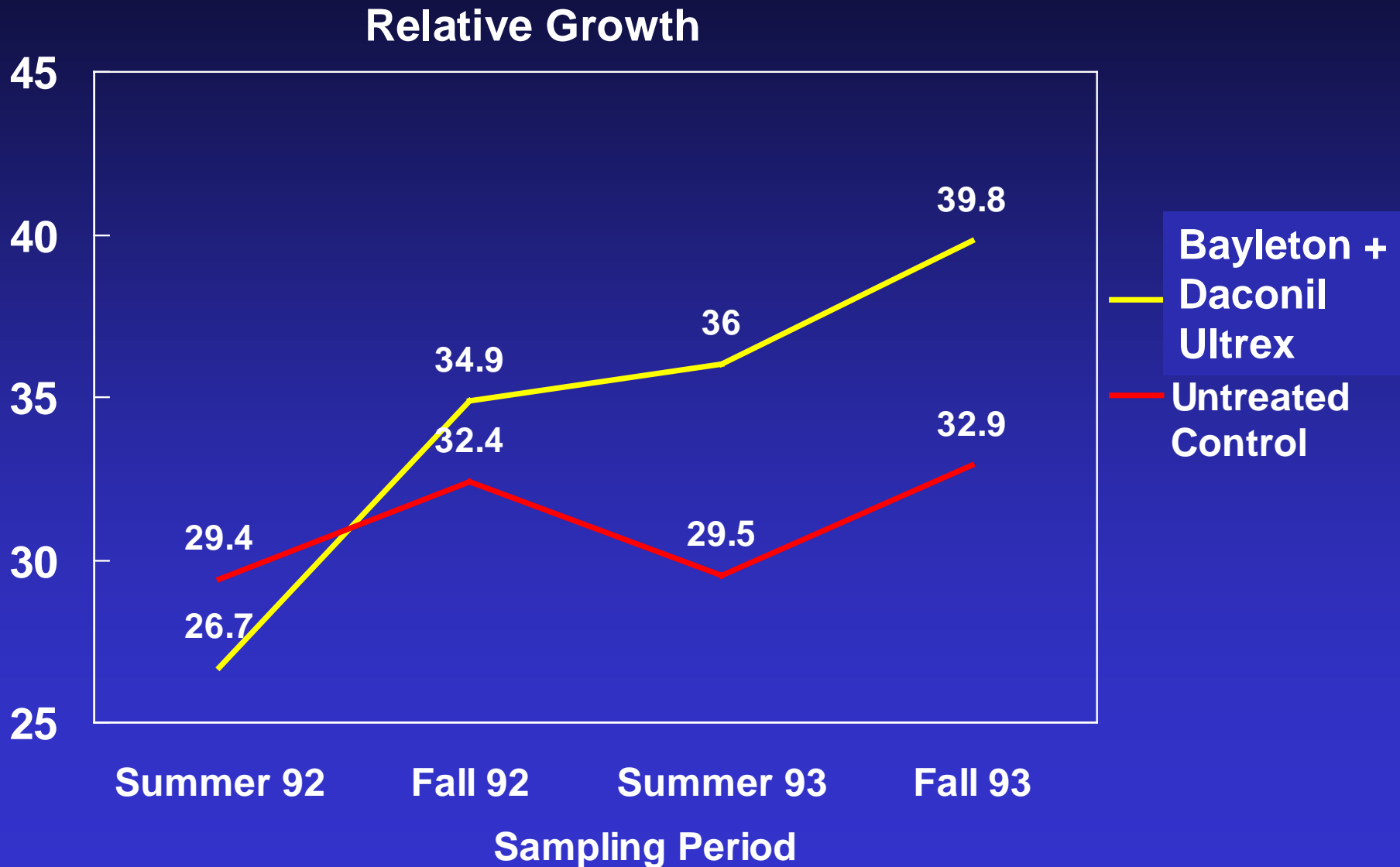
# Dollar Spot Population Analysis



# Dollar Spot Population Analysis

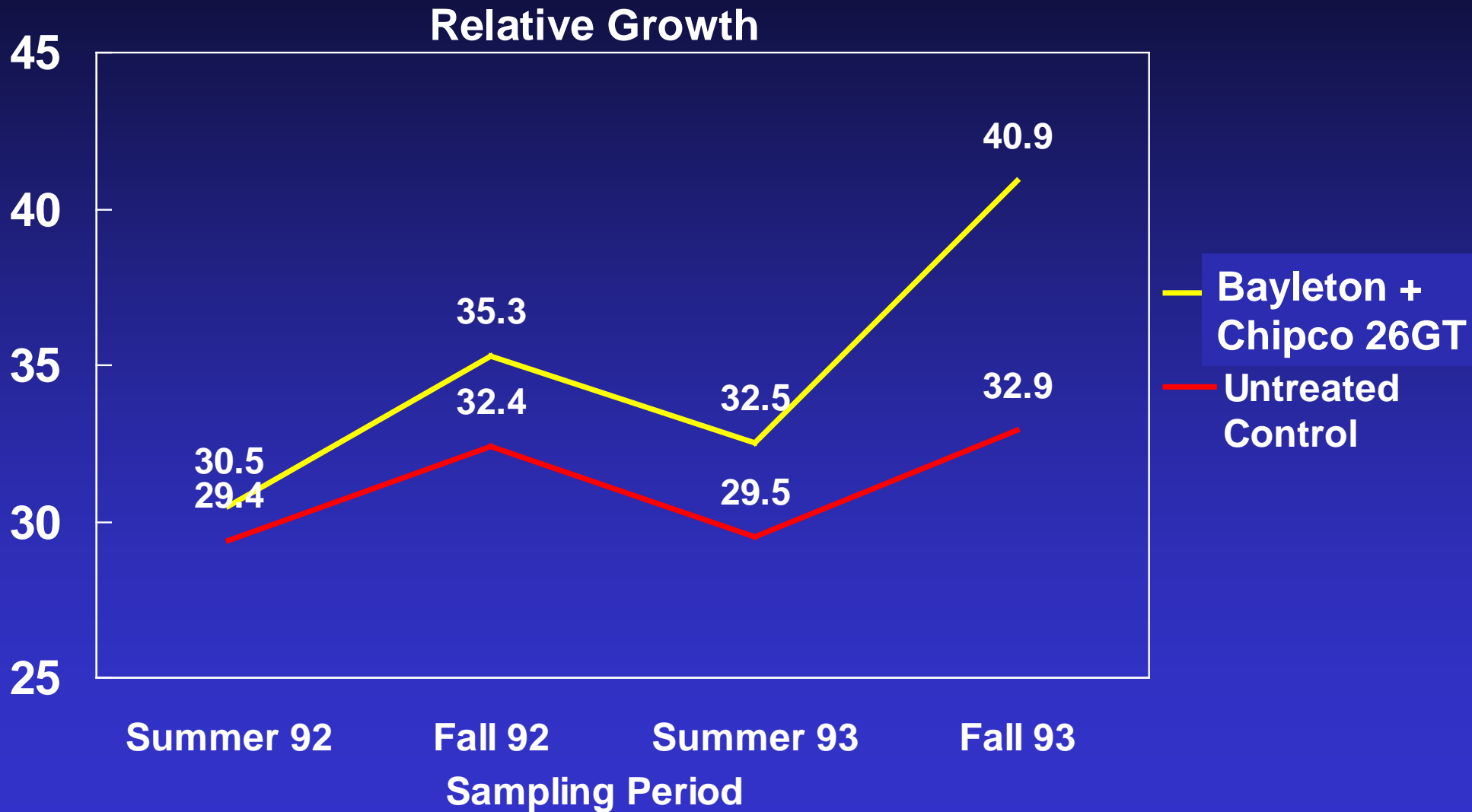


# Dollar Spot Population Analysis





# Dollar Spot Population Analysis



# Insecticide Resistance

- Carbamates 1st 5 years

- Organophosphates 2nd 5 years



10 years of  
control

# Insecticide Resistance

- Carbamates alternated with Organophosphates -  
5 years of control

# Insecticide Resistance

## Time for Resistance to Develop

- Carbamates alone 5 years
- Organophosphates 5 years
- Carbamates alternated with O.P. 5 years

# Number of Applications Needed for Resistance to Develop

Fungicide Group	Number of Applications
• Acylalanines	3-6
• Benzimidazole	3-6
• Dicarboximide	30-50
• DMI	20-30

# Conclusions

- Alternating modes of action will not prevent fungicide resistance.
- Tank mixing or alternating with a contact fungicide will not prevent resistance.
- Alternating different modes of action of site specific fungicides will shorten the life expectancy of both.

# Resistance Management Strategies

- 1) Consider the number of applications that can be made before resistance occurs.
- 2) Aim to delay, not prevent, resistance.
- 3) Include contacts to reduce the number of applications with site specific fungicides.
- 4) Use one site specific fungicide until resistance develops.

