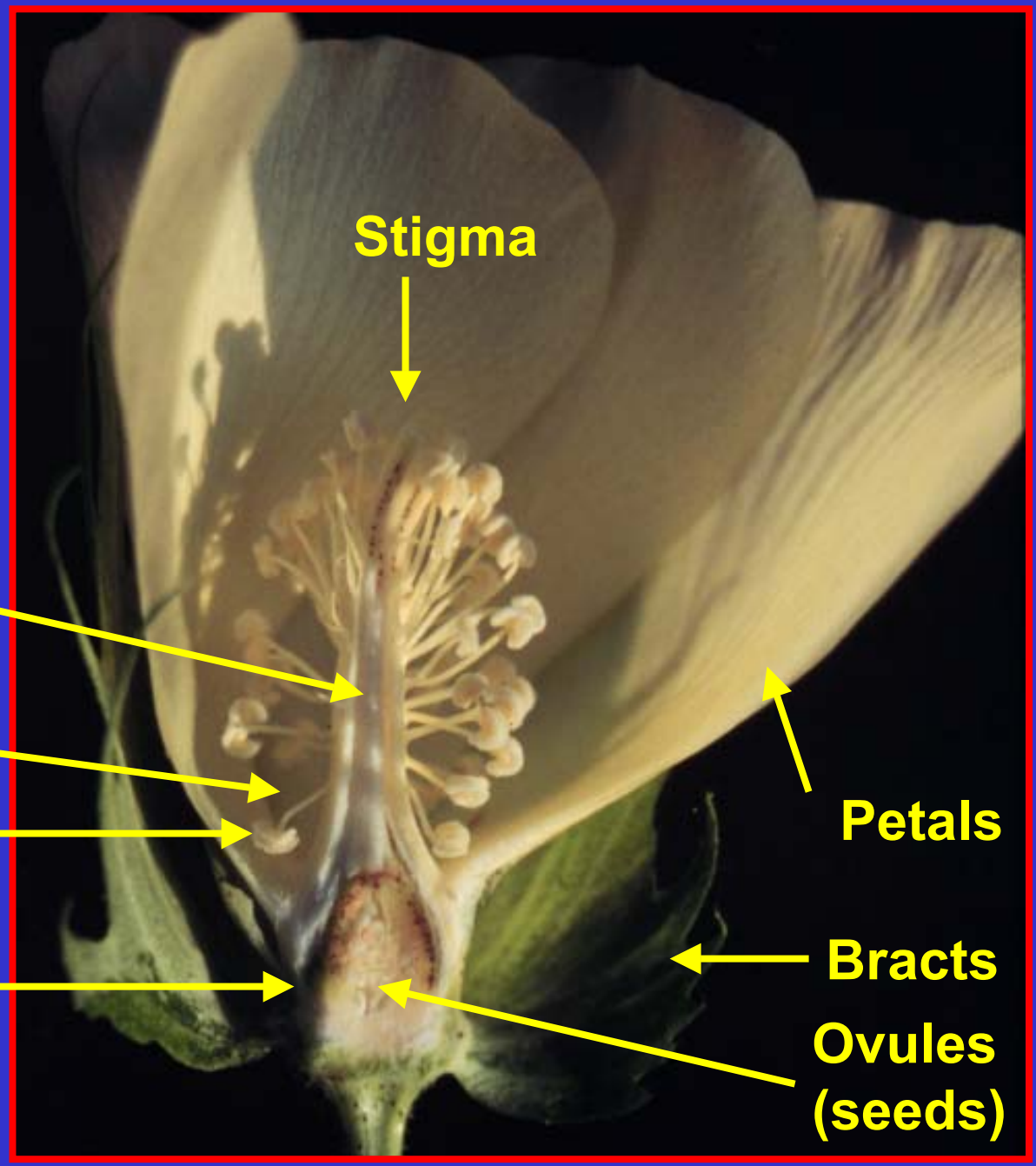
Growth and Development of the Cotton Fruit

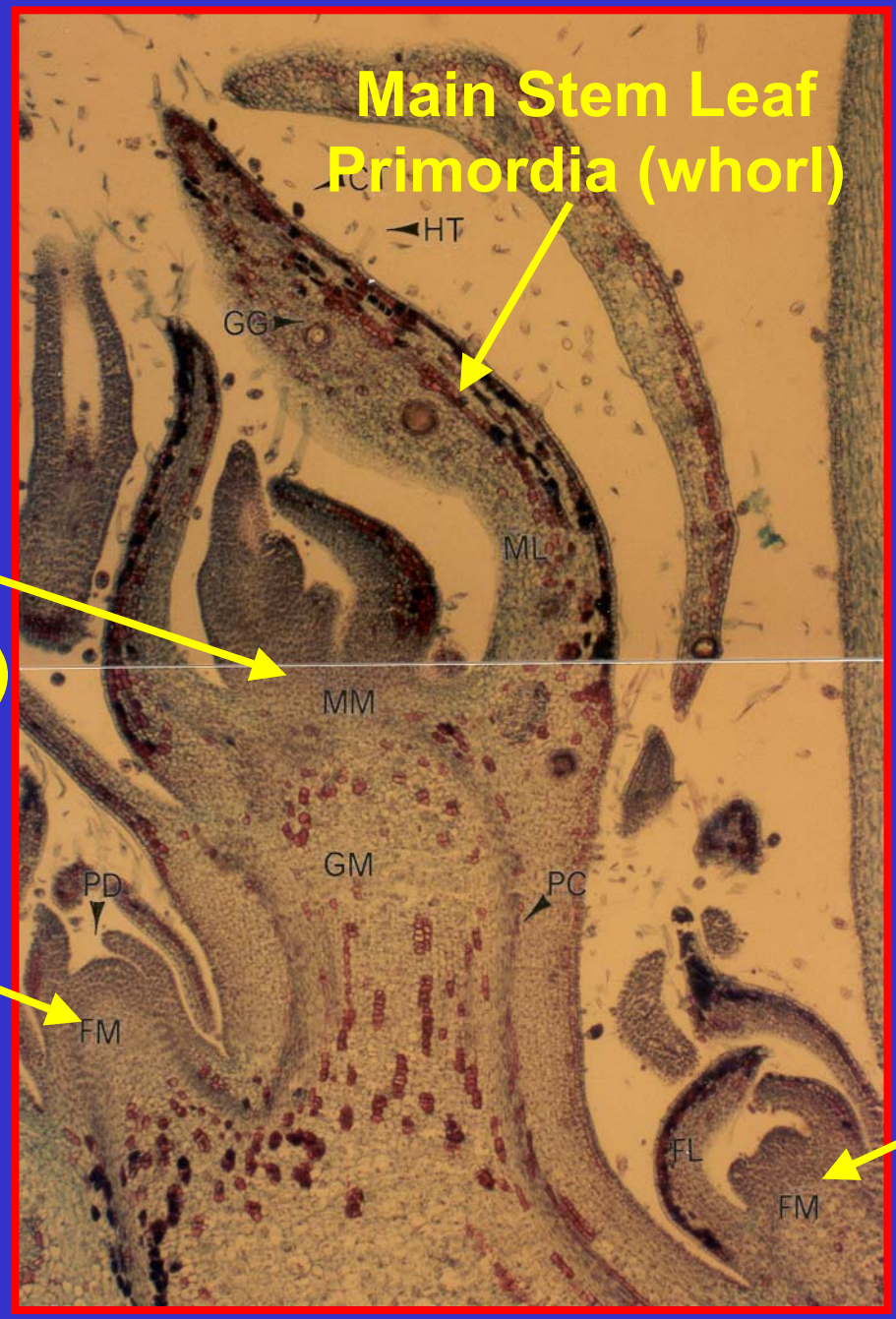
Craig W. Bednarz
University of Georgia
Tifton, GA

Cotton Flower Parts (complete)



Cotton Terminal

(40 X)



Main Stem Meristem (monopodium)

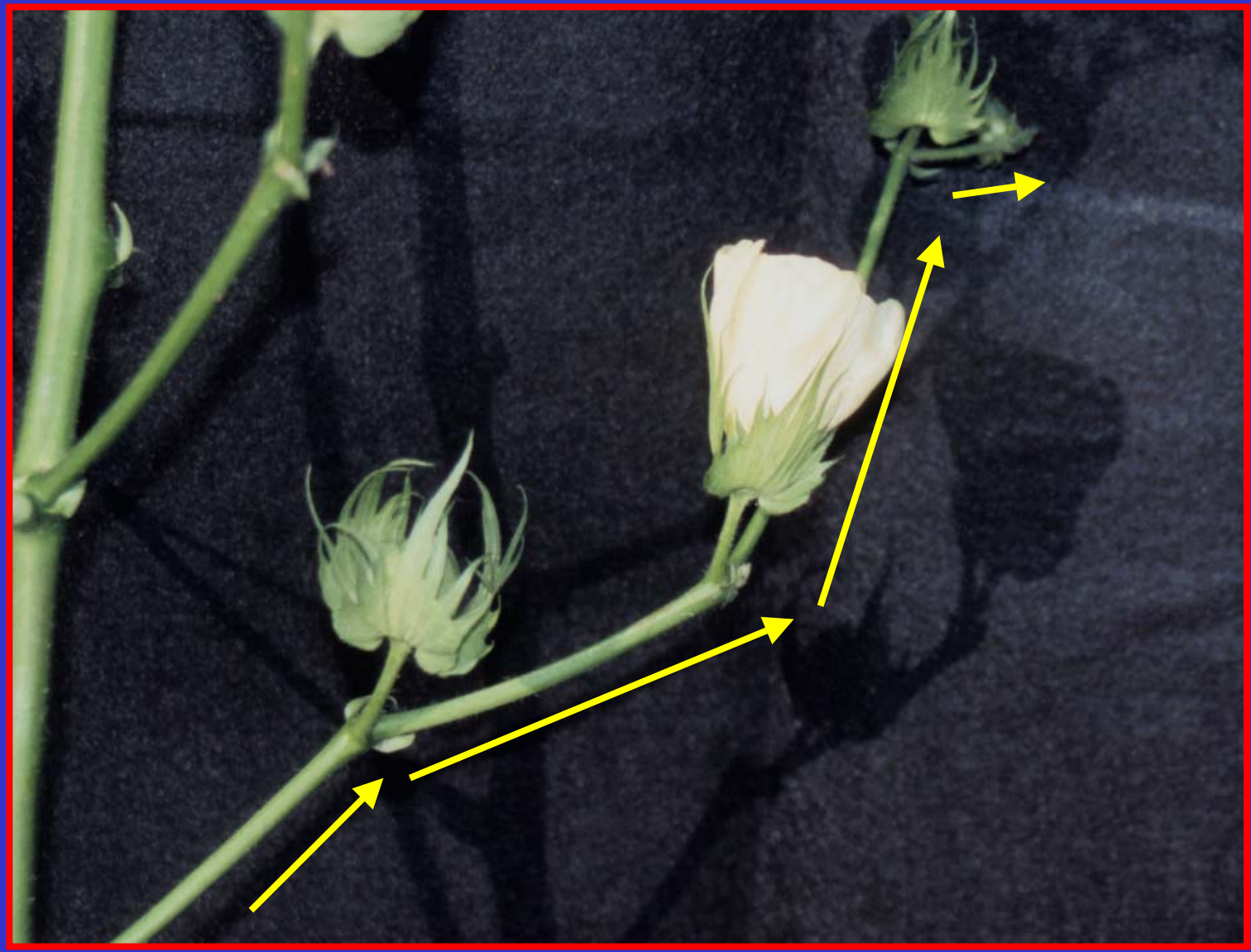
Fruiting Branch Meristem (sympodium)

Fruiting Branch Meristem

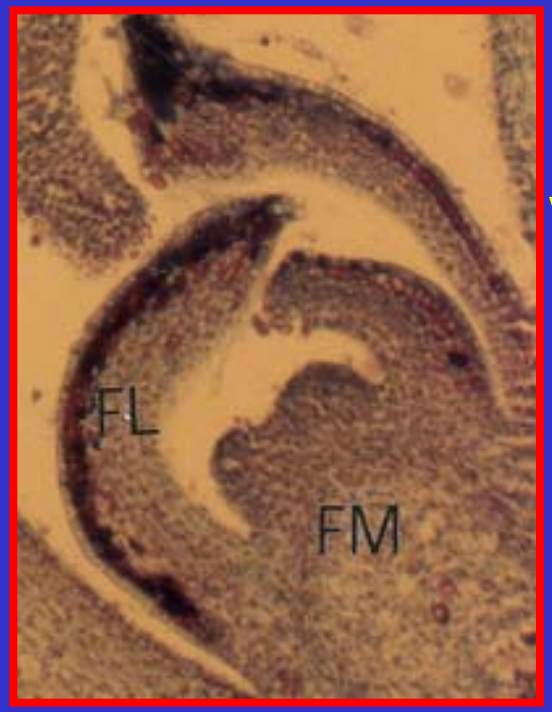
Consecutive Nodes (not visible)

Thrips

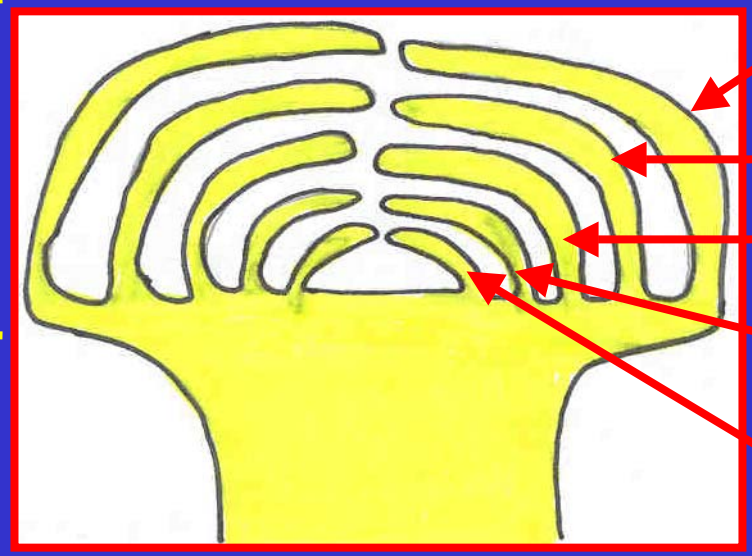
Cotton Sympodia



Cotton Monopodia/Vegetative



whorls



bract

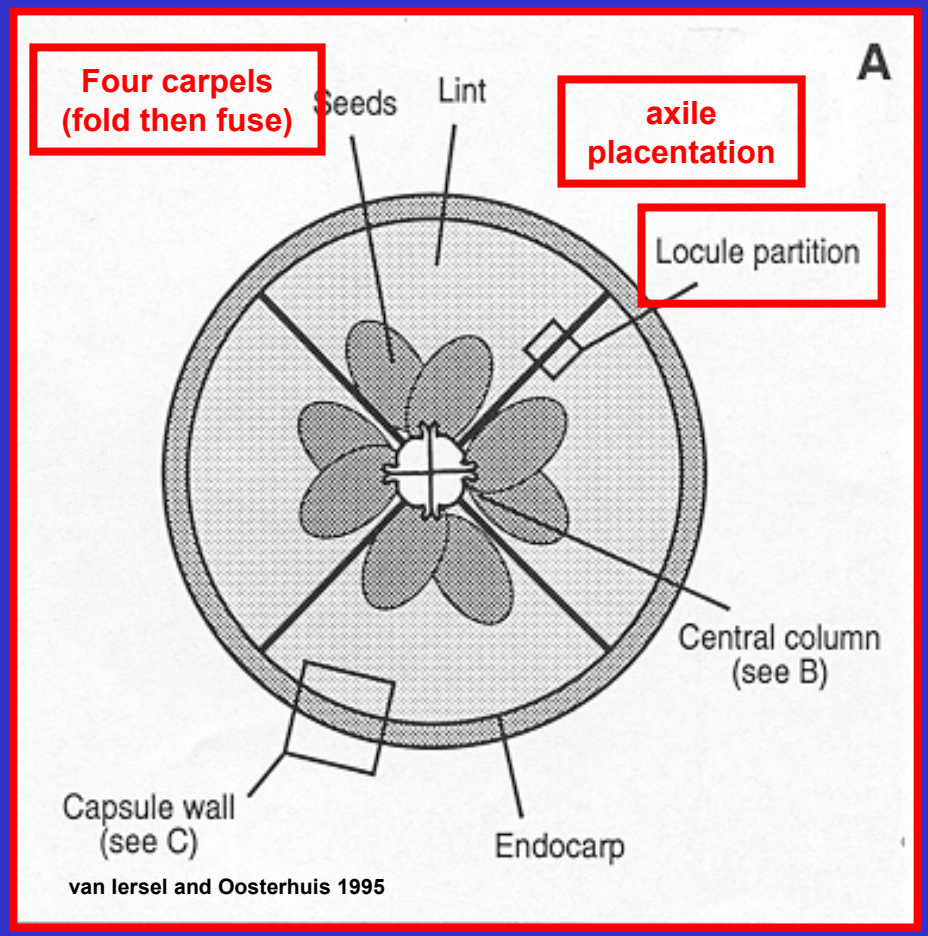
sepal

petal

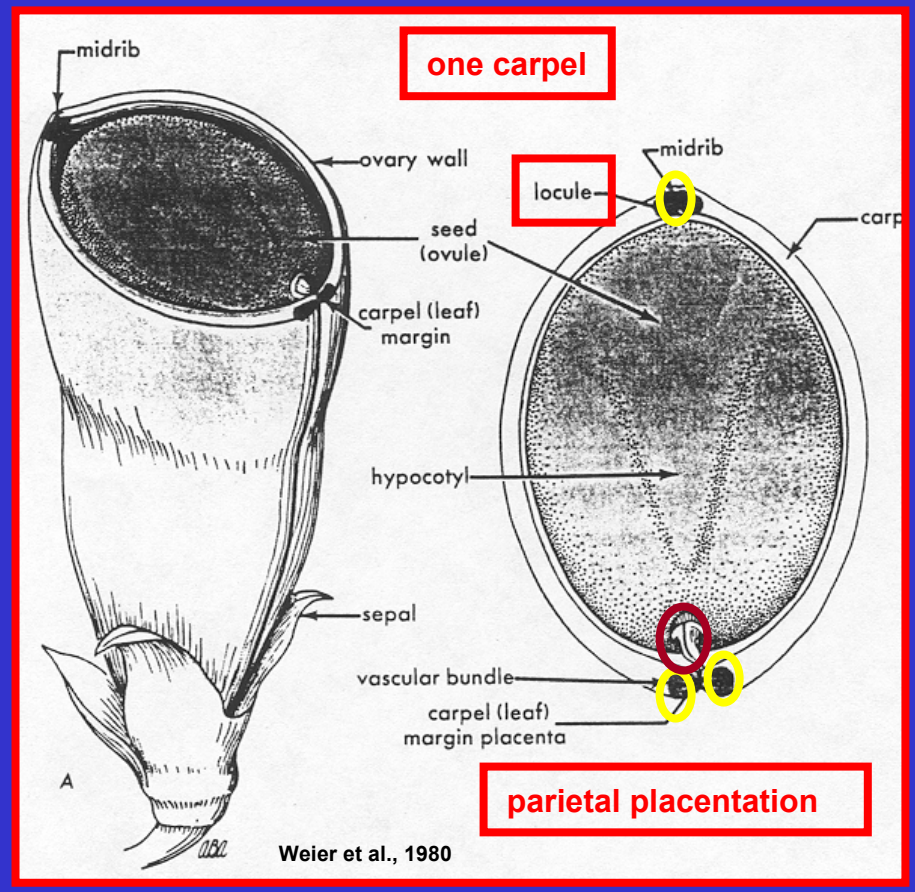
stamen

Carpel
(pistil)

Schematic of a Carpel in Cross Section



cotton, okra



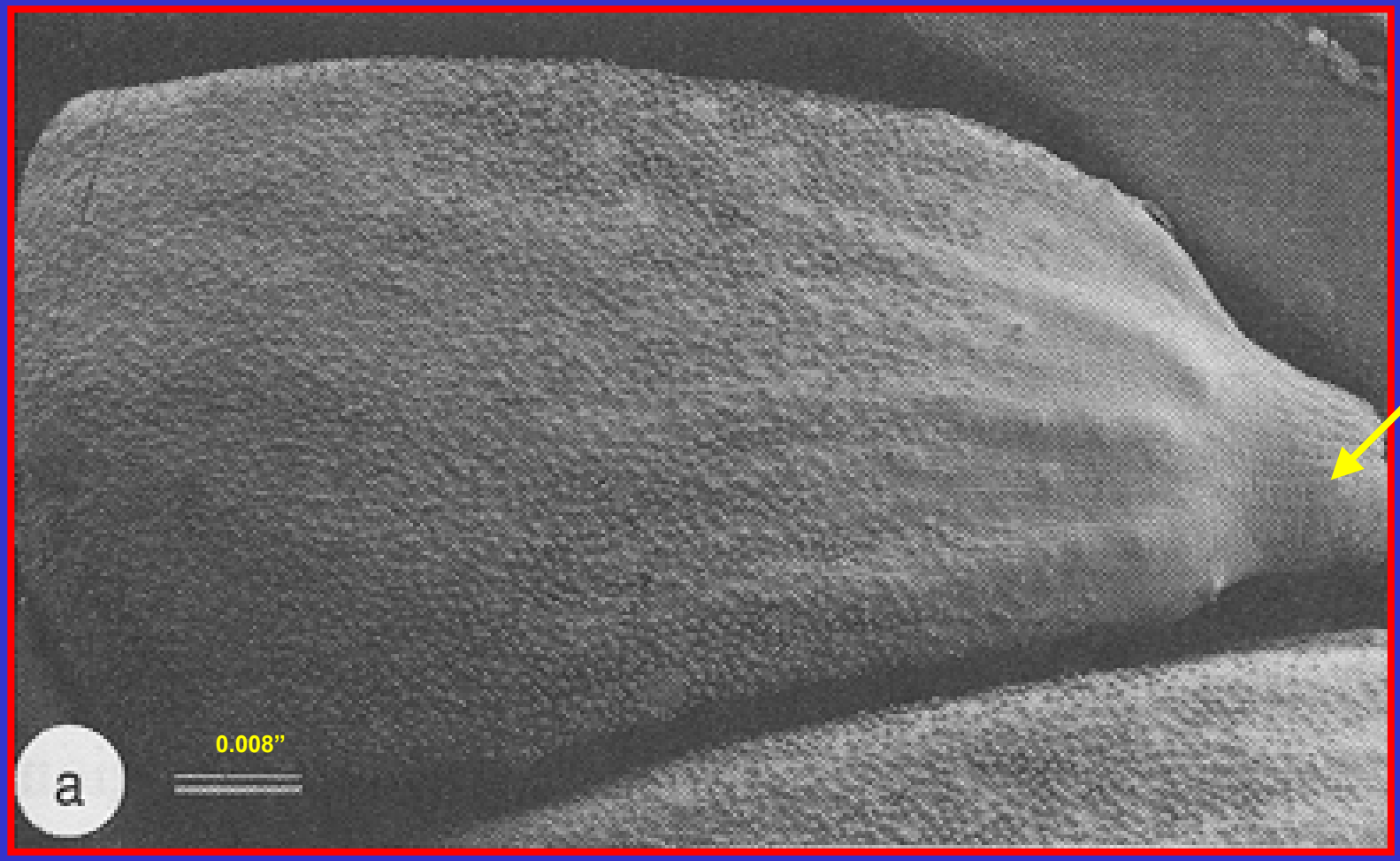
pea

Cotton Pollination

Pollen Tube grows at a rate of several mm/h and is SENSITIVE to EVERYTHING.

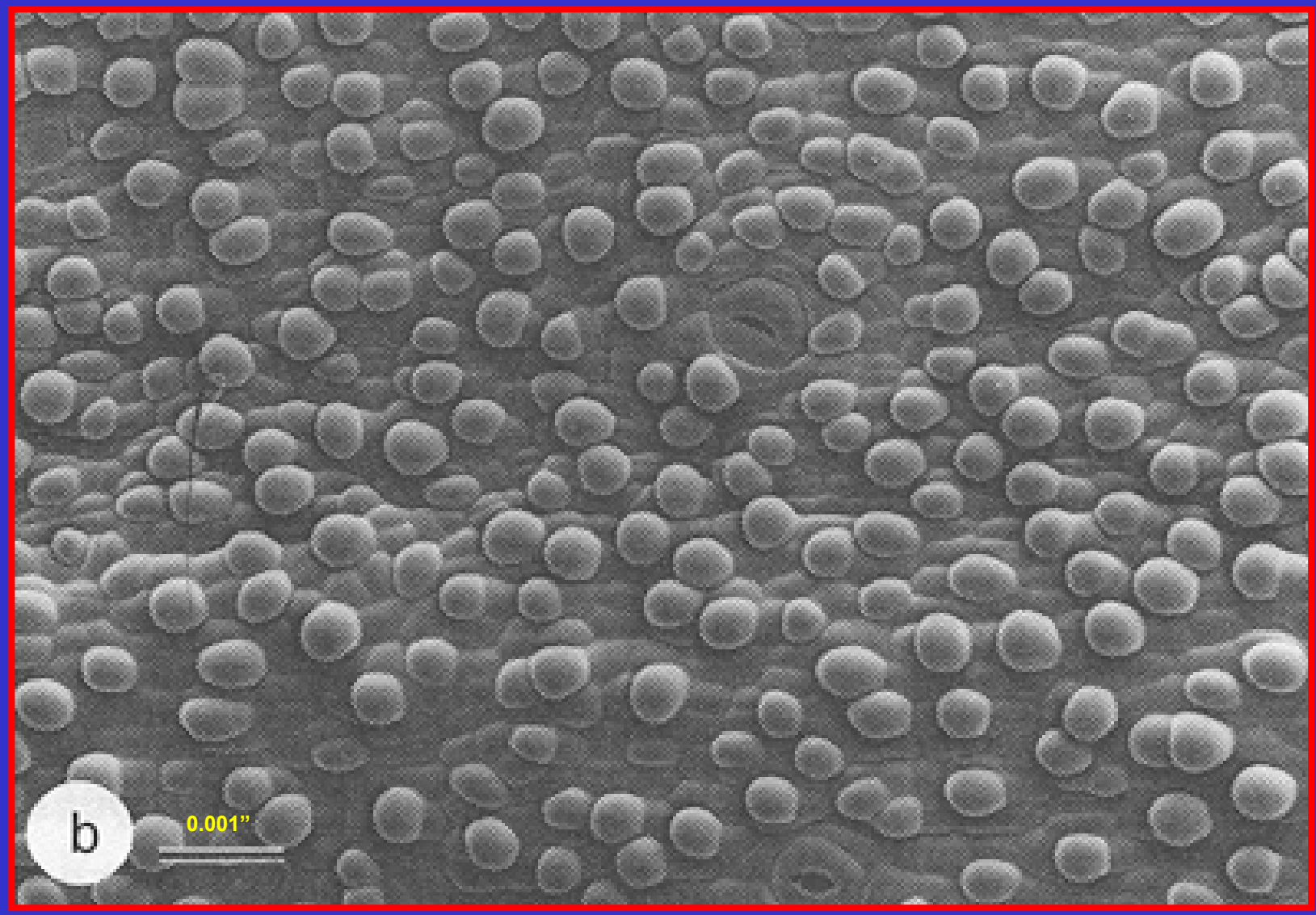
Tube enters mircopyle and male gametes are released.

Cotton Ovule on the Day of Anthesis



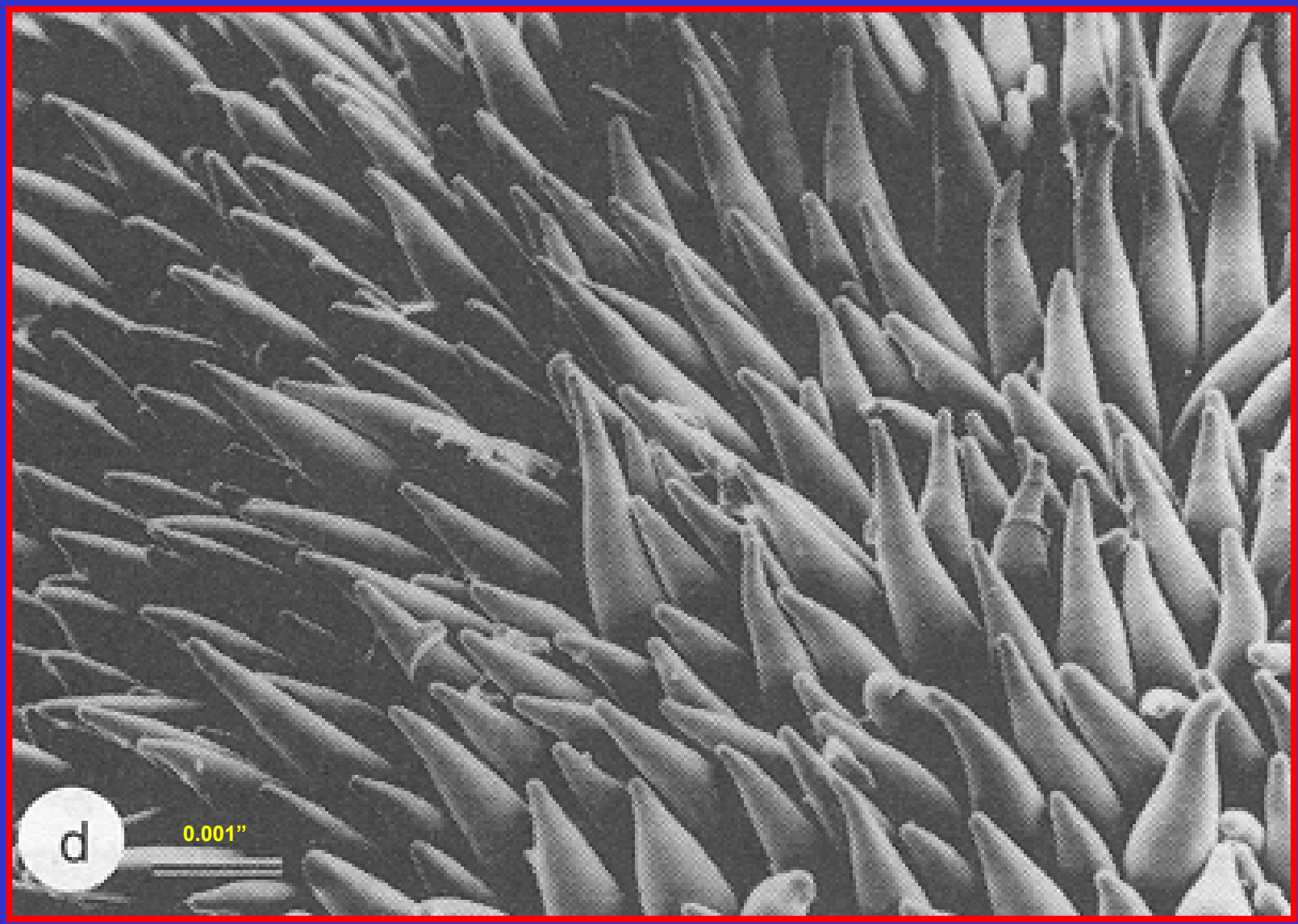
Oosterhuis and Jernstedt, 1999

Fiber Initials on the Day of Anthesis



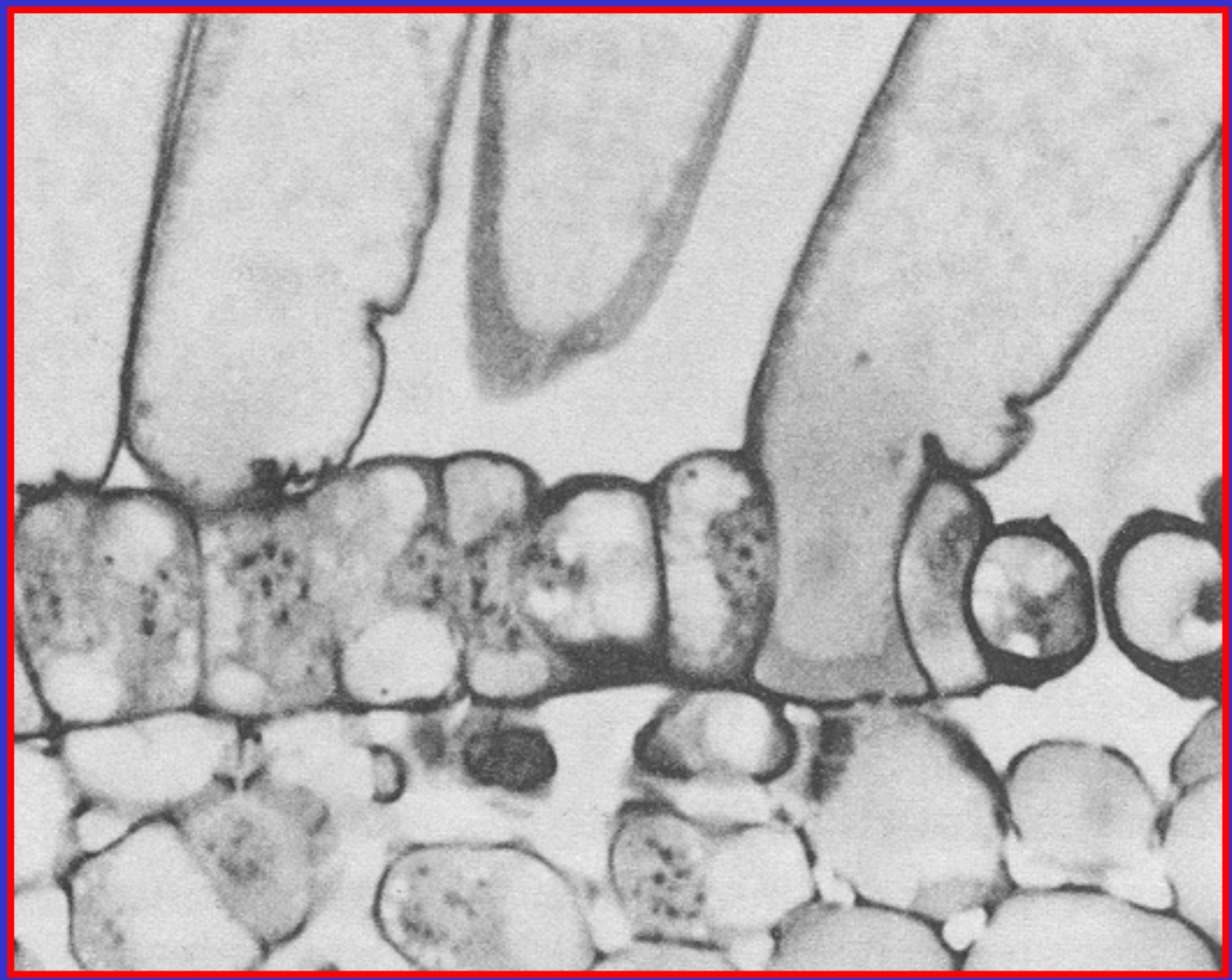
Oosterhuis and Jernstedt, 1999

Developing Cotton Fibers One Day After Antheis



Oosterhuis and Jernstedt, 1999

Cotton Fiber Footing



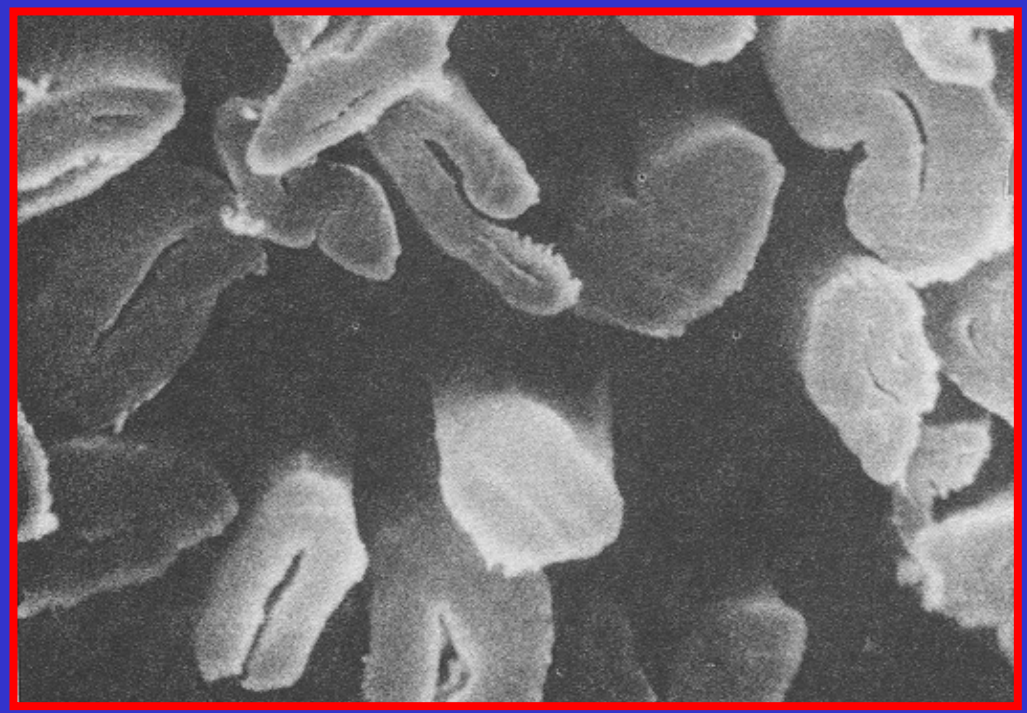
Berlin, 1986

Fibers Elongate for the First Three Weeks After Anthesis (Boll Enlargement Phase)

- Fibers are Single Cell
- Increase in Length 1000 X
- Water Required
- Potassium Required
- Temperature

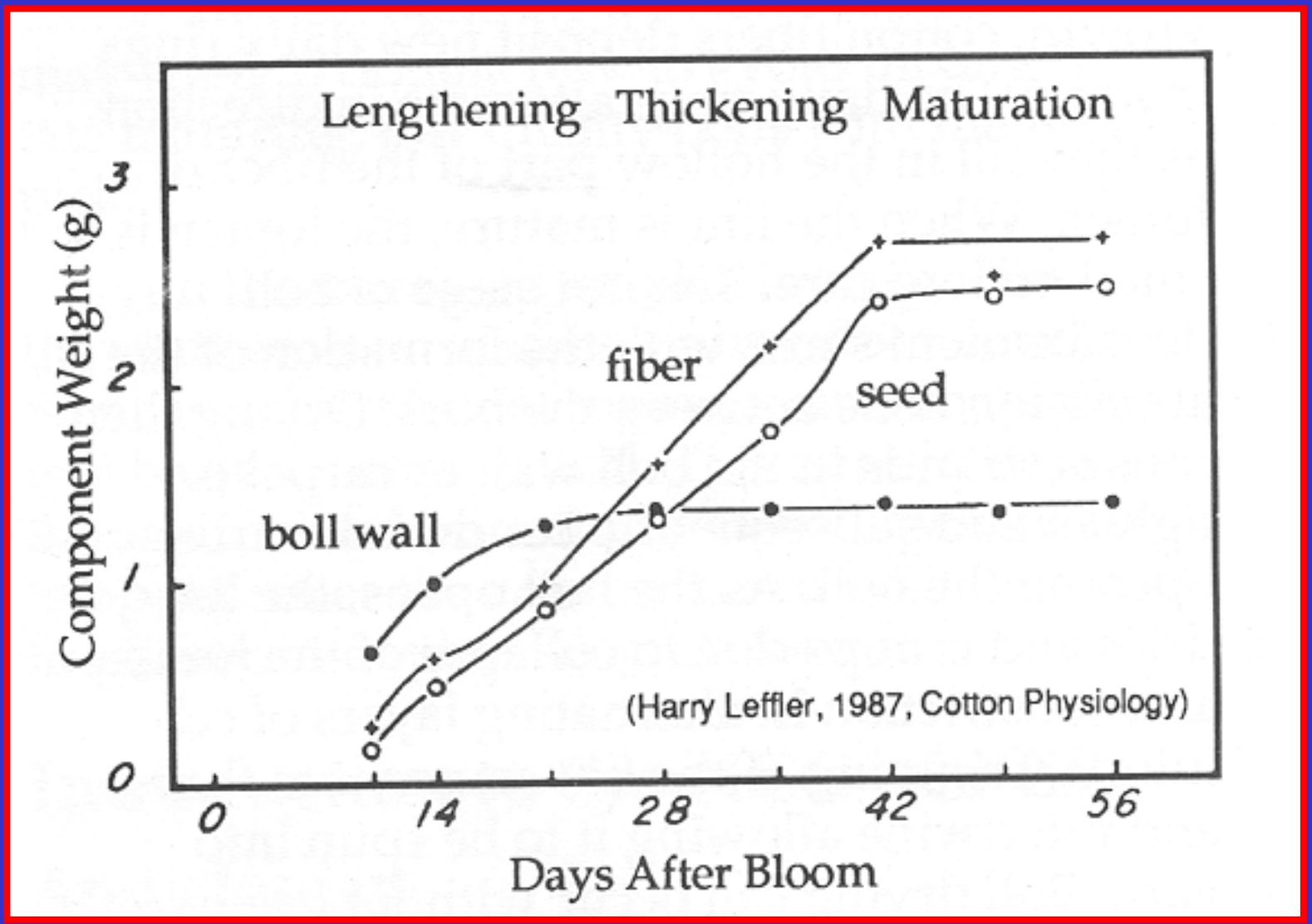
Fibers Fill During the Second Three Weeks After Anthesis (Boll Filling Phase)

- Water
- Potassium
- Temperature



Bill Goynes, USDA-ARS

Stages of Boll Development



What Influences Fiber Properties?

- CHO supply (source)
- CHO demand (sink)
- Water
- Temperature
- Nutrients

Also impact CHO supply and demand.

CHO Supply

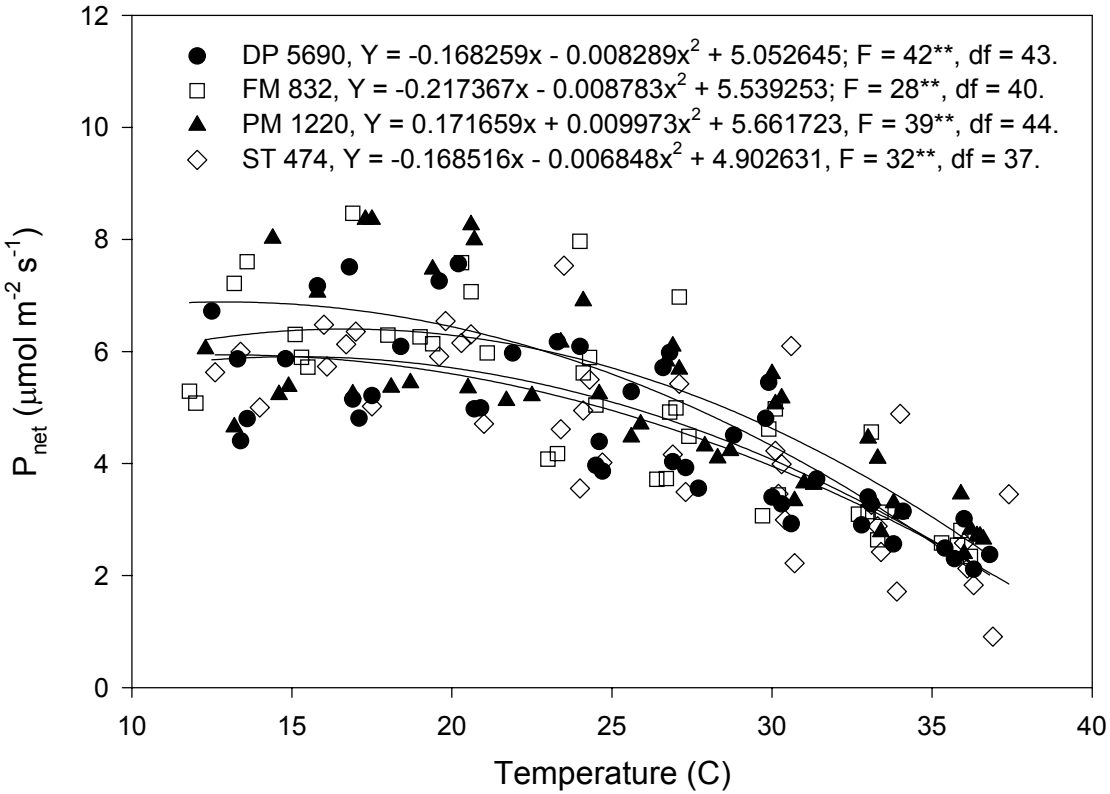


Figure 2. Effect of temperature on net photosynthesis of several cotton cultivars. $x = (X_i - X.)$, X_i = ith temperature recorded during photosynthesis, X. = mean temperature recorded during photosynthesis. ** denotes significance level of $P < 0.01$.

CHO Supply

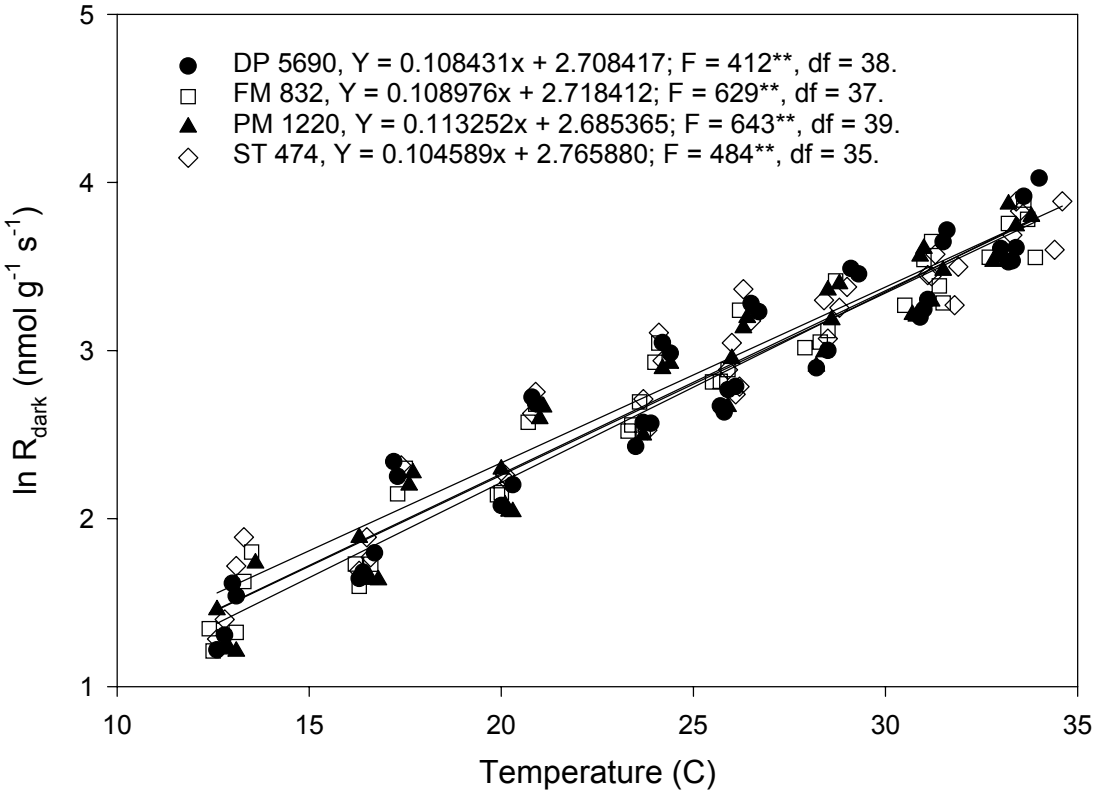
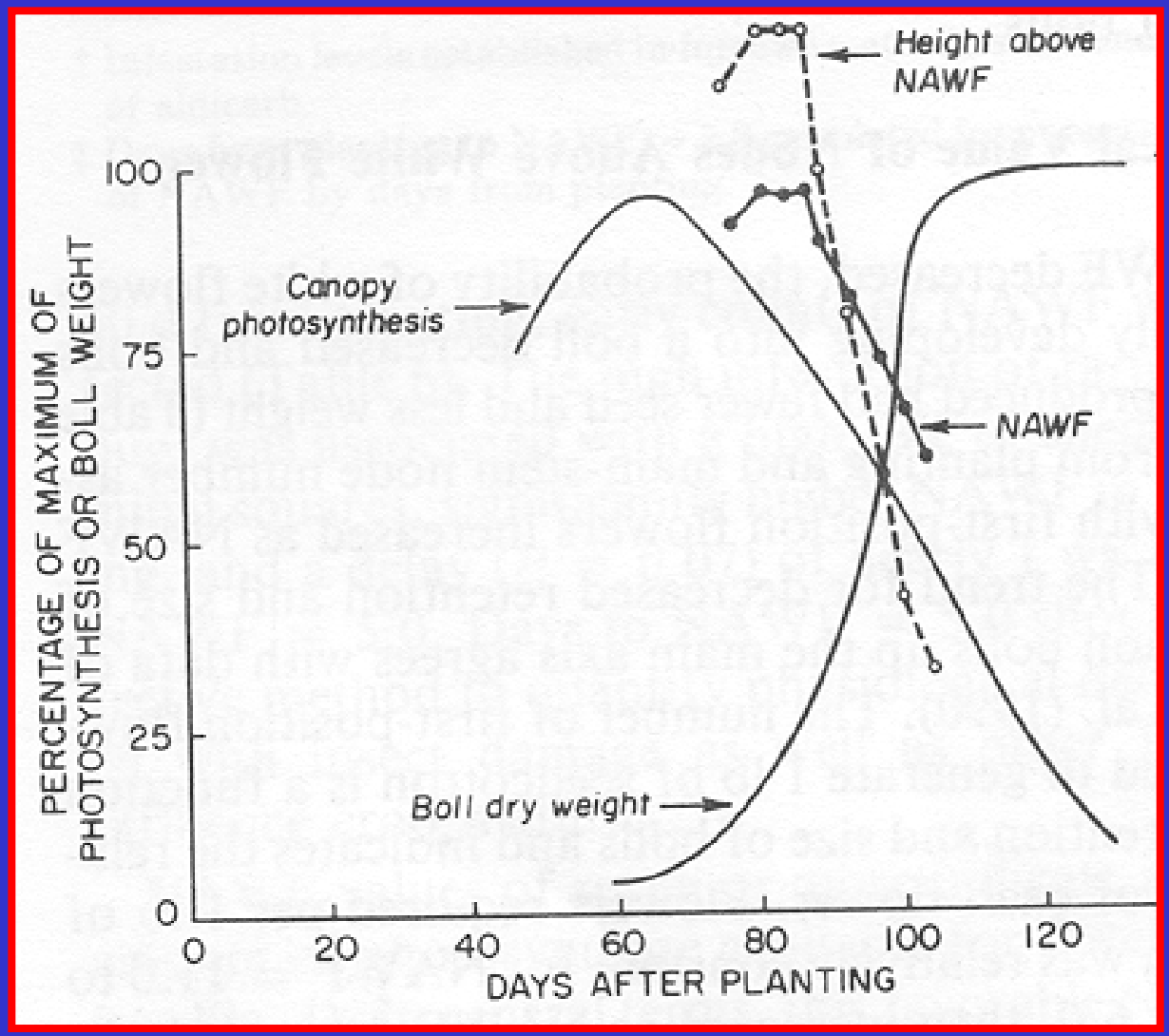


Figure 4. Effect of temperature on dark respiration of several cotton cultivars. $x = (X_i - X.)$, X_i = ith temperature recorded during respiration phase, X. = mean temperature recorded during respiration phase. ** denotes significance level of $P < 0.01$.

Decreased Pnet and Increased Rdark results in:

- Less weight gain.
- Less CHO availability for boll filling.
- Reduced boll weight.
- Reduced fiber mirconaire?

CHO Supply

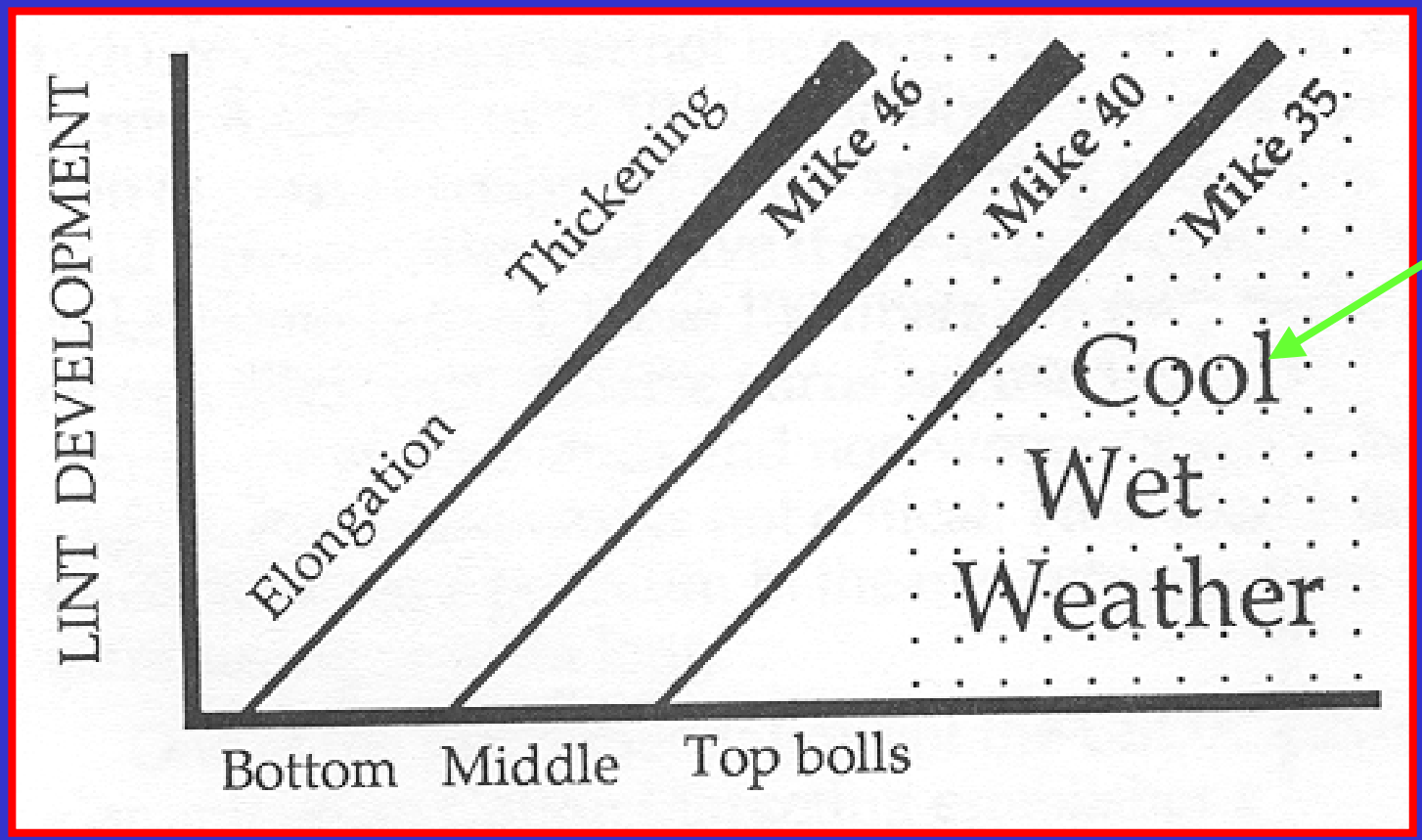


Bourland et al., 1992

Premature aging of crop canopy should be avoided (water stress, fertility stress, etc.). Will impact early season storage of CHO or hasten decline in Pnet

Boll filling occurs with a diminishing CHO supply (root and petiole storage, etc.)

CHO Supply

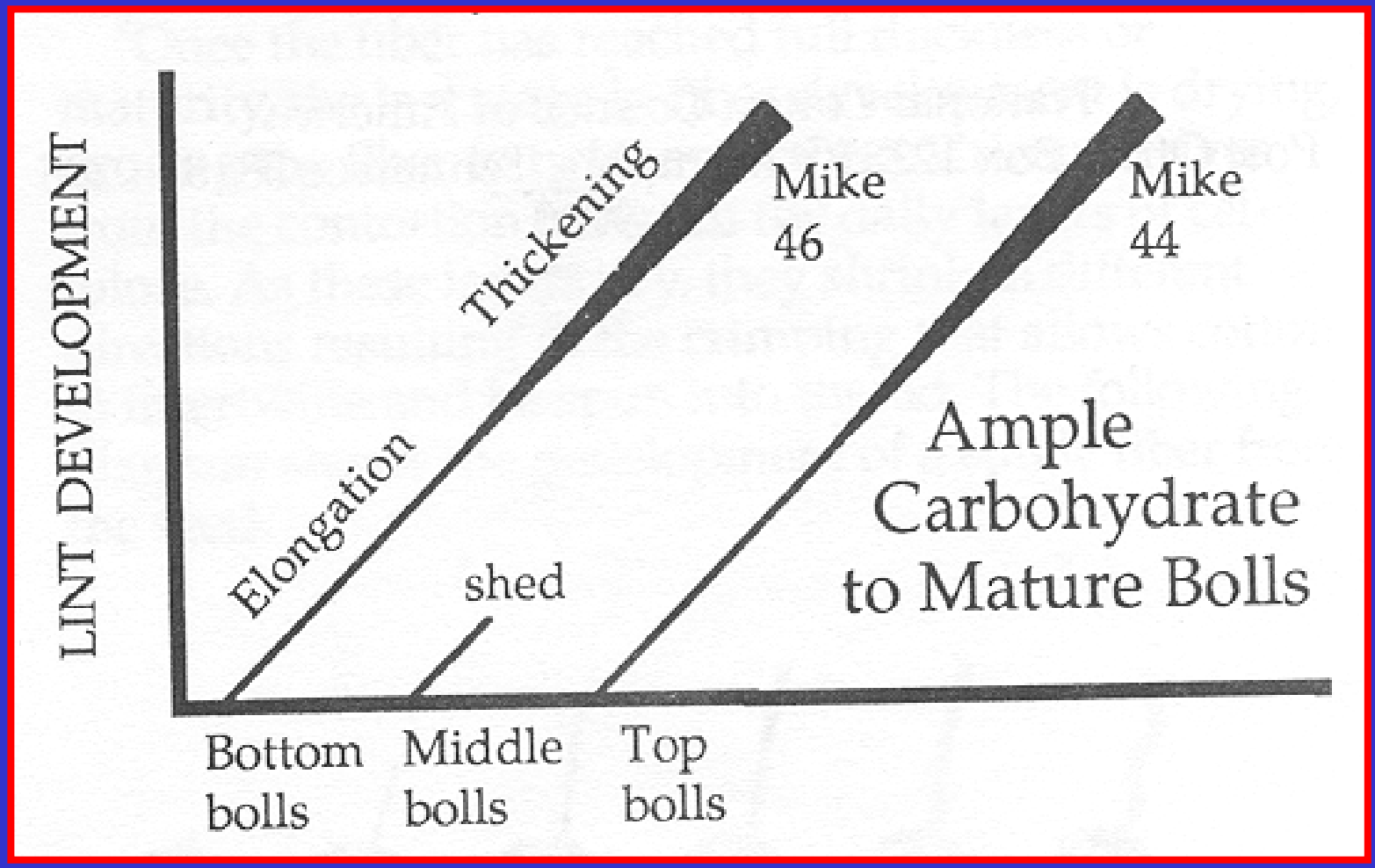


Late Season Heat and Drought?

Short staple and low mike cotton early in harvest season?

Hake et al., 1990

CHO Demand



Hake et al., 1990

CHO Demand

Table 2. ANOVA of plant density studies conducted at Tifton, GA in 1997 and 1998.

Variable	Effect	Sympodial position 1 F ratios	1 Point of inflection	2 F ratios	2 Point of inflection	3 F ratios	3 Point of inflection
Probability	D_L	-80	23 plants m^{-2}	-345	21 plants m^{-2}	-187	13.5 plants m^{-2}
	D_Q	+4		+24		+64	
	N_L	+239	10	+26	9	+3	9
	N_Q	-506		-87		-9	
	D_L X N_L	-25		+6		+13	
	df	739		612		432	
Boll weight	D_L	-20	17 plants m^{-2}	-32	23 plants m^{-2}	-50	19 plants m^{-2}
	D_Q	+4		+0		+2	
	N_L	+152	11	+76	10	+14	9
	N_Q	-226		-133		-25	
	D_L X N_L	-6		-1		+0	
	df	739		612		432	
Boll weight	P_L	+82	53 %	+128	50 %	+79	60 %
	P_Q	-97		-70		-61	
	N_L	+29	11	+51	10	+14	9
	N_Q	-36		-26		-9	
	D_L	-13	21 plants m^{-2}	+0	< 1 plants m^{-2}	+1	<1 plants m^{-2}
	D_Q	+2		-0		-0	
	P_L X N_L	-4		+5		+4	
	P_L X D_L	-19		-5		+3	
	N_L X D_L	-1		+1		+3	
	df	736		609		429	

D = plant density (plants m^{-2}), N = mainstem node number (unitless), P = probability of harvesting a mature boll (%). L = linear coefficient from regression, Q = quadratic coefficient from regression. The + or – sign indicates slope.

Yield Distribution

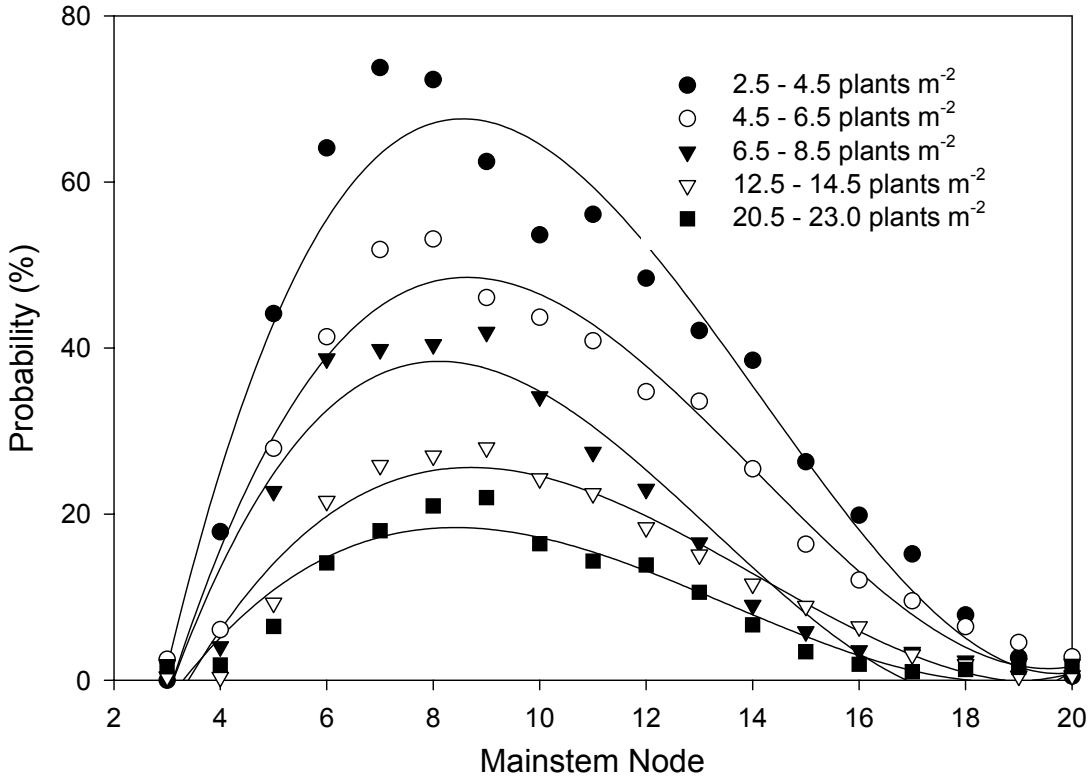


Figure 1. Effect of plant density on the probability of harvesting a pickable boll at each main stem node in studies conducted at Tifton, GA in 1997 and 1998. Data are averaged across all sympodial branch positions.

$Y = 0.2329 - 0.02561d + 0.001515d^2 + 0.01906n - 0.00313n^2 - 0.00175dn + 0.000297dn^2 + 0.000099d^2n - 0.00002d^2n^2$;

d = D - D, n = N - N, D = plant density, D = average plant density, N = mainstem node number, N = average mainstem node number, F = 132.4 **, df = 6, 884.

Yield Distribution

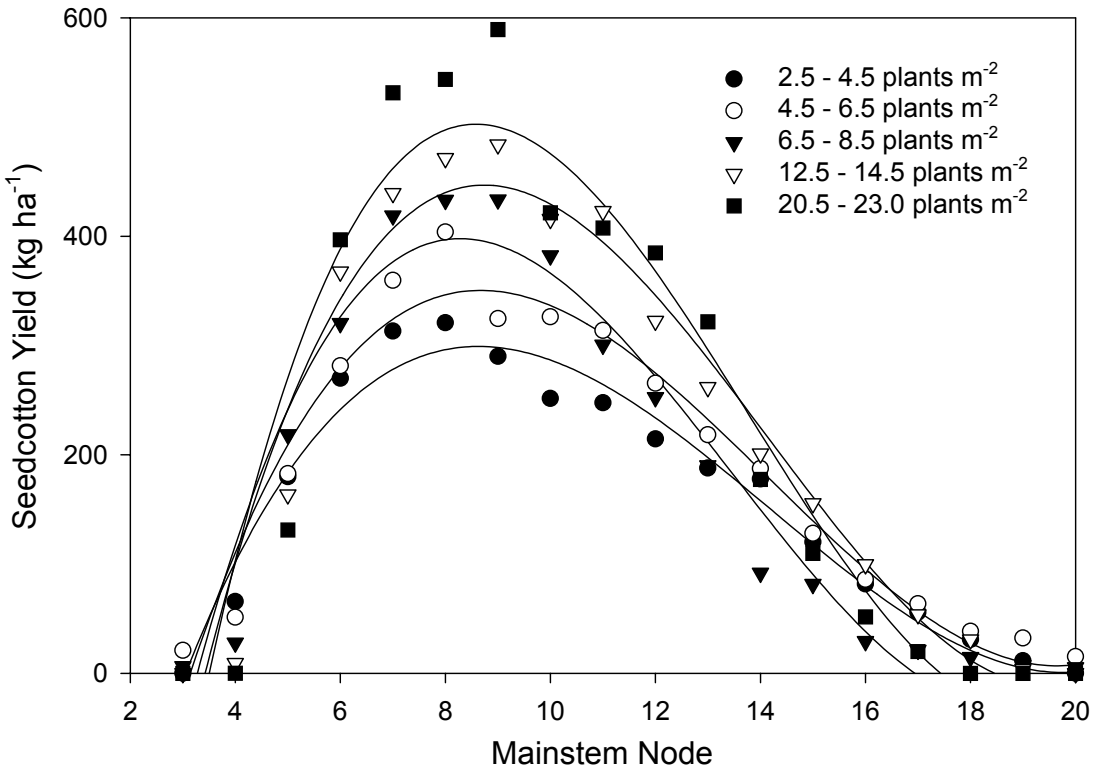


Figure 2. Effect of plant density on total seedcotton yield at each mainstem node in studies conducted at Tifton, GA in 1997 and 1998. Data are totaled across all sympodial branch positions.

$Y = 282.28 + 7.52d - 0.2093d^2 + 24.11n - 3.85n^2 + 0.7604dn - 0.1214dn^2$;

d = D - D, n = N - N, D = plant density, D = average plant density,

N = mainstem node number, N = average mainstem node number,

F = 149.2**, df = 6, 884.

CHO supply (environment) and CHO demand (crop condition, maturity) impact fiber properties.