

Epidemiological Models of Spread of Soybean Rust in the Southeast

Harald Scherm
Rock Christiano



DEPARTMENT OF PLANT PATHOLOGY
UNIVERSITY OF GEORGIA, ATHENS

Ecology and Epidemiology

**Quantitative Aspects of the Spread of Asian Soybean Rust
in the Southeastern United States, 2005 to 2006**

R. S. C. Christiano and H. Scherm

Department of Plant Pathology, University of Georgia, Athens 30602.
Accepted for publication 3 May 2007.

Phytopathology 97:1428-1433 (2007)



OBJECTIVE

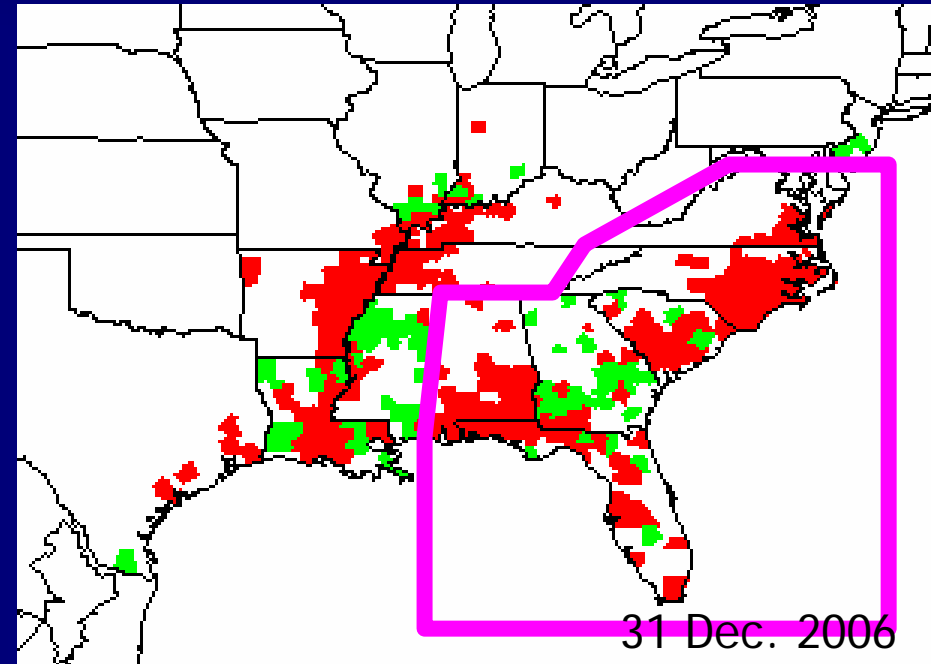
Utilize Data from SBR Sentinel Plot Monitoring Network for Regional Epidemiological Analyses

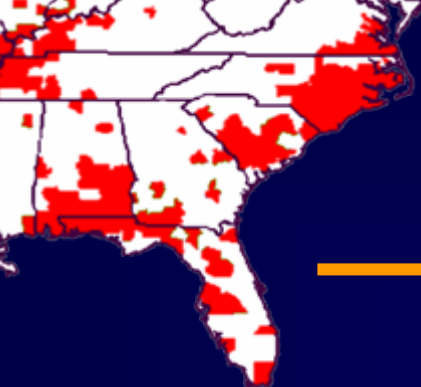
- Temporal disease progress on kudzu vs. soybean
- Time of disease appearance in relation to soybean growth stage
- Interrelationship between epidemics on kudzu and soybean
- Typical distances of spread for new infections
- Regional rates of spatial spread compared with other diseases



DATA BASE: SOUTHEASTERN STATES (FL, GA, AL, SC, NC, VA)

- Likely separate epidemic from that in Mississippi Basin (anticyclonic vs. southerly air flow patterns)
- Three years of data (2005-2007)
- Data source: PIPE (Chronology of Positive Detections)
- Unit of analysis: “case” (unique, new, confirmed report)

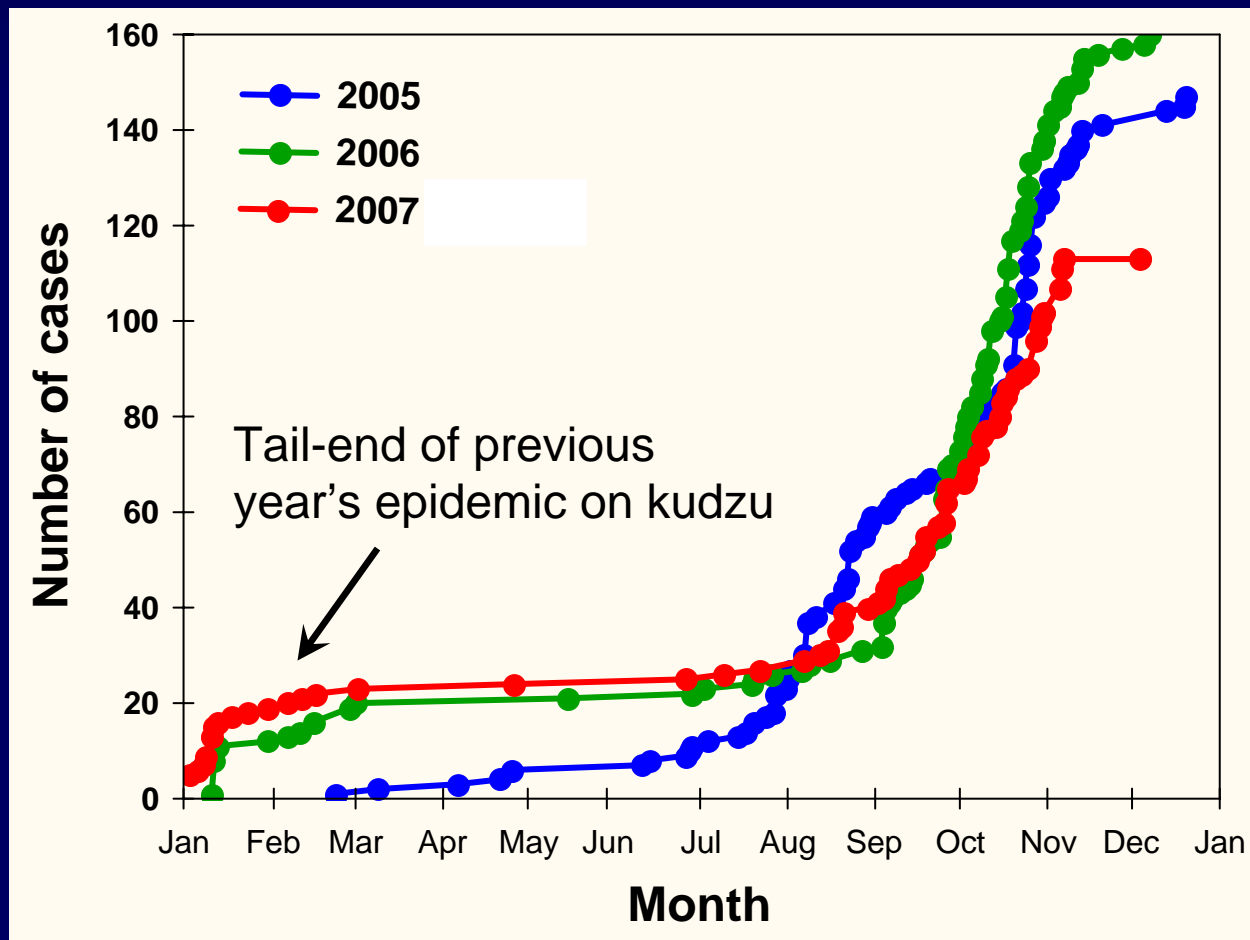


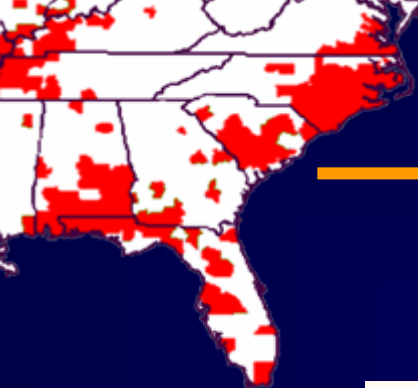


TEMPORAL DISEASE PROGRESS (KUDZU & SOY COMBINED)

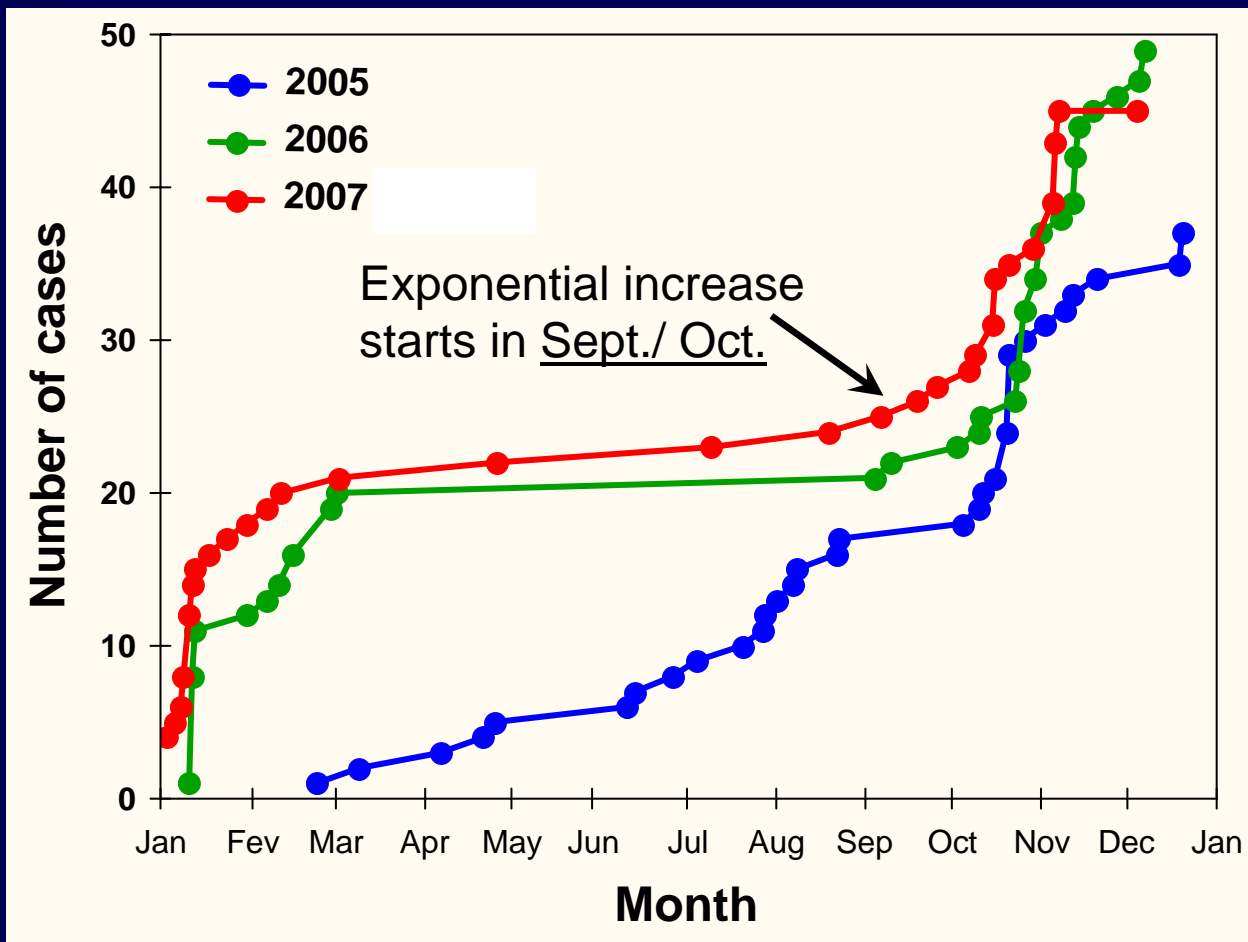
Season-long average:

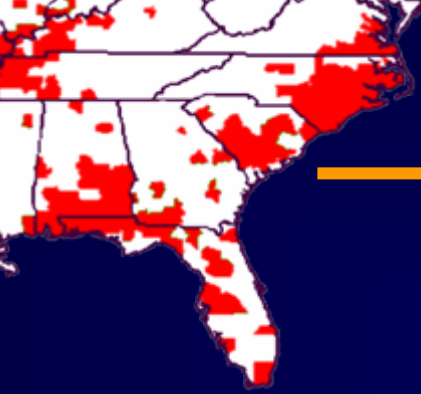
- 2005: 0.49 cases/day
- 2006: 0.48 cases/day
- 2007: 0.34 cases/day



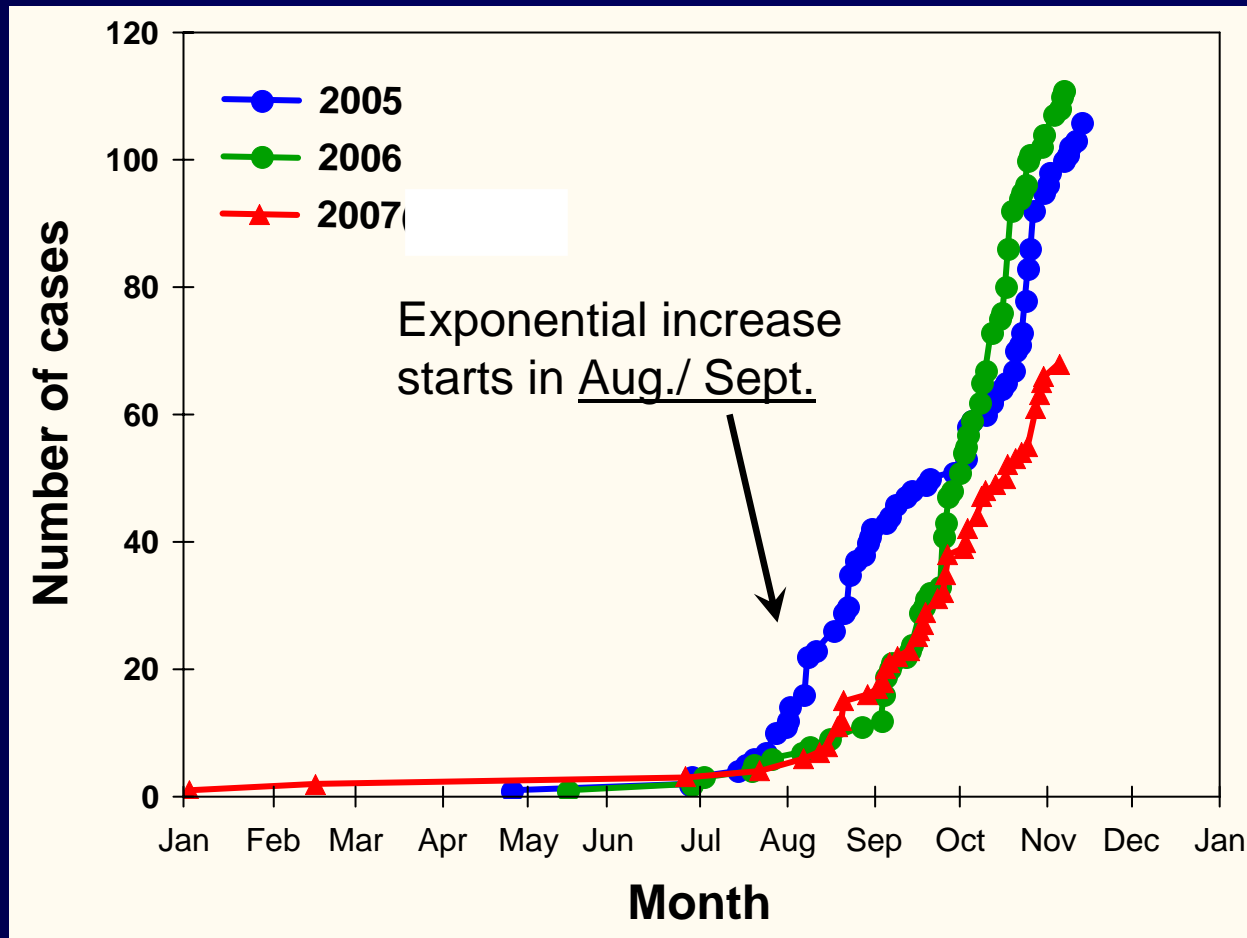


TEMPORAL PROGRESS ON KUDZU





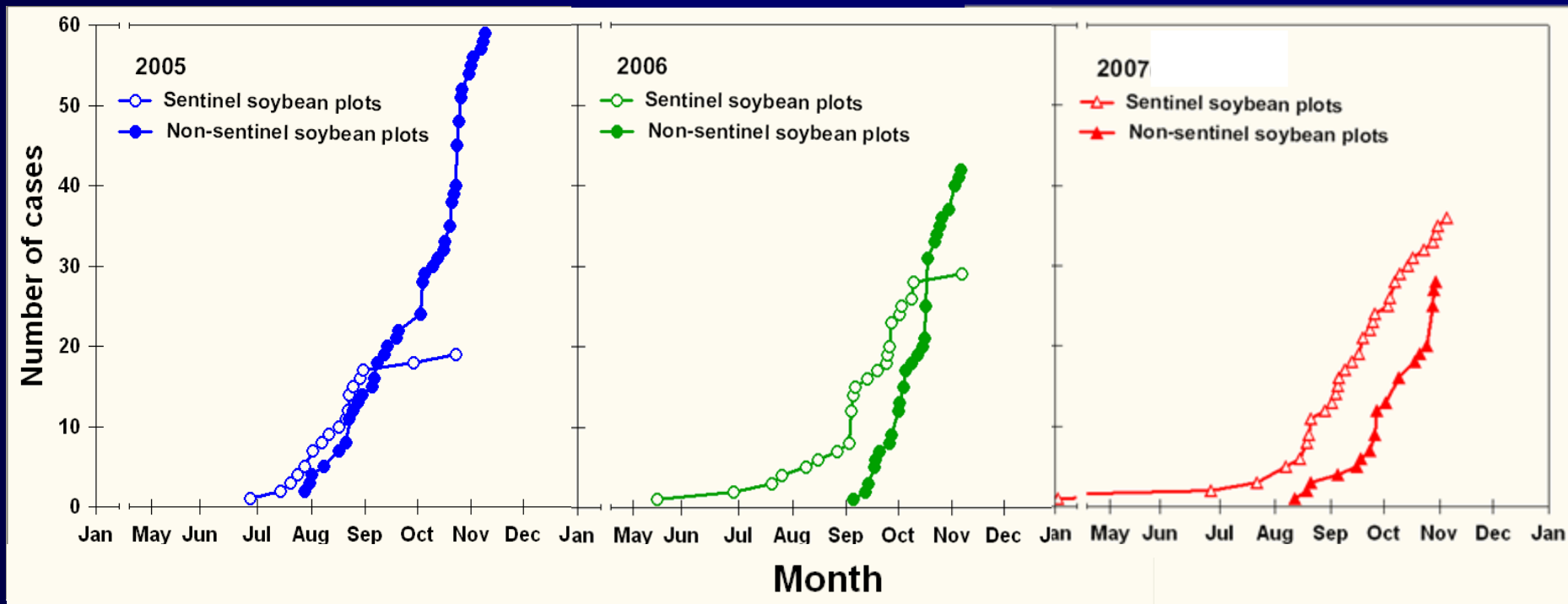
TEMPORAL PROGRESS ON SOY

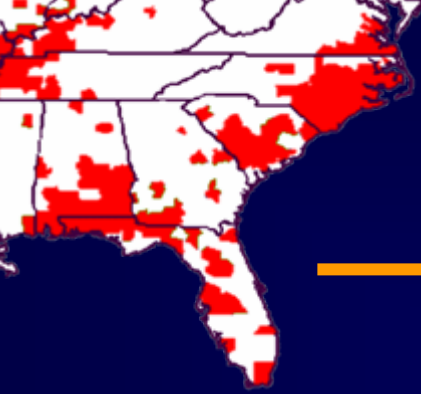




TEMPORAL PROGRESS IN SENTINEL VS. OTHER SOY PLOTS

- ≥ 1 month lead time in sentinel plots
- Very rapid increase in non-sentinel plots

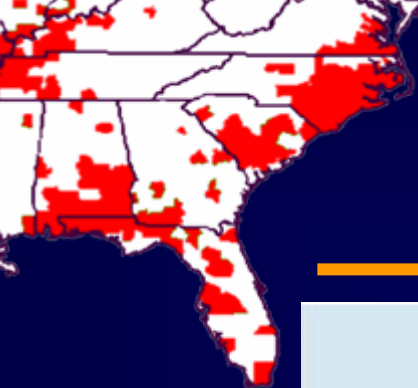




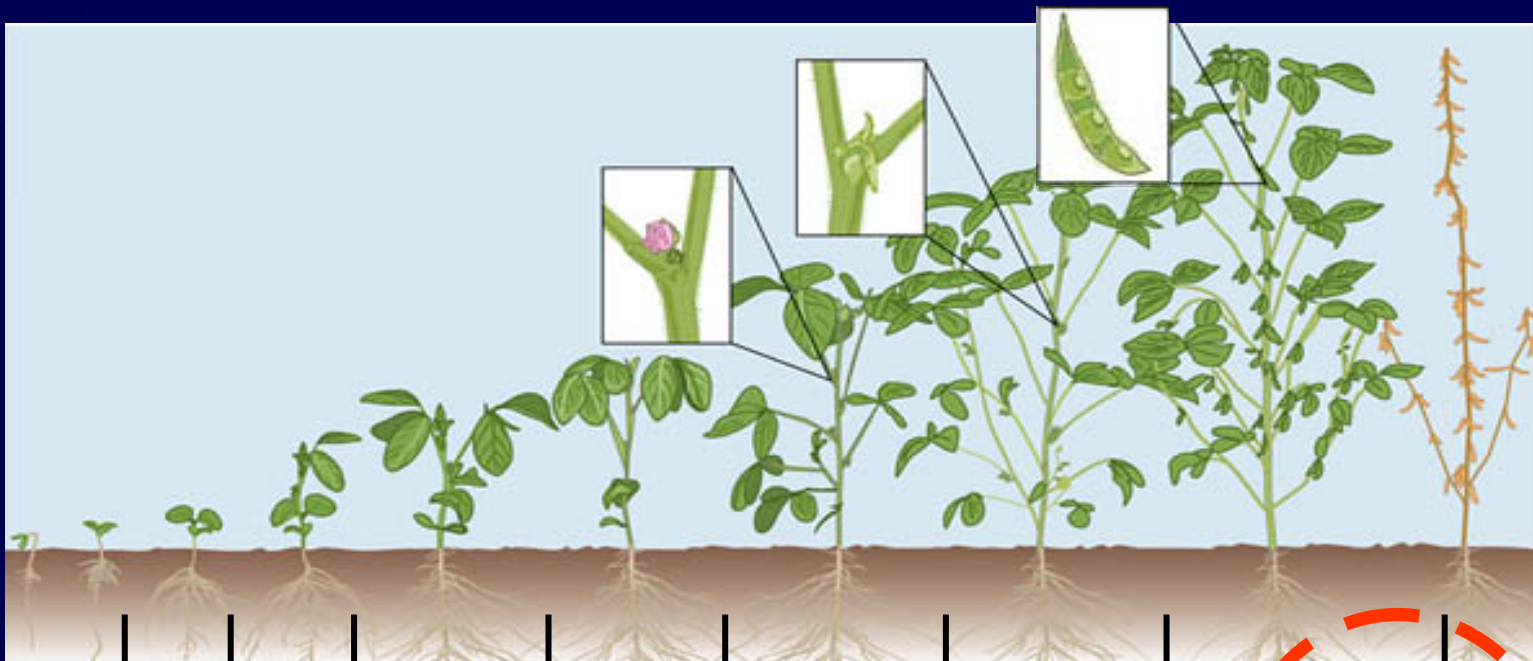
AVERAGE RATES OF TEMPORAL SPREAD ON DIFFERENT HOSTS

	Cases/day		
	2005	2006	2007 (Dec. 5)
All hosts combined	0.49	0.48	0.34
Kudzu	0.12 (0.26)	0.15 (0.31)	0.15 (0.24)
Sentinel soybean plots	0.16	0.28	0.27
Non-sentinel soybean plots	0.58	0.68	0.35

Non-sentinel soybean > sentinel soybean > kudzu

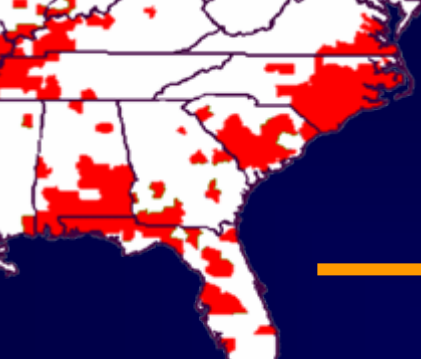


FREQUENCY OF CASES RELATED TO SOYBEAN GROWTH STAGE

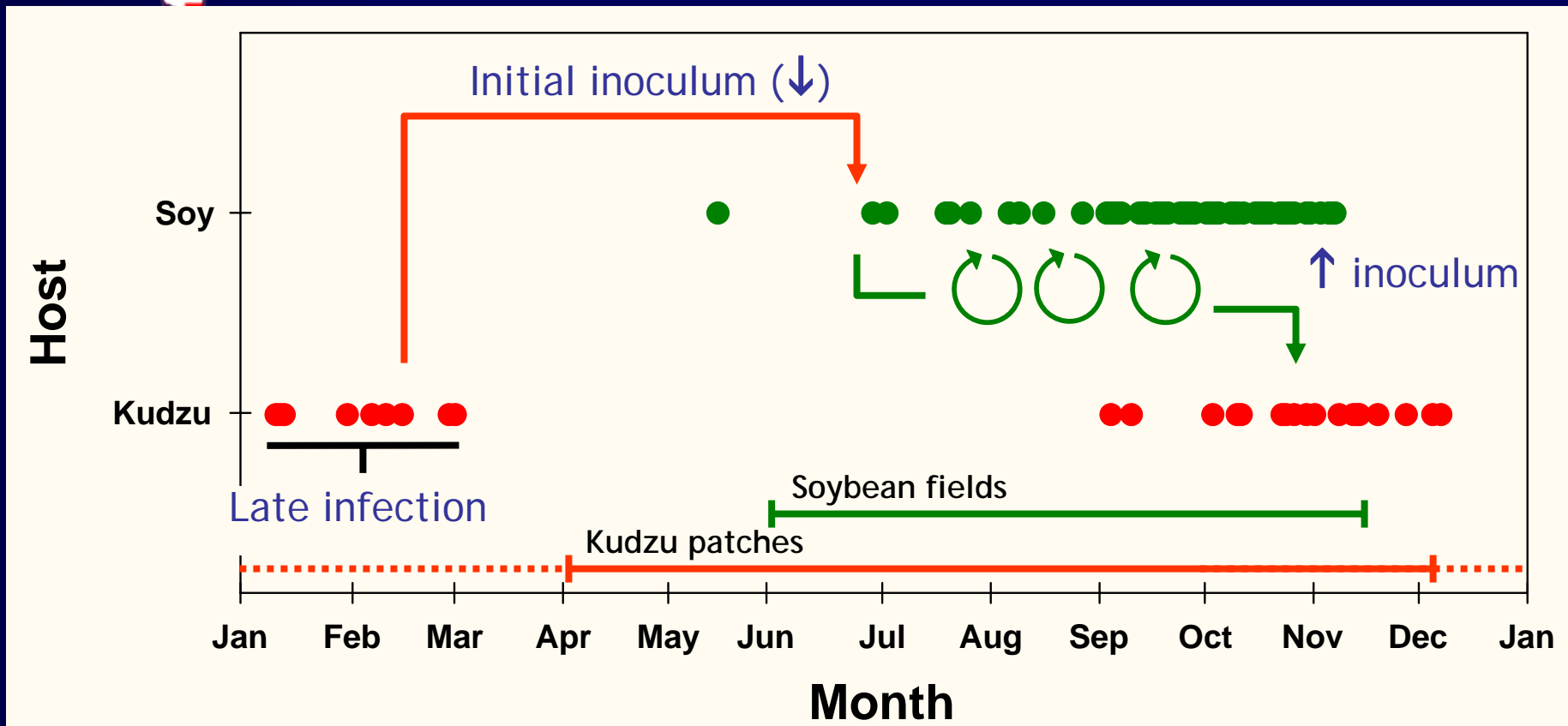


Year	VE	VC	V1	V2	V3	V8	R1	R2	R3	R4	R5	R6	R7	R8
2005	-	-	-	-	-	1	-	-	4	1	7	9	2	17
2006	-	-	-	-	-	-	1	-	1	2	12	17	22	16
2007	-	-	-	-	-	-	-	4	1	4	10	23	9	13

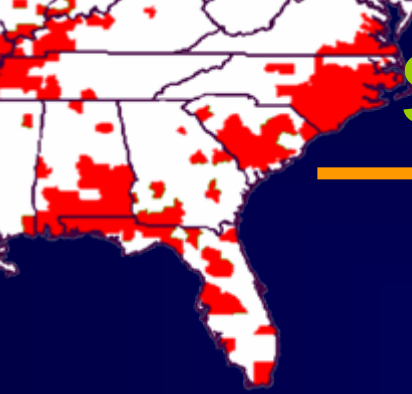
75% ≥ R6



RELATION BETWEEN PROGRESS ON SOY AND KUDZU (2006)

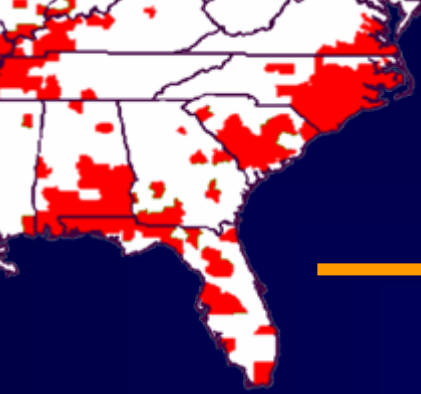


- Early: kudzu provides initial inoculum for epidemic in soybean
- Late: inoculum from soy drives fall epidemic in kudzu



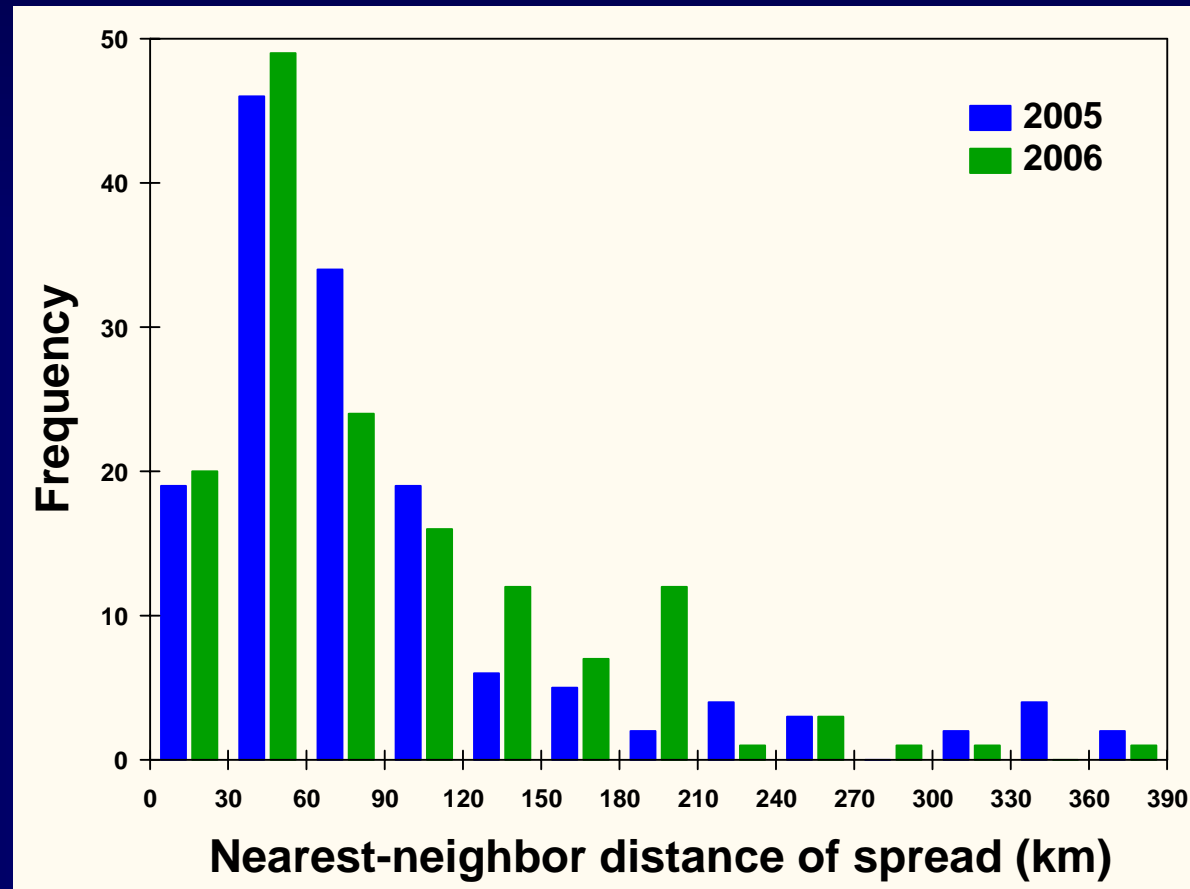
SUMMARY - TEMPORAL PROGRESS

- Rate of disease progress: non-sentinel soy > sentinel soy > kudzu
- Very rapid disease progress on non-sentinel soybean once disease is first detected (Aug./ Sept.)
- $\geq 75\%$ of first detections in soybean at R6 or higher
- Bi-phasic progress curve on kudzu
 - First detection early in the year (tail-end of previous yr.)
 - Very limited increase in spring/ summer
 - Rapid increase in early October (after soybean)



OVER WHAT DISTANCES DOES SPATIAL SPREAD OCCUR?

- Assumption: each new case originates from nearest previously reported case
- Restrictions:
 - Source must have been ≥ 10 days old
 - Source no longer active after 60 days



- Most distances between 30 and 60 km (median: 70 km)
- 10% of distances >200 km



SPATIAL EXTENT OF EPIDEMIC IN SOYBEAN IN THE SOUTHEAST

Year	Counties	Distance	Epidemic duration	Rate of spread
2005	Baldwin (AL) Tyrrell (NC)	1223 km	139 days	8.8 km/day
2006	Mobile (AL) Accomack (VA)	1378 km	132 days	10.4 km/day
2007	Mobile (AL) Mathews (VA)	1328 km	132 days*	10.1 km/day

Compare with:

- Tobacco blue mold in Southeast: **9 -18 km/day**
- SBR in Mississippi Basin: 2006: **18.1 km/day**, 2007: **16.4 km/day**
- Wheat stem rust in Mississippi Basin: **17-76 km/day**



SUMMARY – SPATIAL PROGRESS

- Nearest-neighbor distance of spread
 - Most common distance 30 to 60 km
 - 10% of distances >200 km
- Average season-long rate of spread ~10 km/day
 - At low end of rate of spread of tobacco blue mold in same region
 - 50% lower than SBR in Mississippi Basin
- Factors that may limit rate of spread
 - Low inoculum (2005) and drought (2006, 2007)
 - Inherently lower disease progress rate on kudzu
 - Opportunities for disease establishment more limiting than those for inoculum dissemination – no “green wave”, hence epidemic runs out of time