A General Plant Model

SWAT Model

- Simulates plant growth through leaf area, light interception, biomass production and stress simulation
- Water balance, nutrient cycling, and temperature responses

SWAT Model

- Field Scale, daily time step
- Uses commonly available soil inputs, with soil characteristics varying with soil depth
- Uses daily maximum and minimum temperature, solar radiation, and rainfall
- Can generate weather data by using monthly means for a location

Development rate is temperature driven by thermal time with a base temperature and optimum temperature.

PHU is the thermal time (degree days) from planting to maturity. PHU varies with maturity type.

Maize as an example

8 degree C base temperature

32 degree C optimum temperature

About 1800 PHU for maturity

Processes described

Light interception description using Beer's Law, with LAI

Radiation use efficiency

Harvest Index

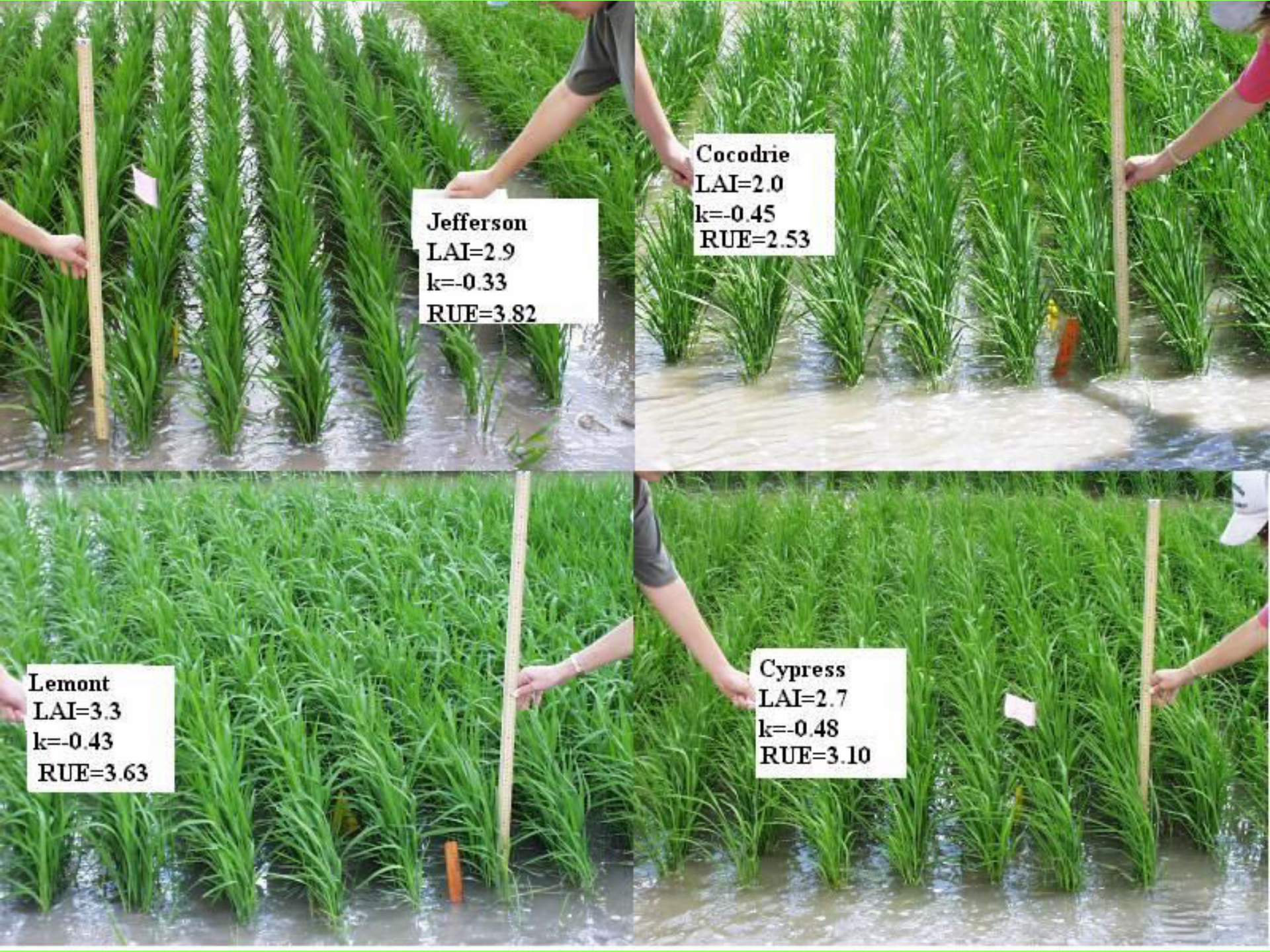
Beer's Law (Monsi and Saeki, 1953)

Fraction of Light intercepted by leaves =

$$1 - \exp(-k * LAI)$$

k is the light extinction coefficient

LAI is the leaf area index


Jefferson
LAI=2.9
k=-0.33
RUE=3.82
Cocodrie
LAI=2.0
k=-0.45
RUE=2.53
Lemont
LAI=3.3
k=-0.43
RUE=3.63
Cypress
LAI=2.7
k=-0.48
RUE=3.10

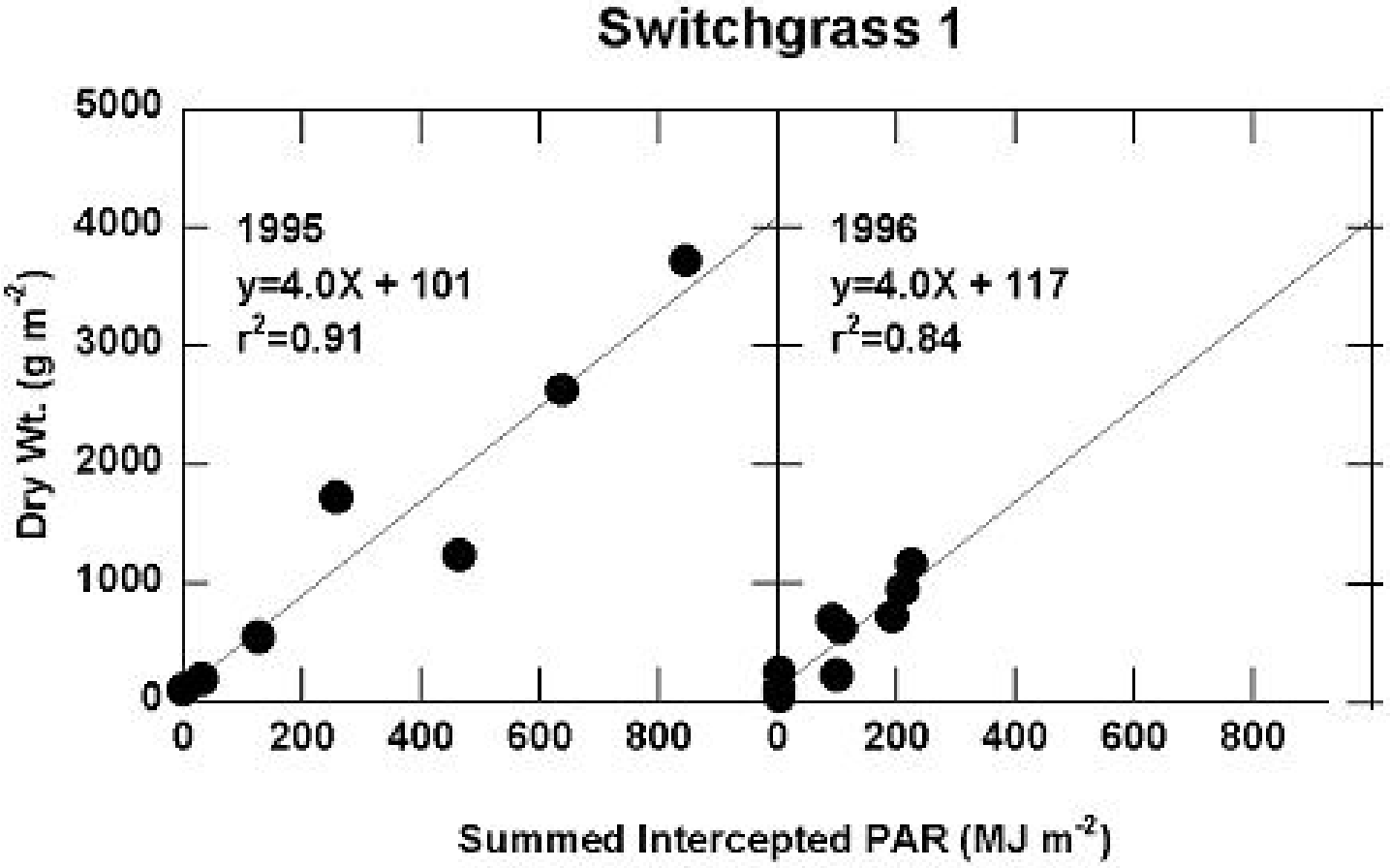
Radiation Use Efficiency

<u>Several times during a season</u>:

Measure fraction of PAR with a light bar

Destructive sampling for biomass

Slope of above ground dry biomass as a function of cumulative intercepted PAR is the RUE


Switchgrass 1
Dry Wt. (g m-2)
5000
4000
3000
2000
1000
0
1995
y=4.0X + 101
r2=0.91
1996
y=4.0X + 117
r2=0.84
0
200
400
600
800
Summed Intercepted PAR (MJ m-2)

High Yielding Field Study

At Etter near Dumas

Current Research

- Switchgrass simulation in TX, LA, AR
- Switchgrass simulation for Oak Ridge and Dartmouth study
- Improved grasses (coastal bermudagrass and bahiagrass)
- Saltcedar modeling with M.S. student
- Work with field scientists in Mexico, doing large area simulation of maize and sorghum

Methods

Alamo switchgrass (*Panicum virgatum* L.)

Eastern gamagrass [*Tripsacum dactyloides* (L.) L.]

Sideoats grama [*Bouteloua curtipendula* (Michaux) Torrey]

Big bluestem (*Andropogon gerardii* Vitman)).


Big Bluestem
1/2 M


BLUE
GRAMA
1/2 M


Blue grama
May 20, 1999
12M


Western
wheatgrass
May 20, 1999
12M


Buffalograss
May 20, 1999


Coastal
May 20, 1999


INDIAN
GRASS
1/2 M


Sideoats grama
May 20, 1999
Trojans
12M
2

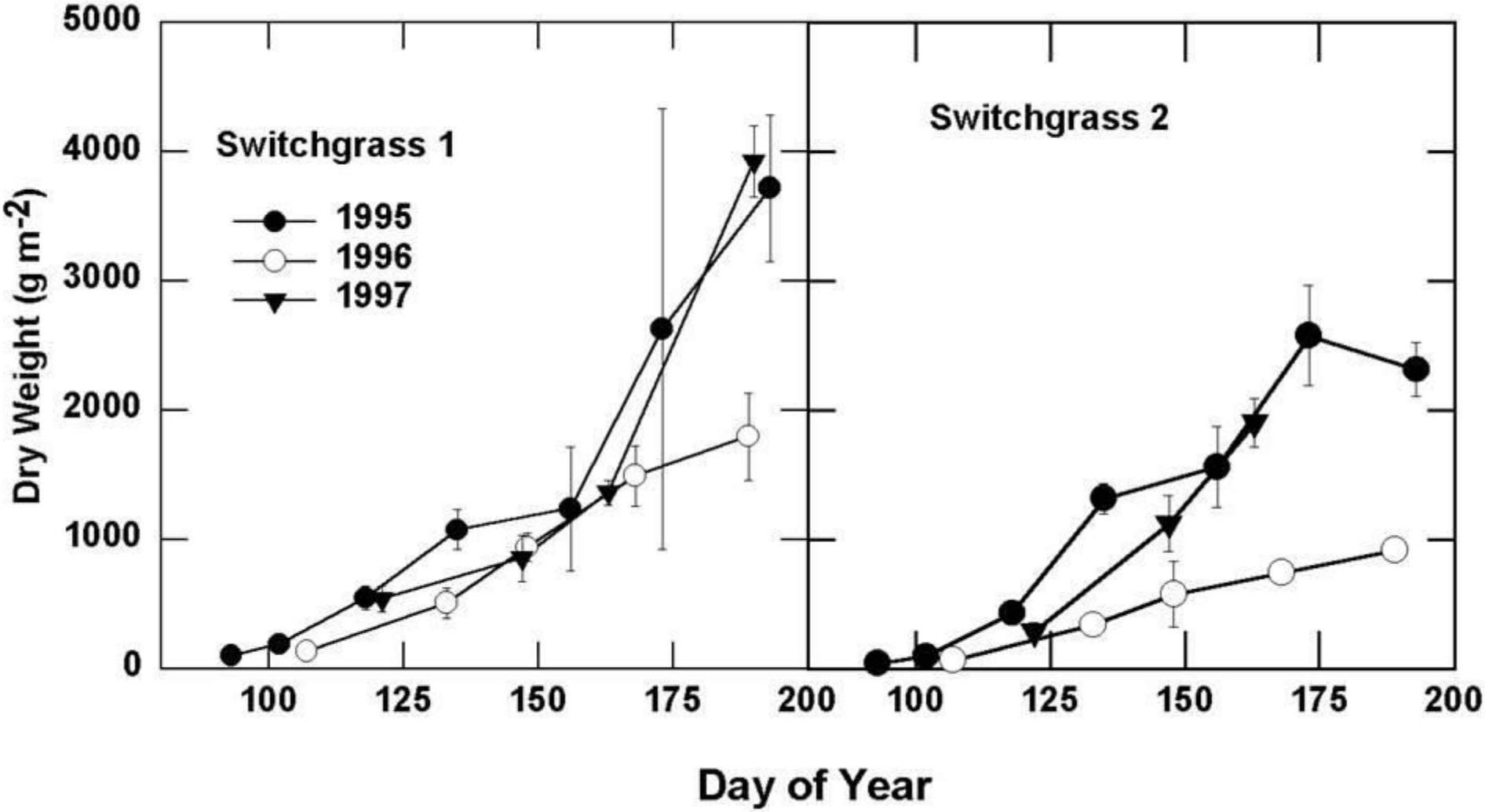
Leaf area index (LAI)
Above-ground biomass
Light interception

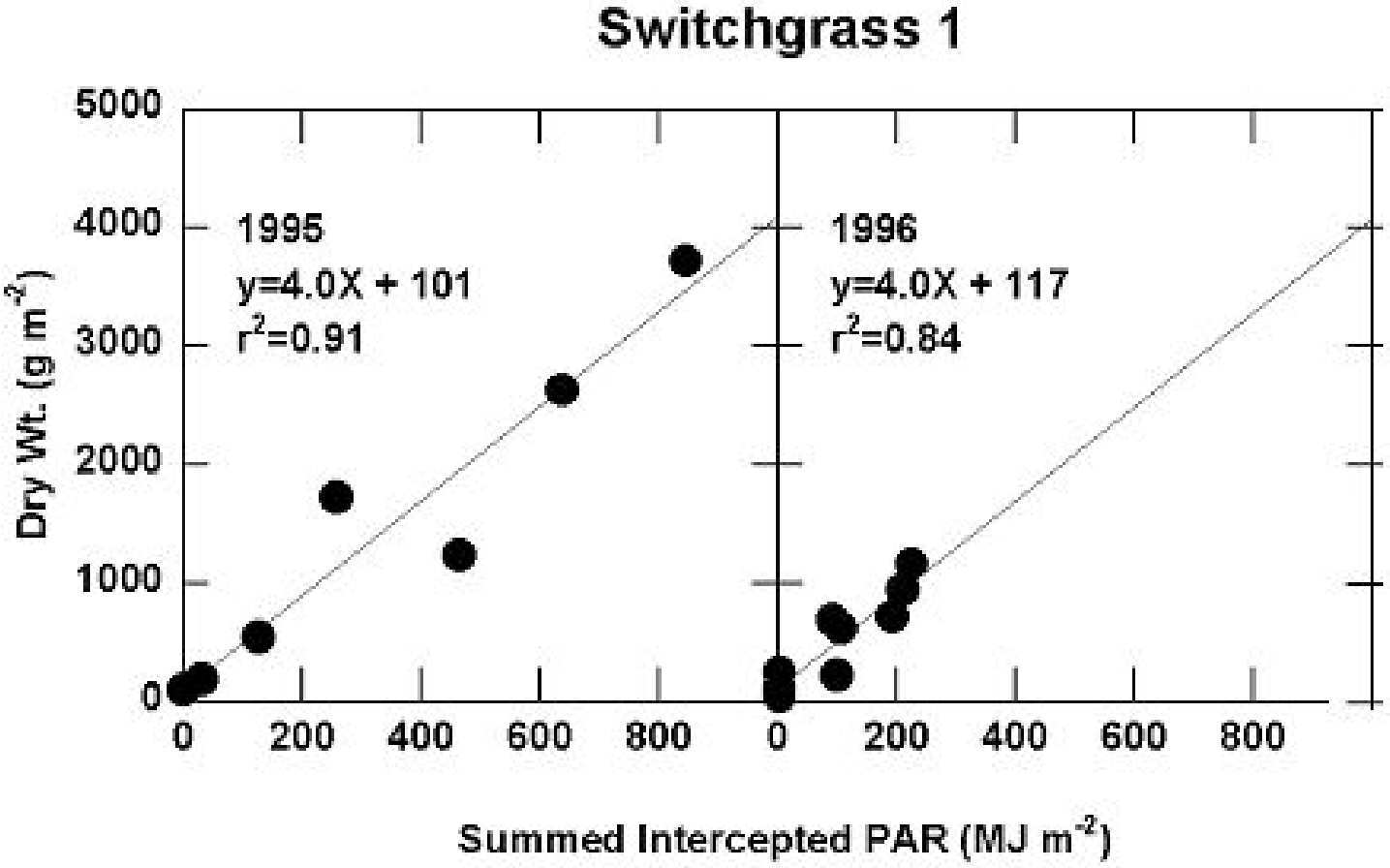
Houston Black clay soil near Temple, TX.

Also measured **root mass** and **soil carbon** with soil cores at the end of two growing seasons.

Plots 5 m by 75 m were established in 1993. Adequate N was applied to prevent nutrient stress. Grasses were burned in Feb. each year.

Results


Switchgrass 1
Switchgrass 2
1995
1996
1997
Dry Weight (g m-2)
0
1000
2000
3000
4000
5000
100
125
150
175
200
Day of Year


Switchgrass 1
Dry Wt. (g m-2)
5000
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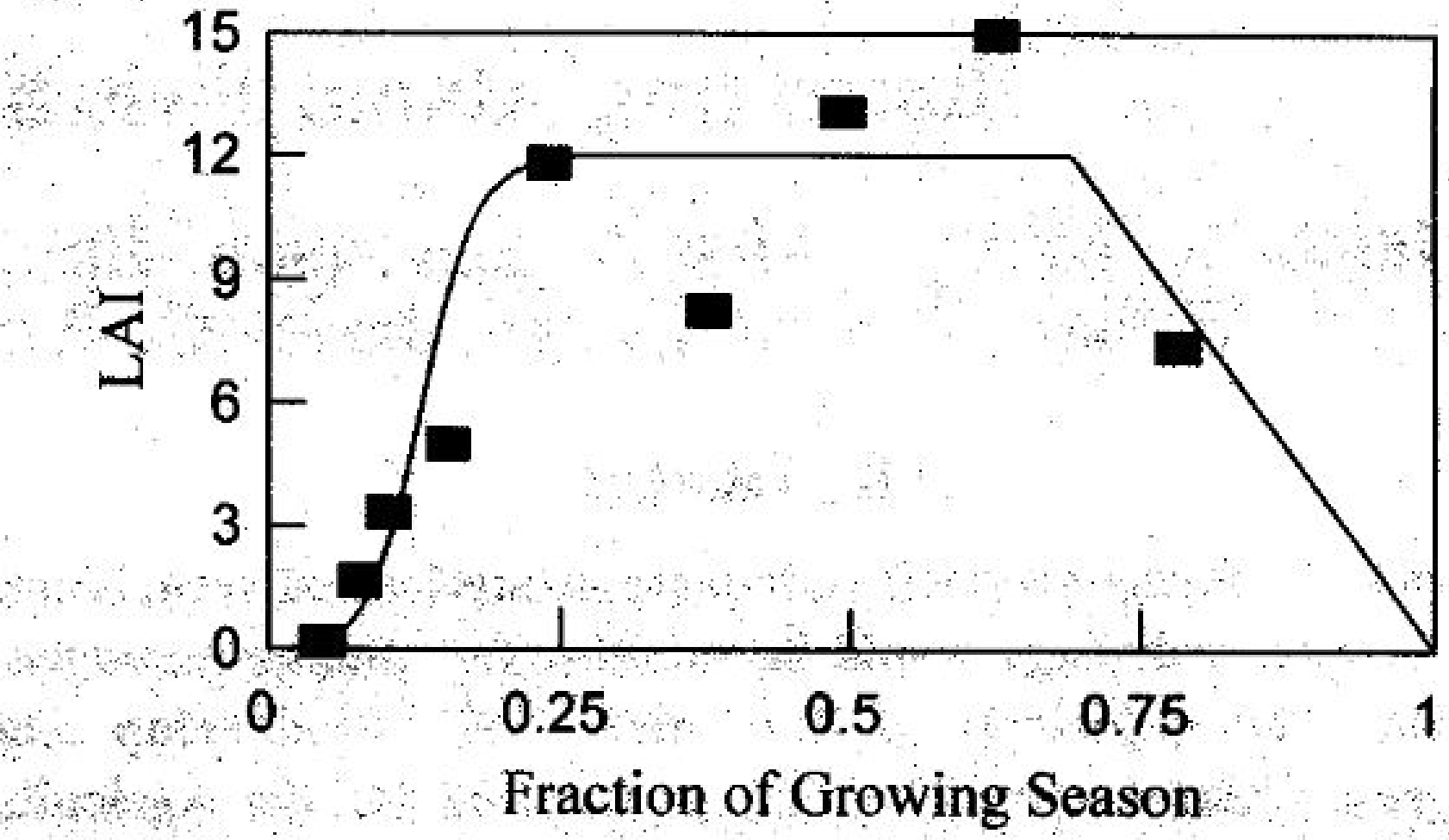
3000
2000
1000
0
1995
y=4.0X + 101
r2=0.91
1996
y=4.0X + 117
r2=0.84
0
200
400
600
800
Summed Intercepted PAR (MJ m-2)

Conclusions

With the exception of switchgrass, the biomass and LAI values of the grasses we studied were similar to values reported in the literature for other grasses. Differences among species in biomass production were not related to N concentrations, partitioning between roots and shoots, or soil organic carbon.


15
12
9
6
3
0
LAI
0
0.25
0.5
0.75
1
Fraction of Growing Season

Simulating White Spruce Trees in Alberta with

Our experience modeling trees

- Work with mesquite
- Work with saltcedar


Fisherbrand

Simulating Water Use by Saltcedar With the EPIC Model

Jim Kiniry, Jimmy Williams, Kurtiss Schmidt, and Larry D. White

USDA-ARS, TAES, and Texas A&M

Developing Parameters to Simulate a Tree or Grass

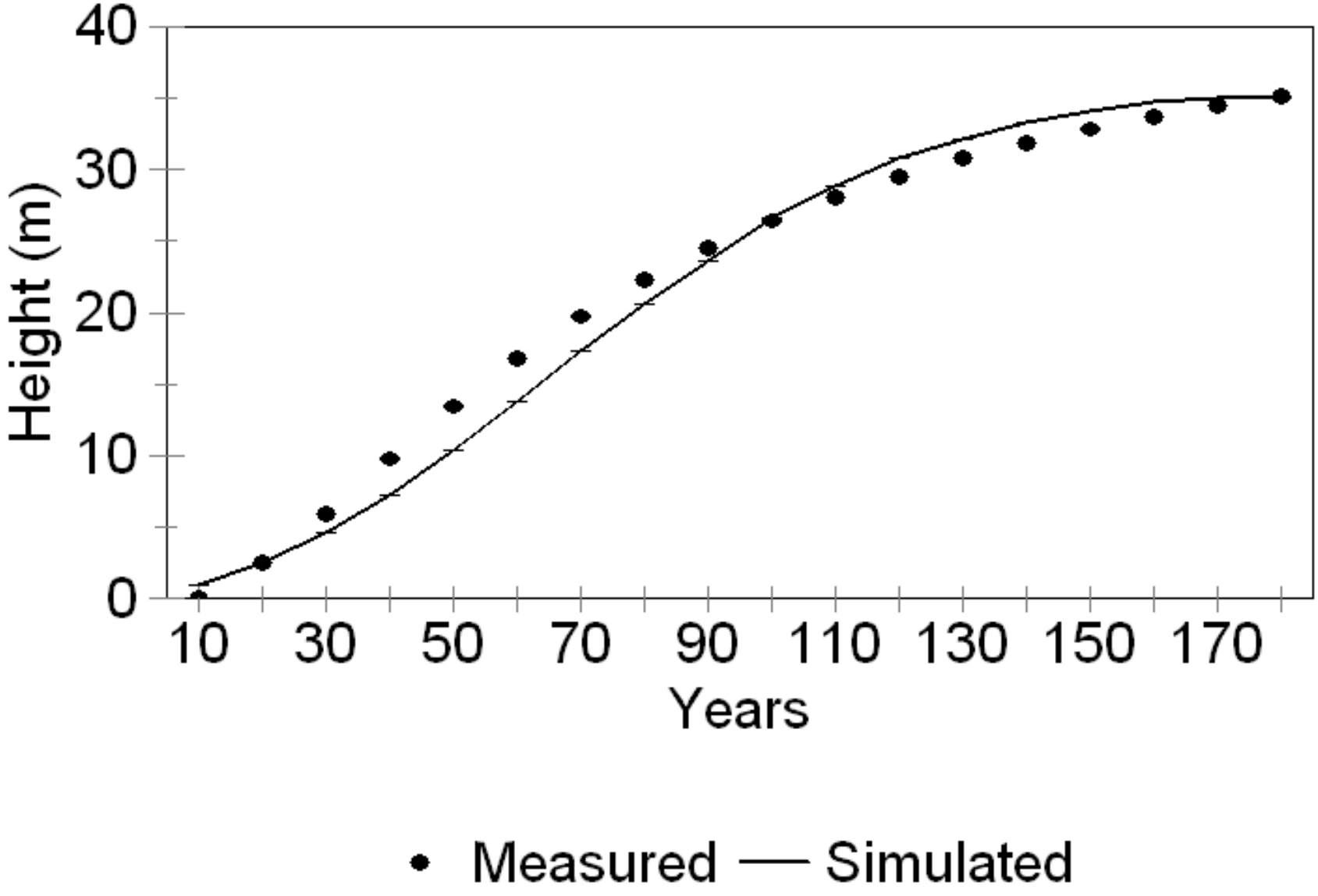
Several Important Parameters: Leaf area Index, light extinction coefficient, potential growth per unit light intercepted.

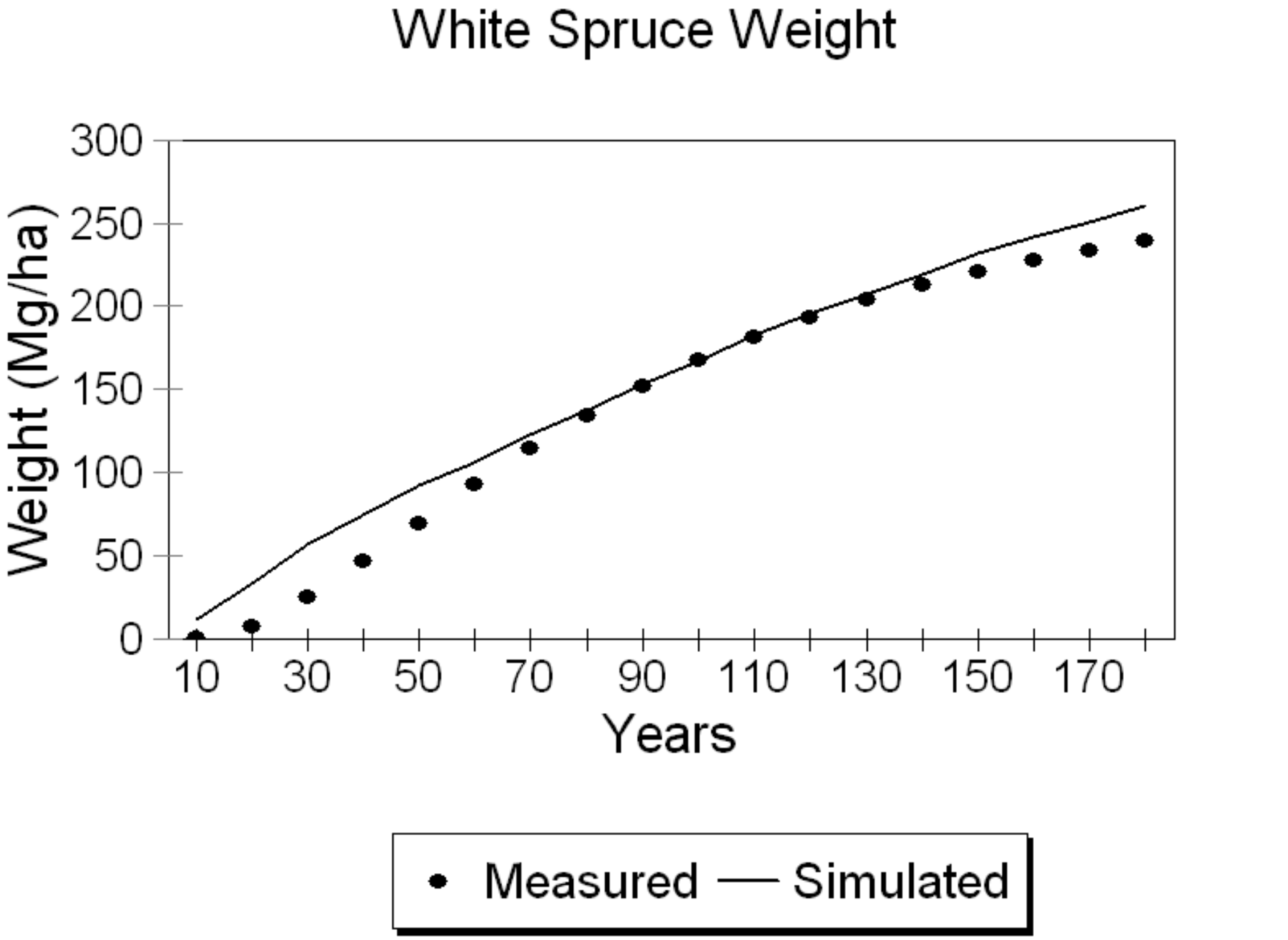
Simulating White Spruce Trees in Alberta

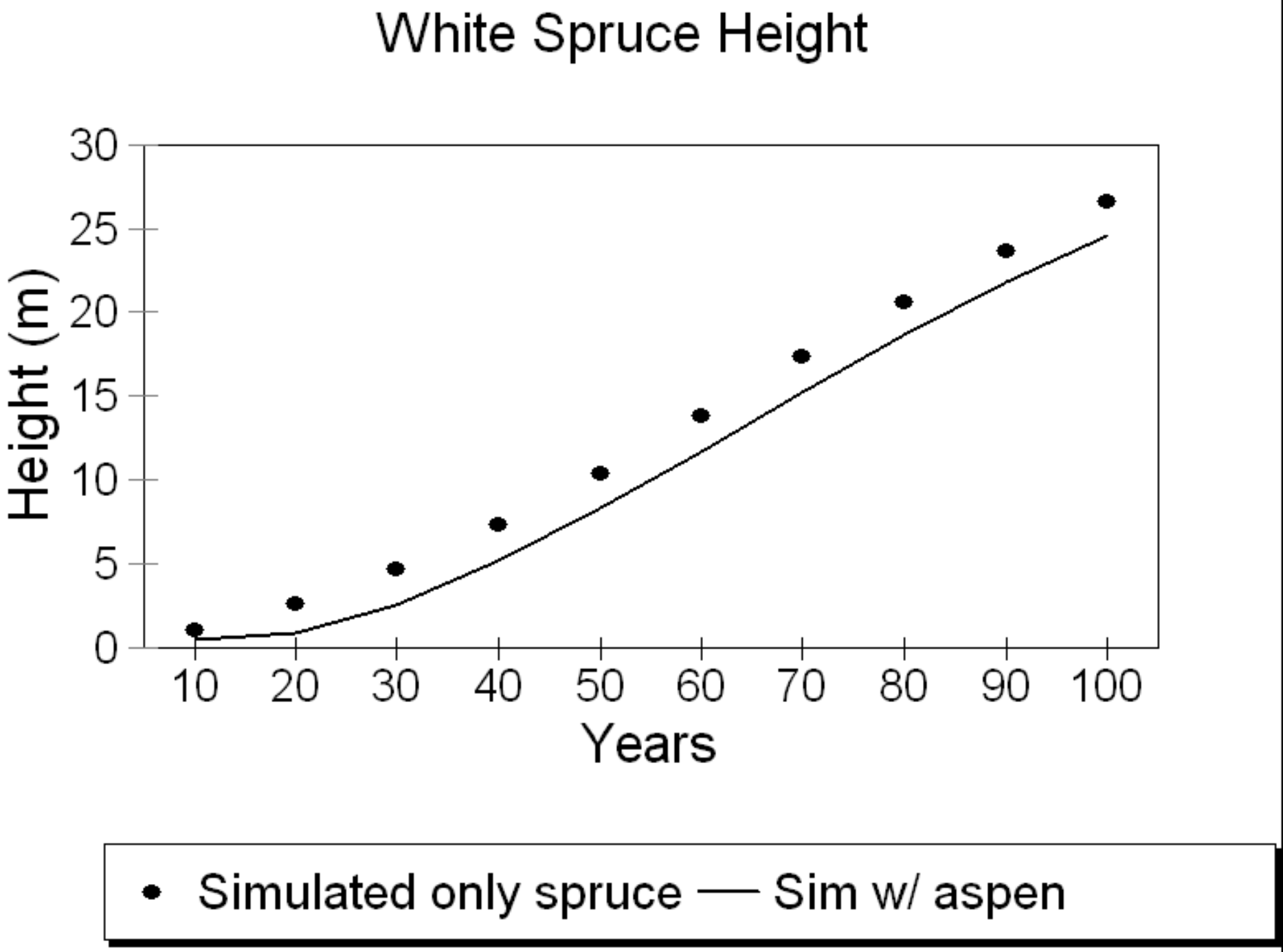
Assumptions

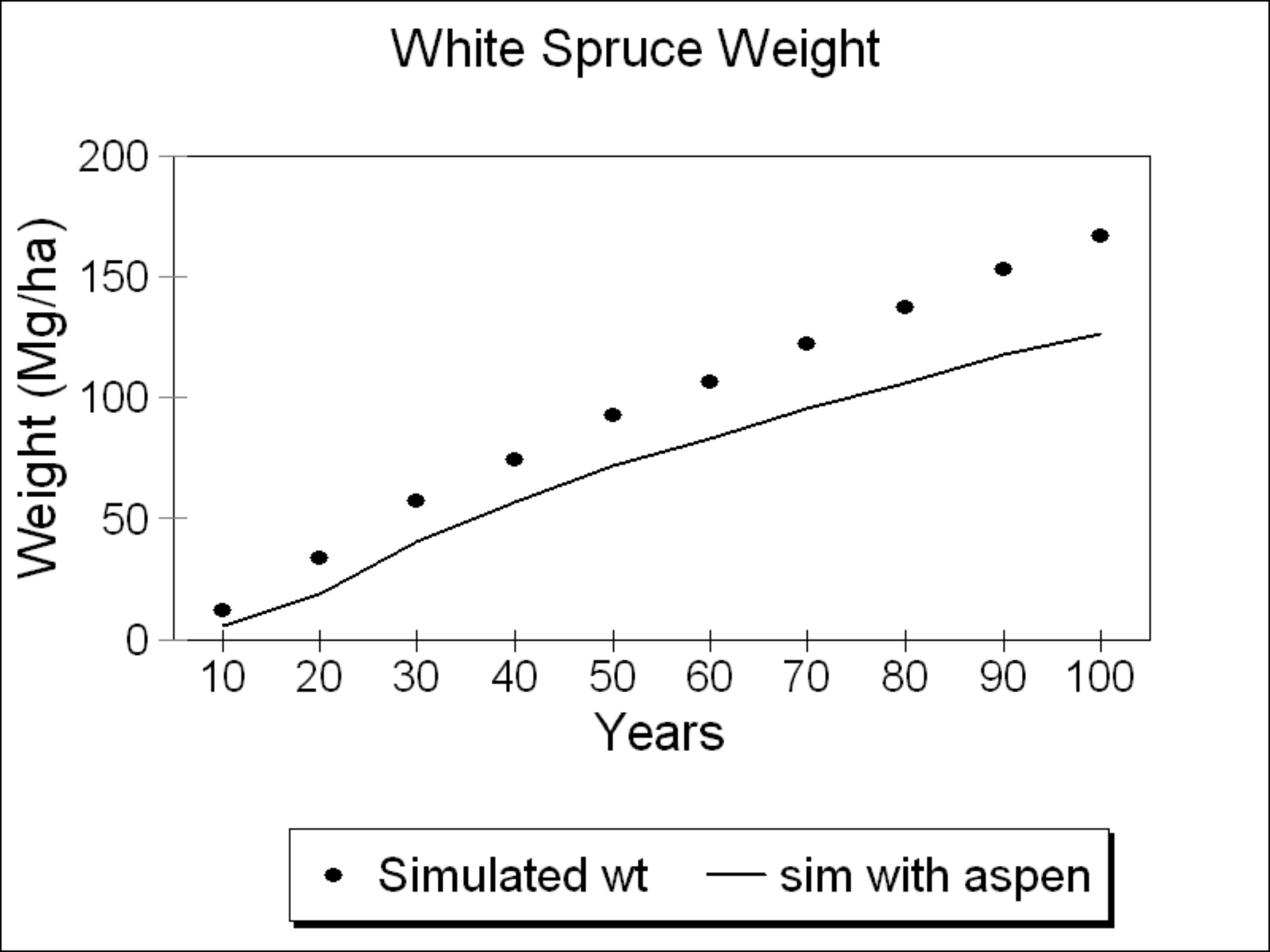
- Edmonton weather used to generate 180 years of weather data.
- 1.5 m soil depth
- RUE of white spruce was 1.5 g per MJ
- LAI of white spruce was 2.7
- 25 yrs. to max LAI and 180 yrs. to max. ht.

White spruce simulations




White Spruce Weight
Weight (Mg/ha)
300
250
200
150
100
50
0
10
30
50
70
90
110
130
150
170
Years
Measured
Simulated


White Spruce Height
Height (m)
0
5
10
15
20
25
30
10
20
30
40
50
60
70
80
90
100
Years
Simulated only spruce
Sim w/ aspen


White Spruce Weight
Weight (Mg/ha)
200
150
100
50
0
10
20
30
40
50
60
70
80
90
100
Years
Simulated wt
sim with aspen