Fertilization of Douglas-fir: Effects on Growth and Mortality

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IFTNC Annual Meeting

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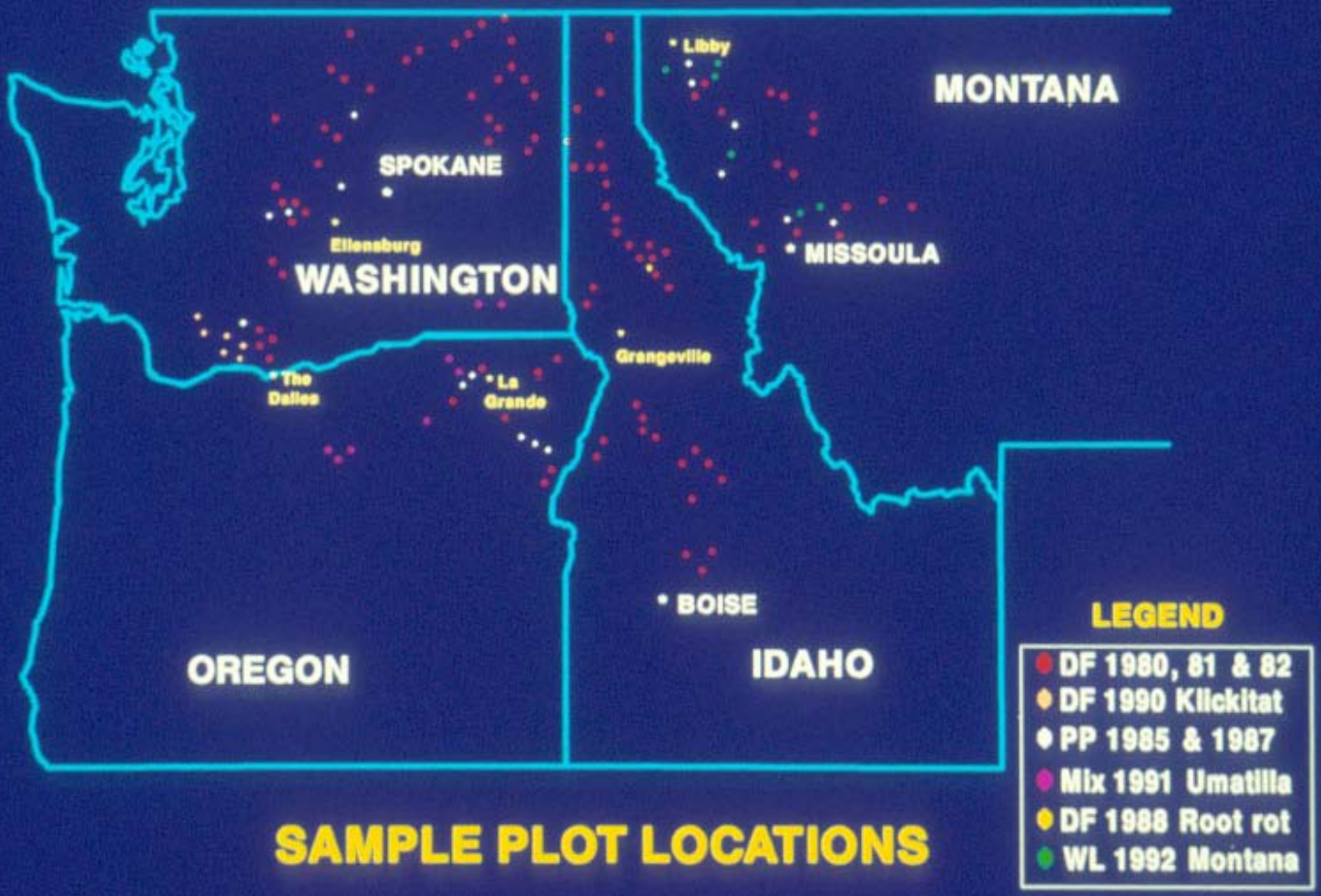
INTERMOUNTAIN FOREST TREE NUTRITION COOPERATIVE

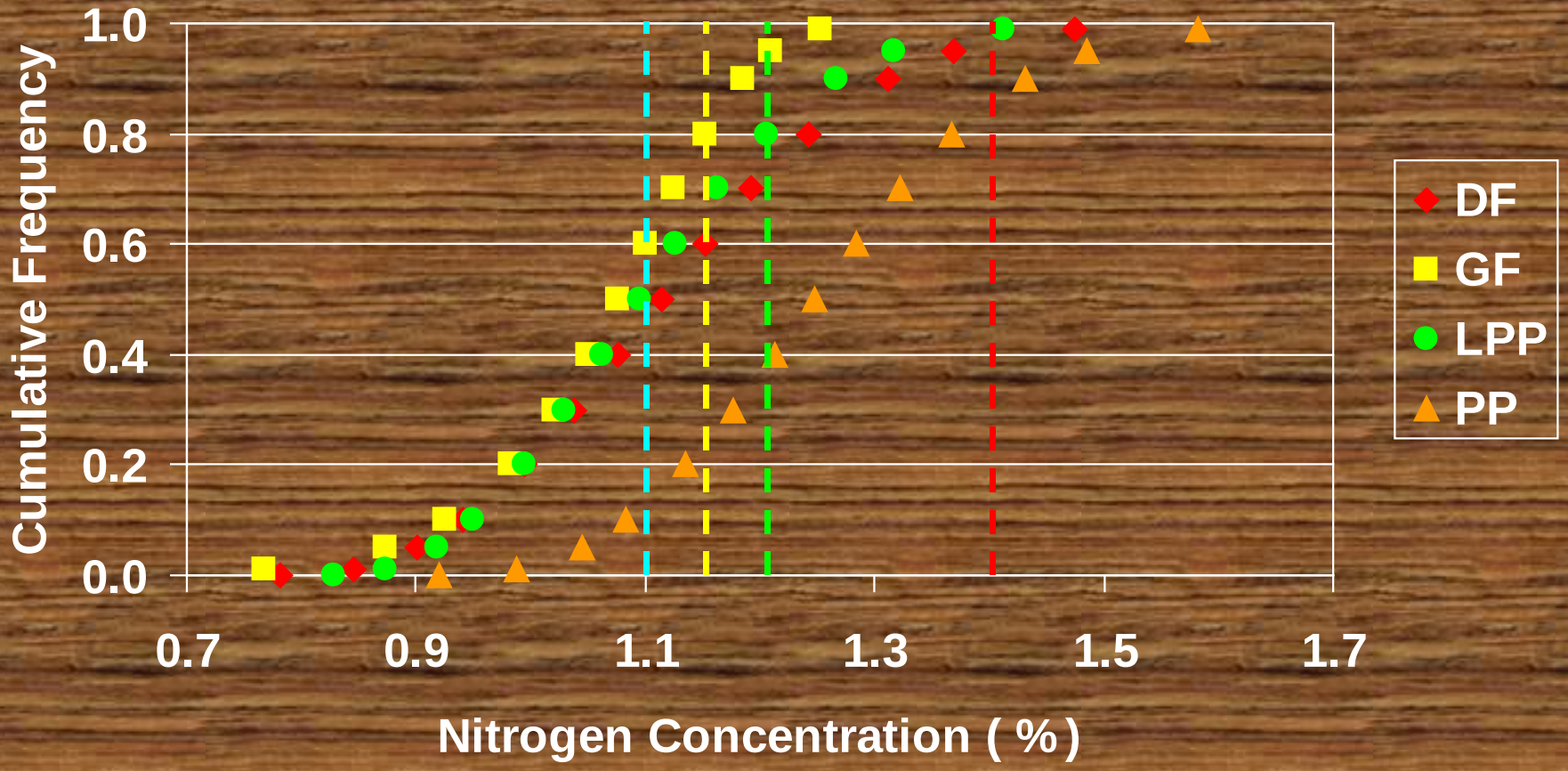


SAMPLE PLOT LOCATIONS

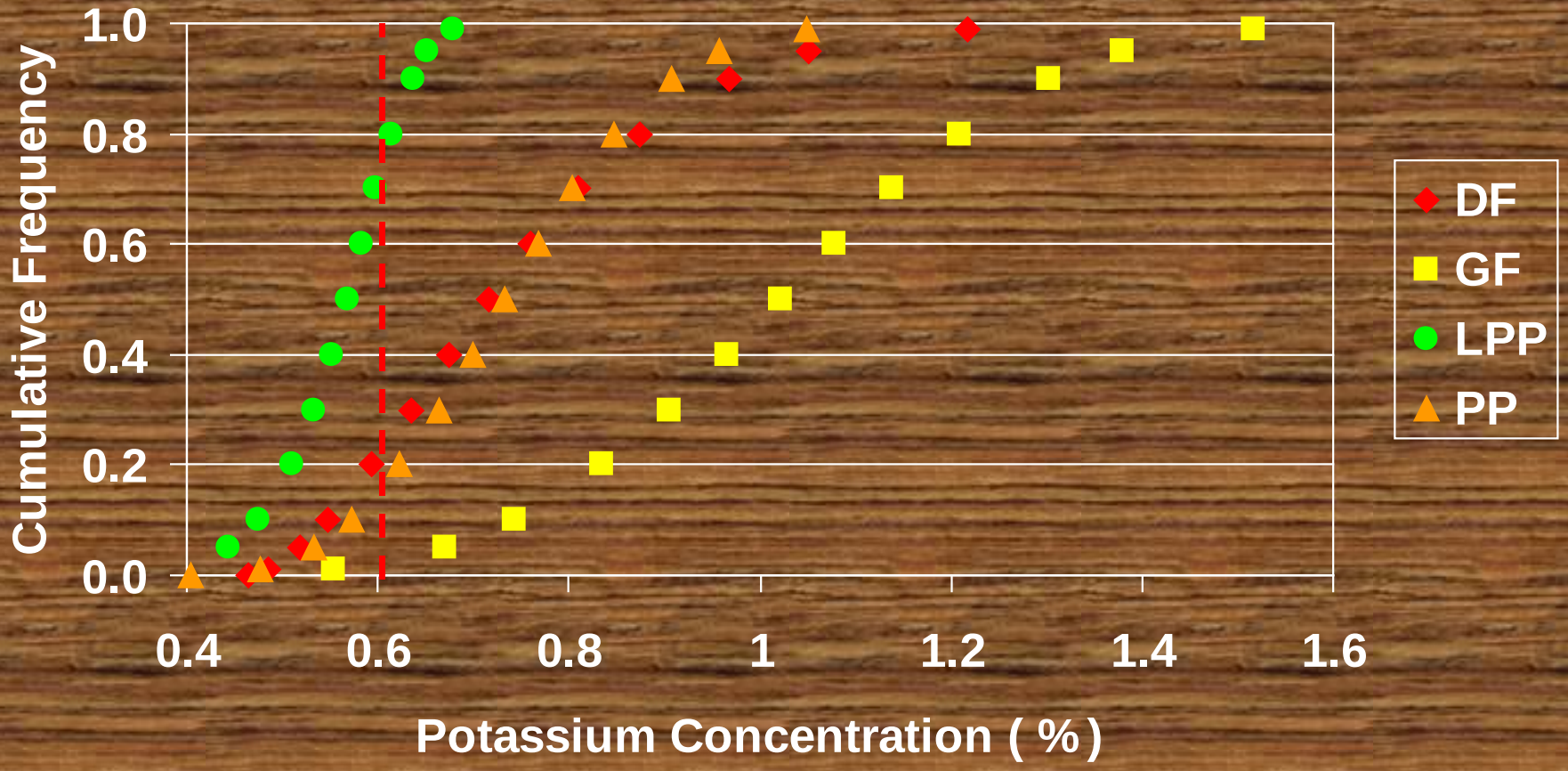
IFTNC Studies Characteristics

Study	Location	Fertilizer Treatments	Vegetation Types	Rock Types
Douglas-fir N Trials	C &NE WA, C & N ID, W MT, NE OR	200#N, 400#N	DF,GF, WRC/WH	Basalt, Granite, Glacial, Metamorphic, Sediment, Modern Sediments
Klickitat N&K Study	SC WA	200#N, 200#N+170#K	GF, WRC	Basalt
Umatilla Mixed-Conifer	NE OR, SE WA	200#N, 200#N+100# S	GF, SAF	Basalt
Forest Health	C &NE WA, C & N ID, NE OR	N and K at various rates 90# S, Micros(B,CU,Zn,Mo)	DF, GF, WRC/WH	Basalt, Granite, Metamorphic, Mixed
Multinutrient Screening Trials	C &NE WA, C & N ID, NE OR	N, K, S, B, Cu, Mg, Fe, Zn	DF, GF, WRC	Basalt, Granite, Metamorphic, Mixed

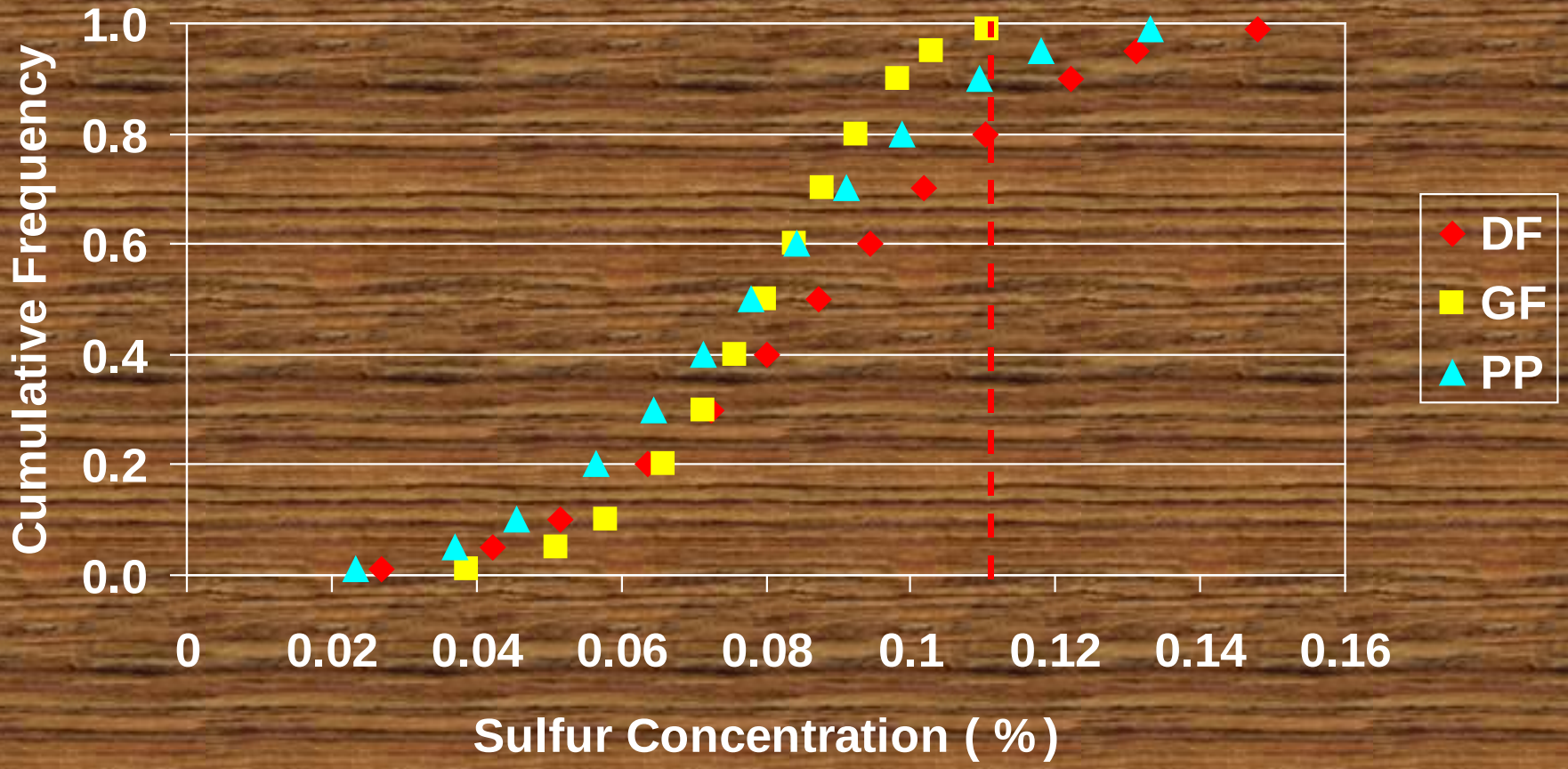
Distribution of Foliar N Concentration by Tree Species



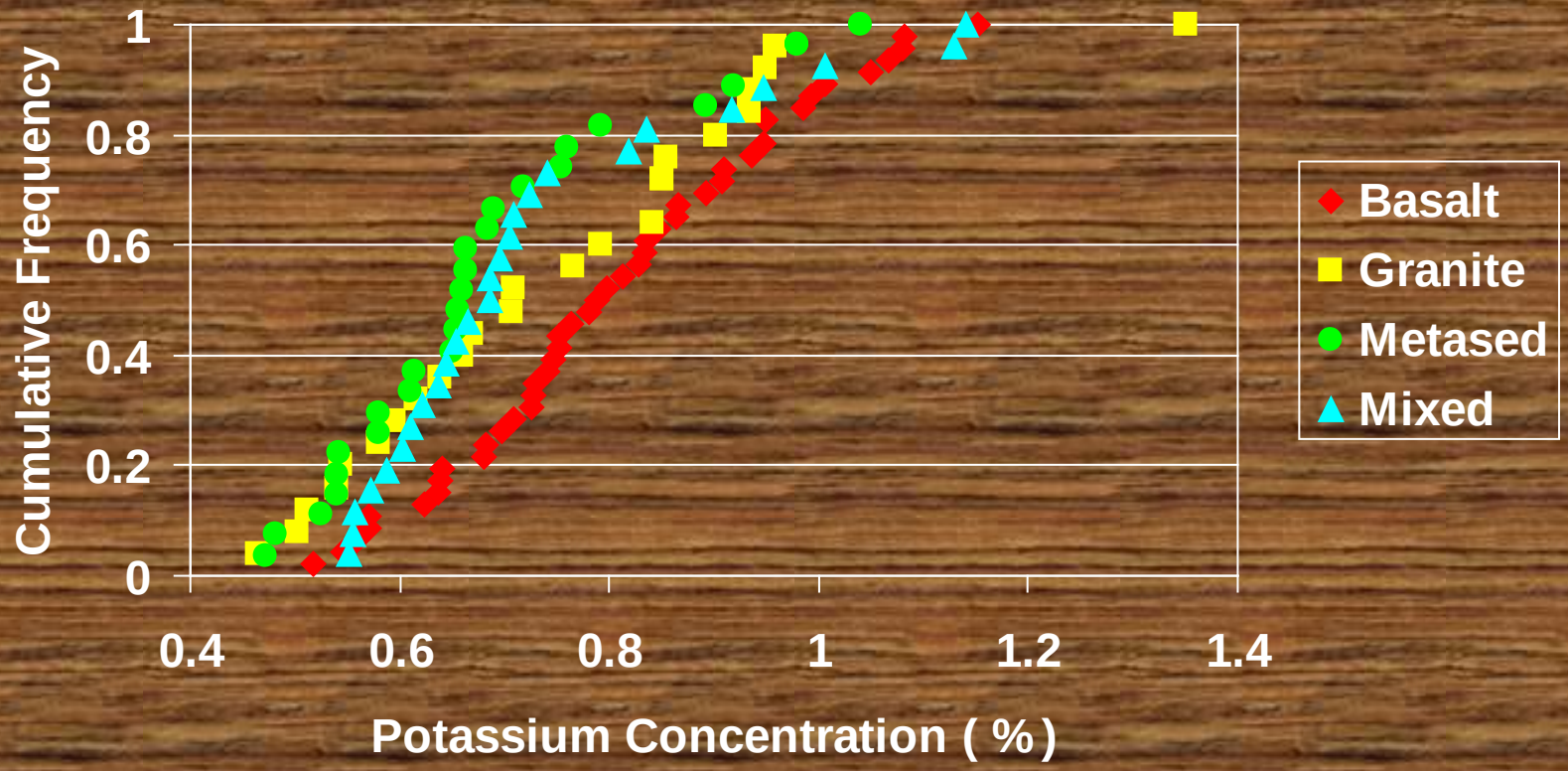
Distribution of Foliar K Concentration by Tree Species



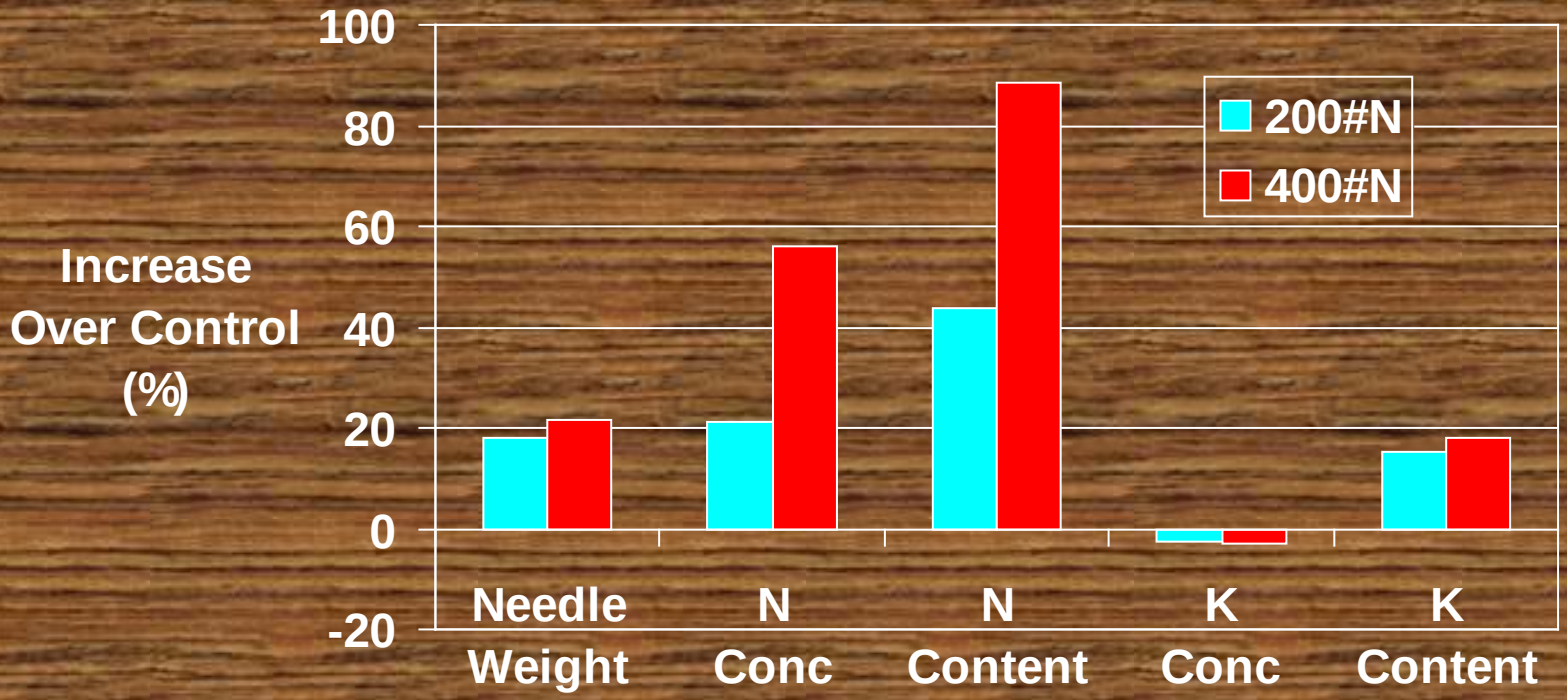
Distribution of Foliar S Concentration by Tree Species



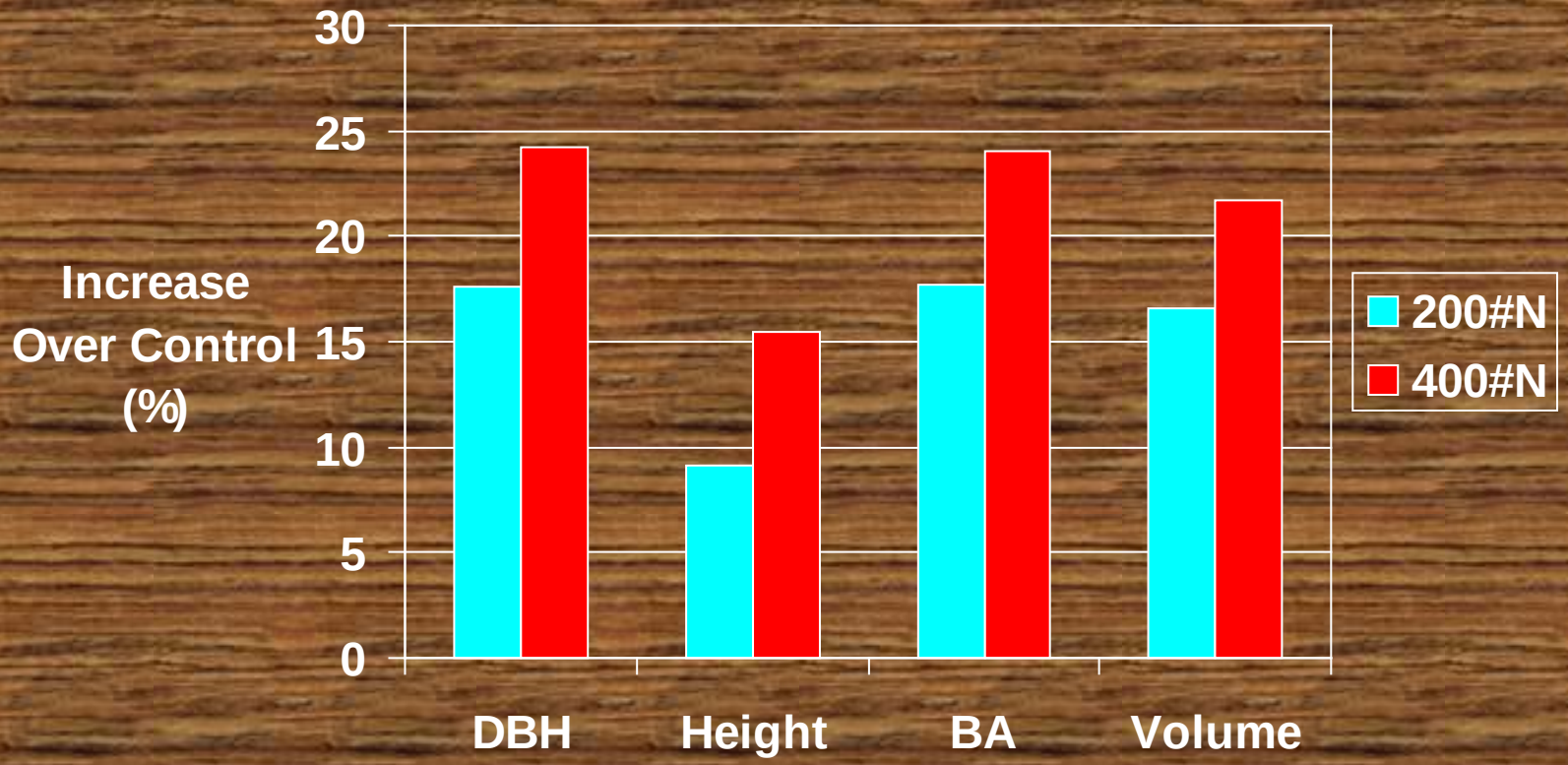
Distribution of DF Foliar K Concentration by Rock Type



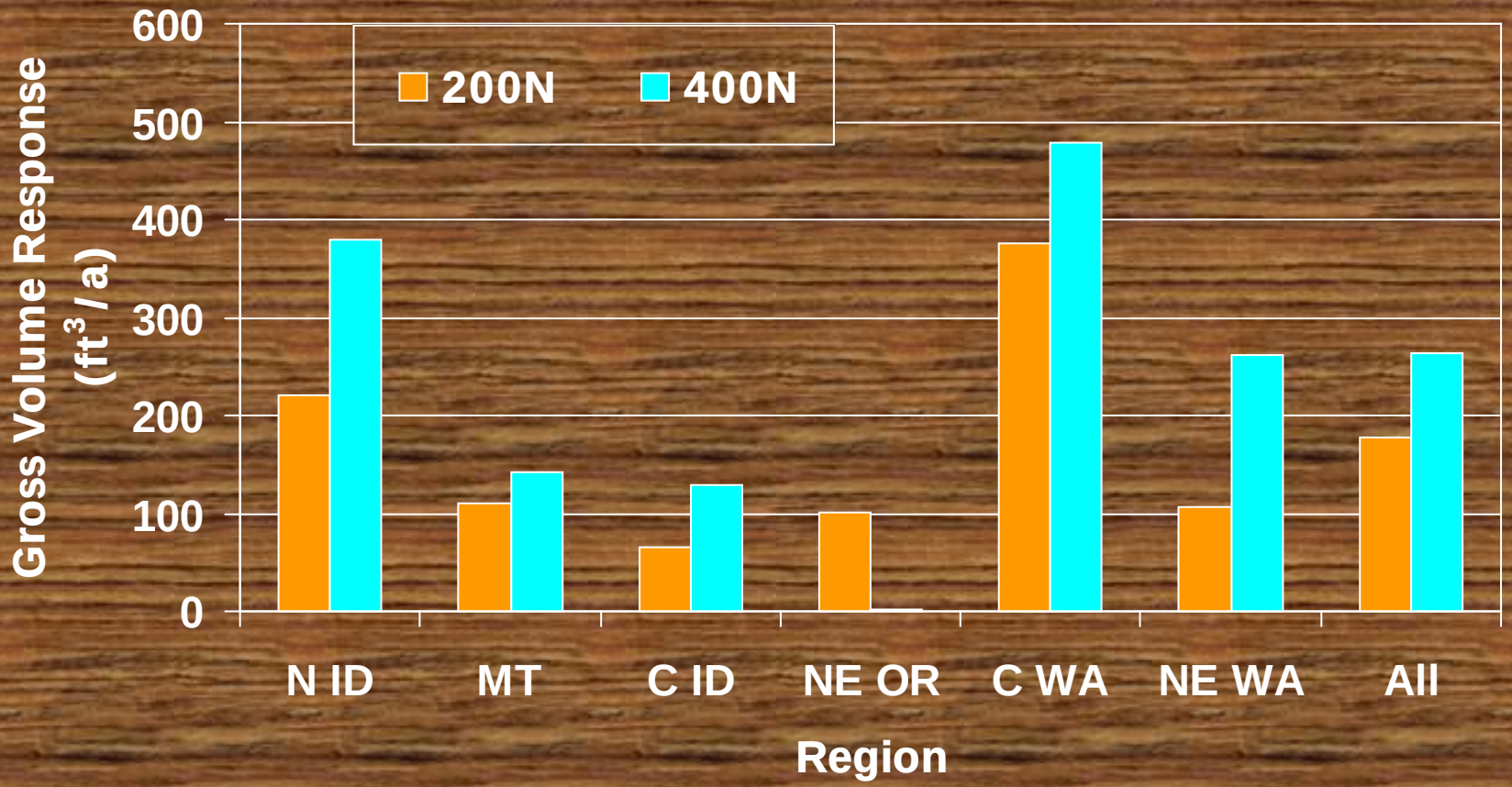
DF Trials
Treatment Effects
on Foliage Chemistry



DF Trials
10-Year Response to Fertilization



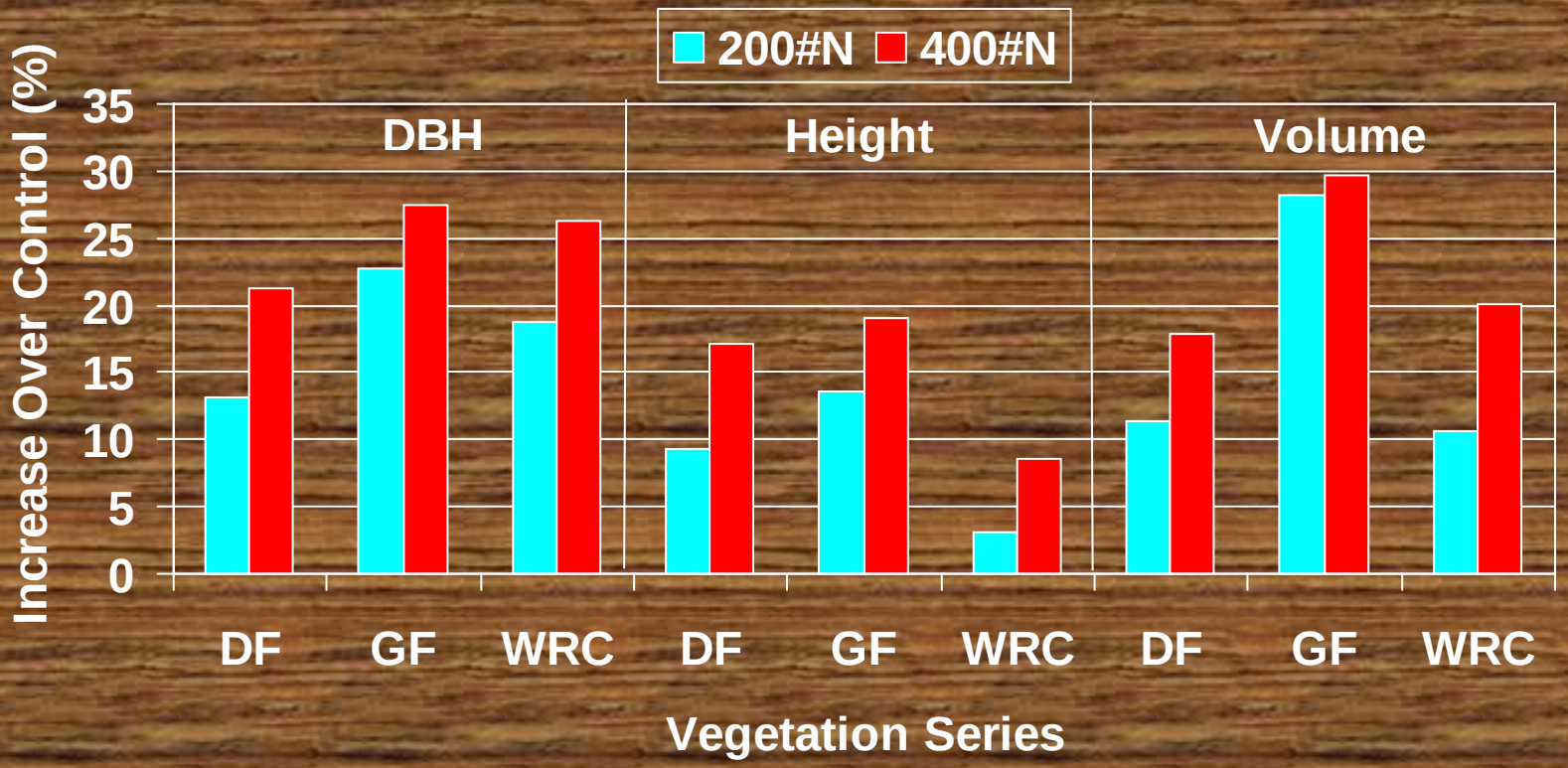
Ten Year Average *Gross Volume* Response by Region and Treatment



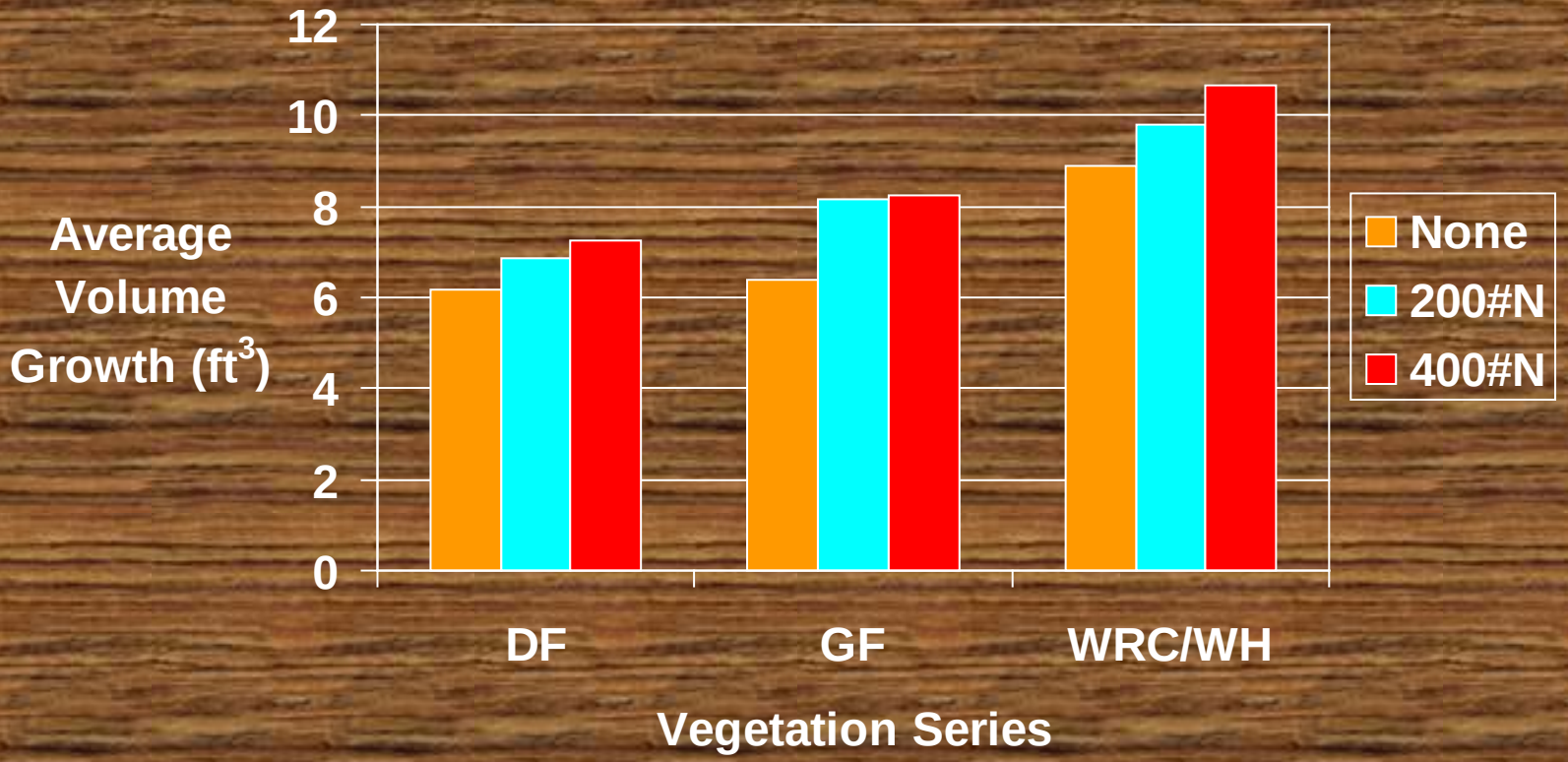
Site Distribution by Rock Type and Vegetation Series

	Rock Type						
Series	Basalt	Glacial	Granite	Metased	Modern Sed	Sediment	All
GF	11	2	5	6	2	3	29
DF	13	14	8	8	2	4	49
WRC/WH	3	2	2	9			16
All	27	18	15	23	4	7	94

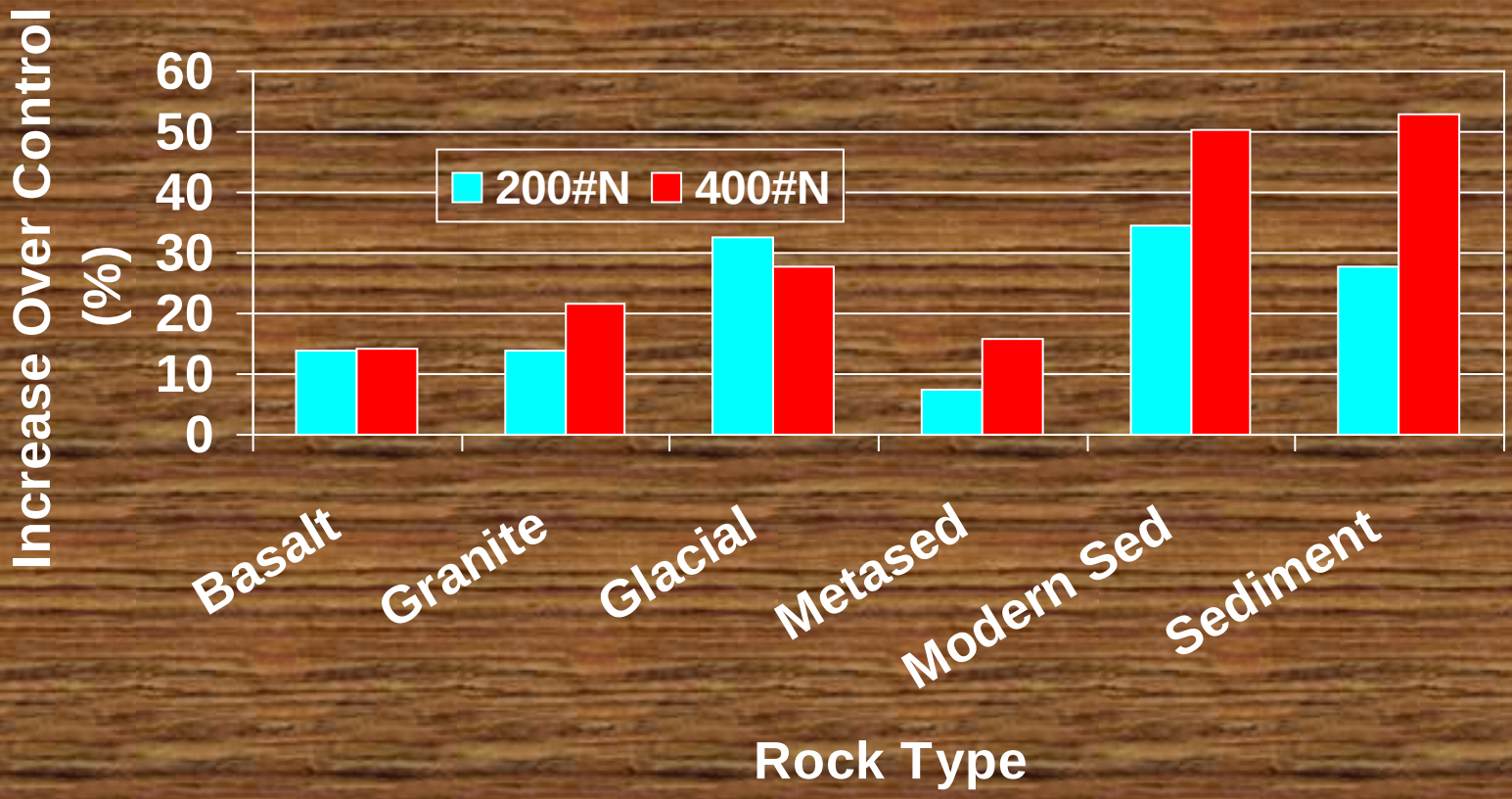
DF Trials
Response to Fertilization
by Vegetation Series



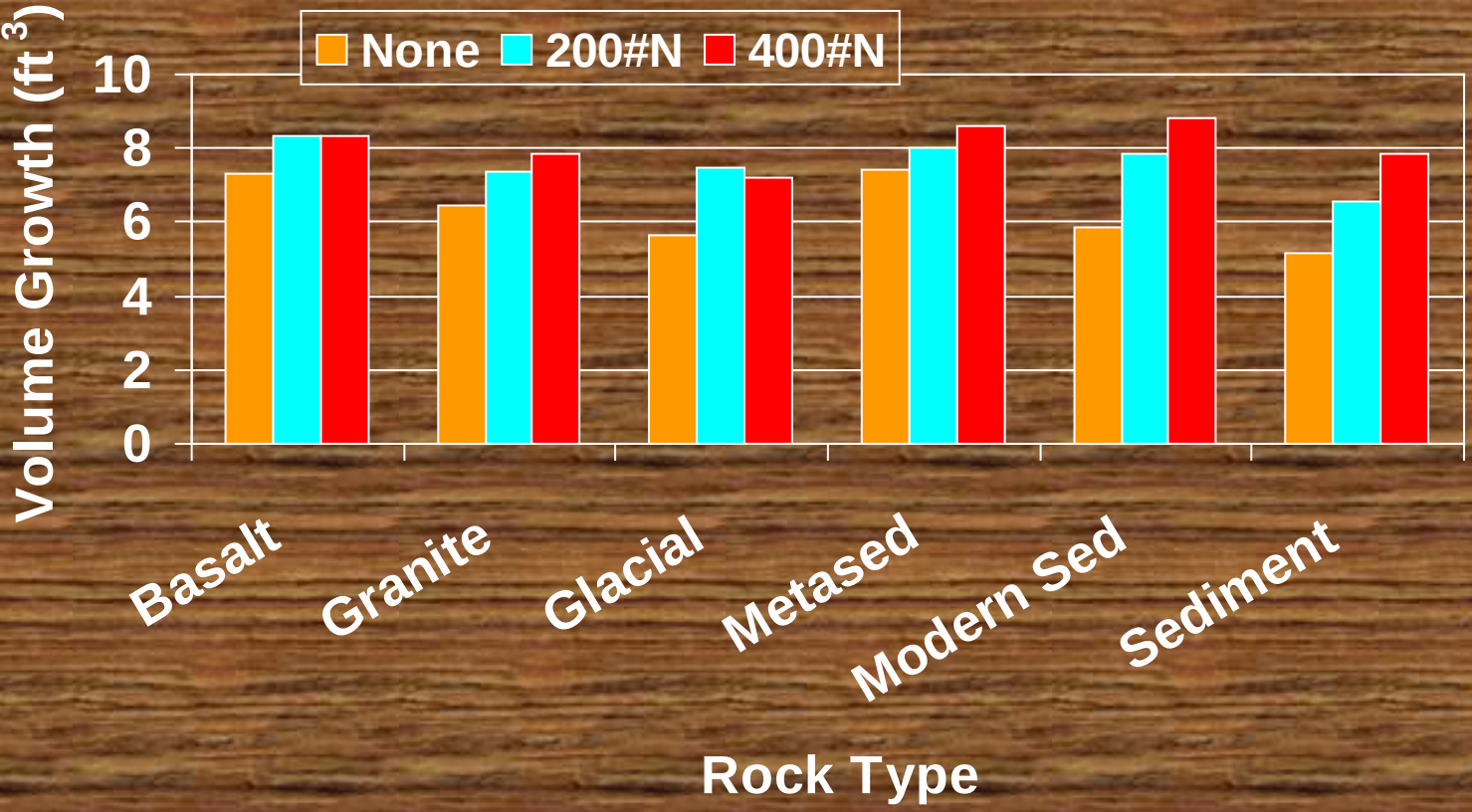
DF Trials
Average Volume Growth by Vegetation Series



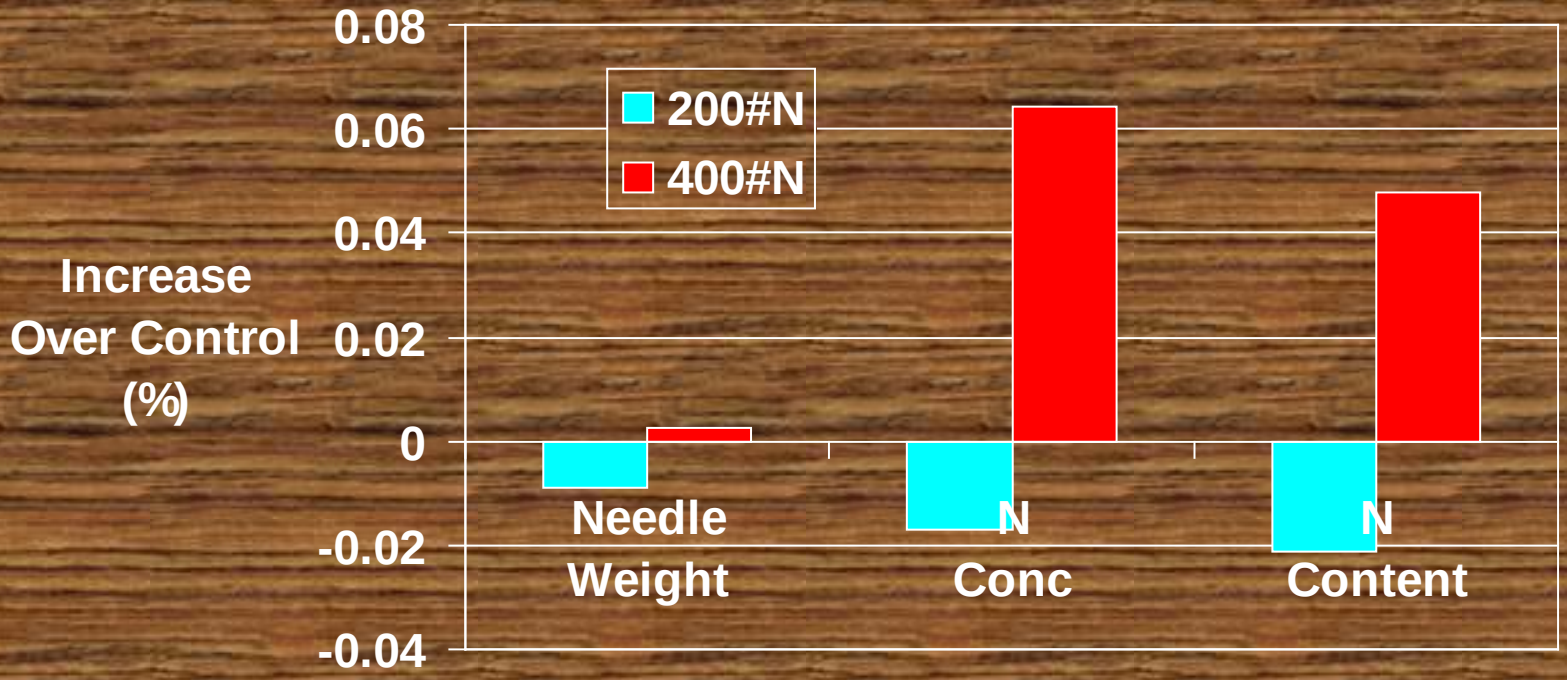
DF Trials
Volume Response to Fertilization by Rock Type



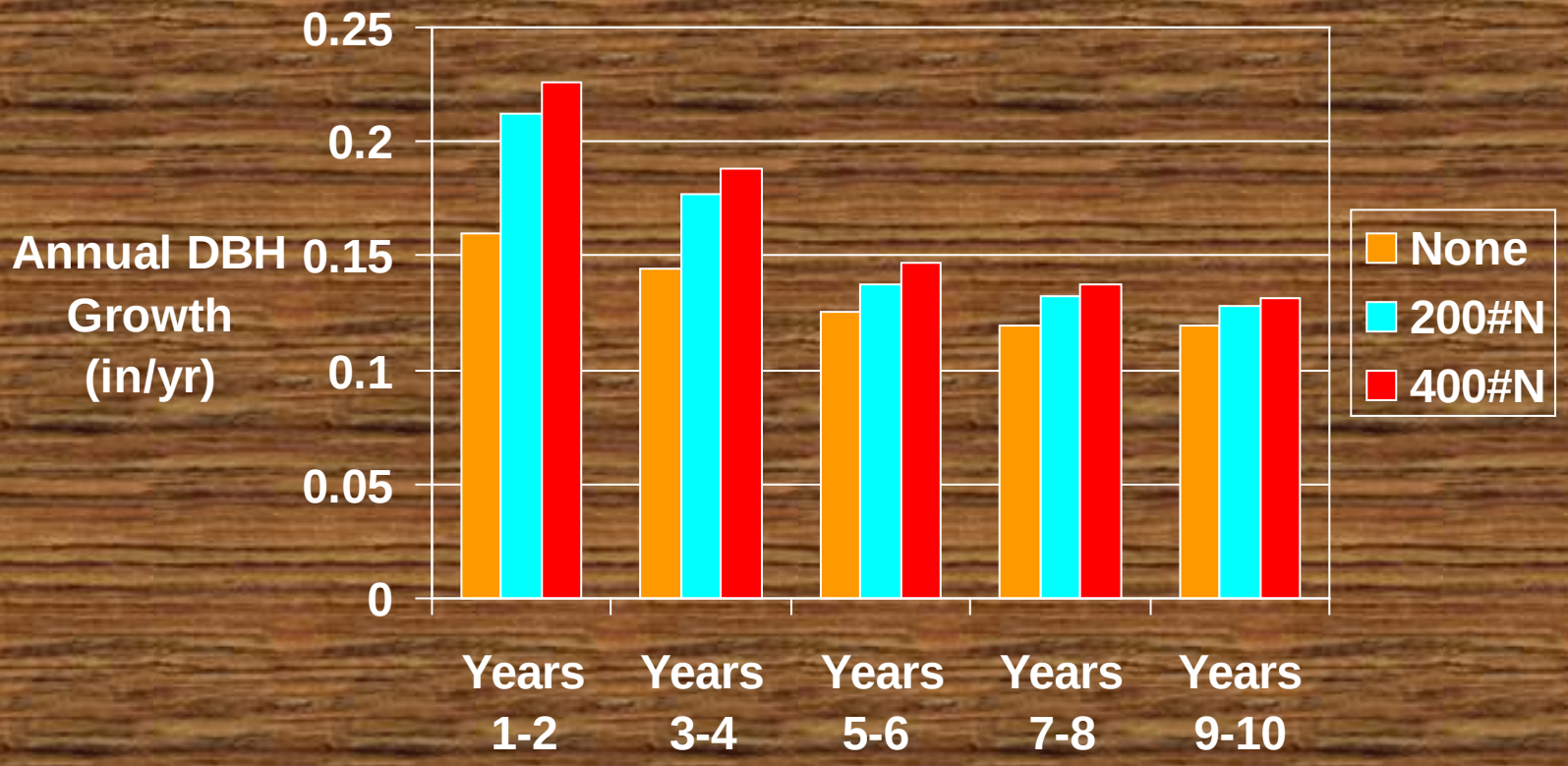
DF Trials
Average Volume Growth by Rock Type



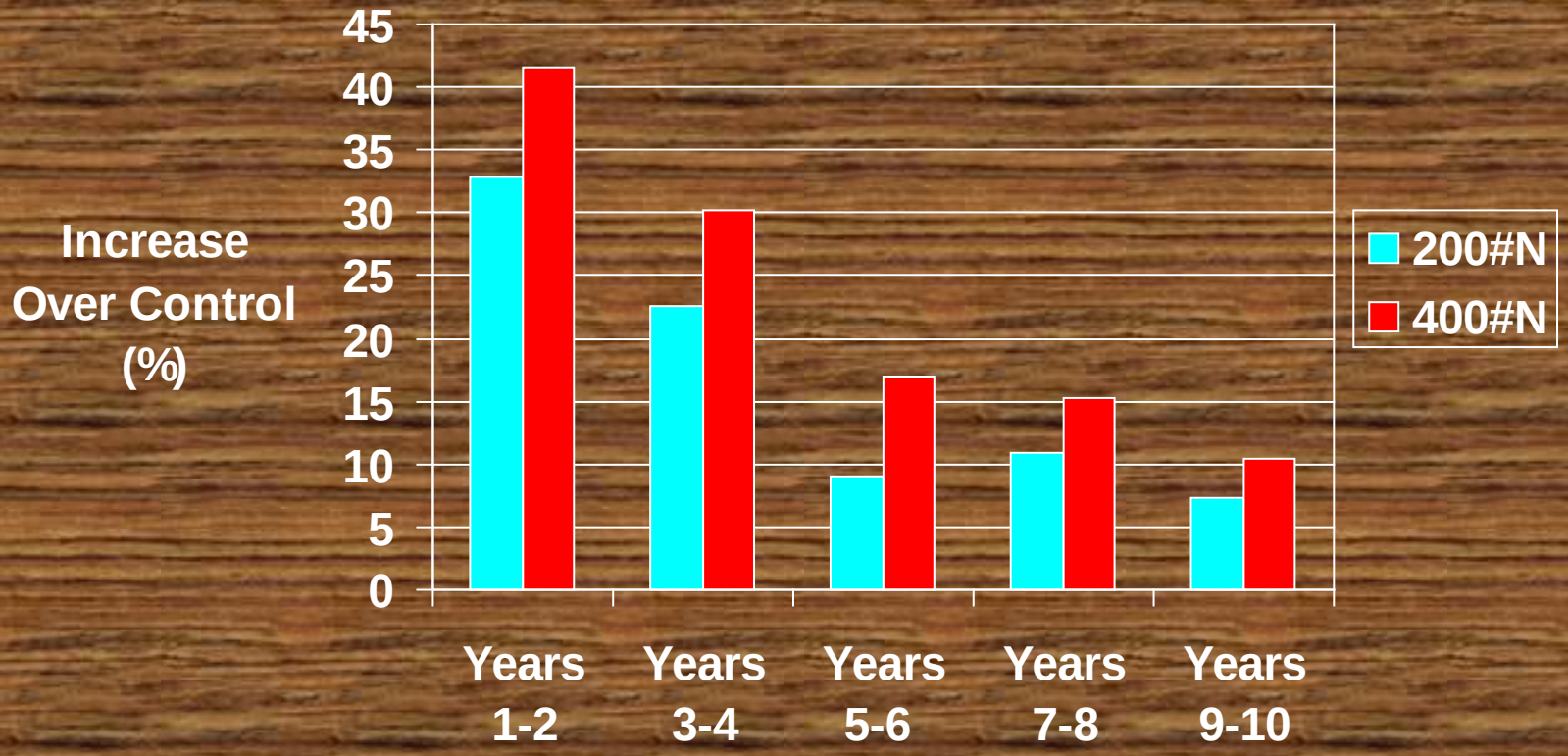
DF Trials
Treatment Effects on Foliage Chemistry
7 Years After Treatment



DF Trials
Diameter Growth

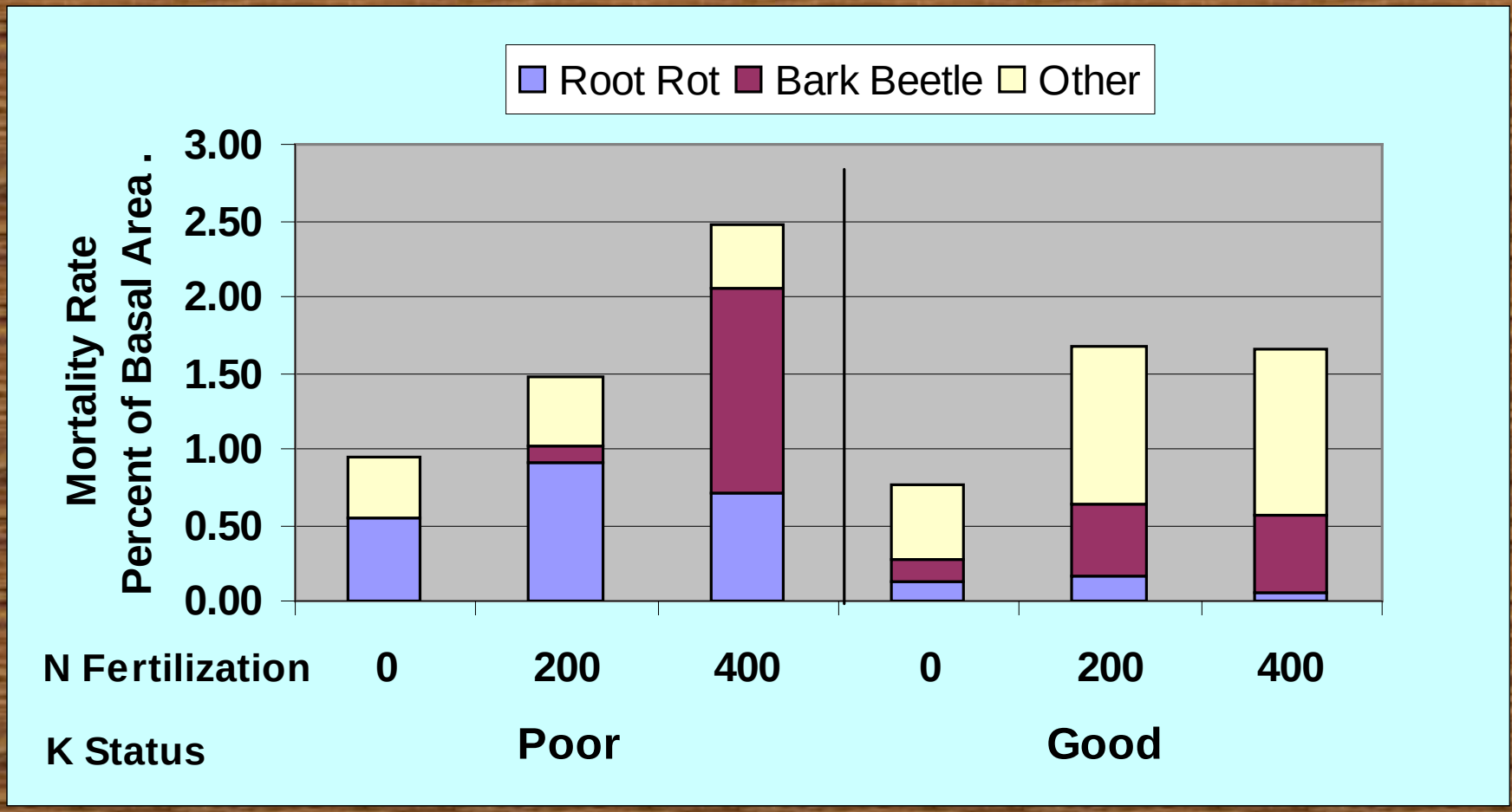


DF Trials
Diameter Response



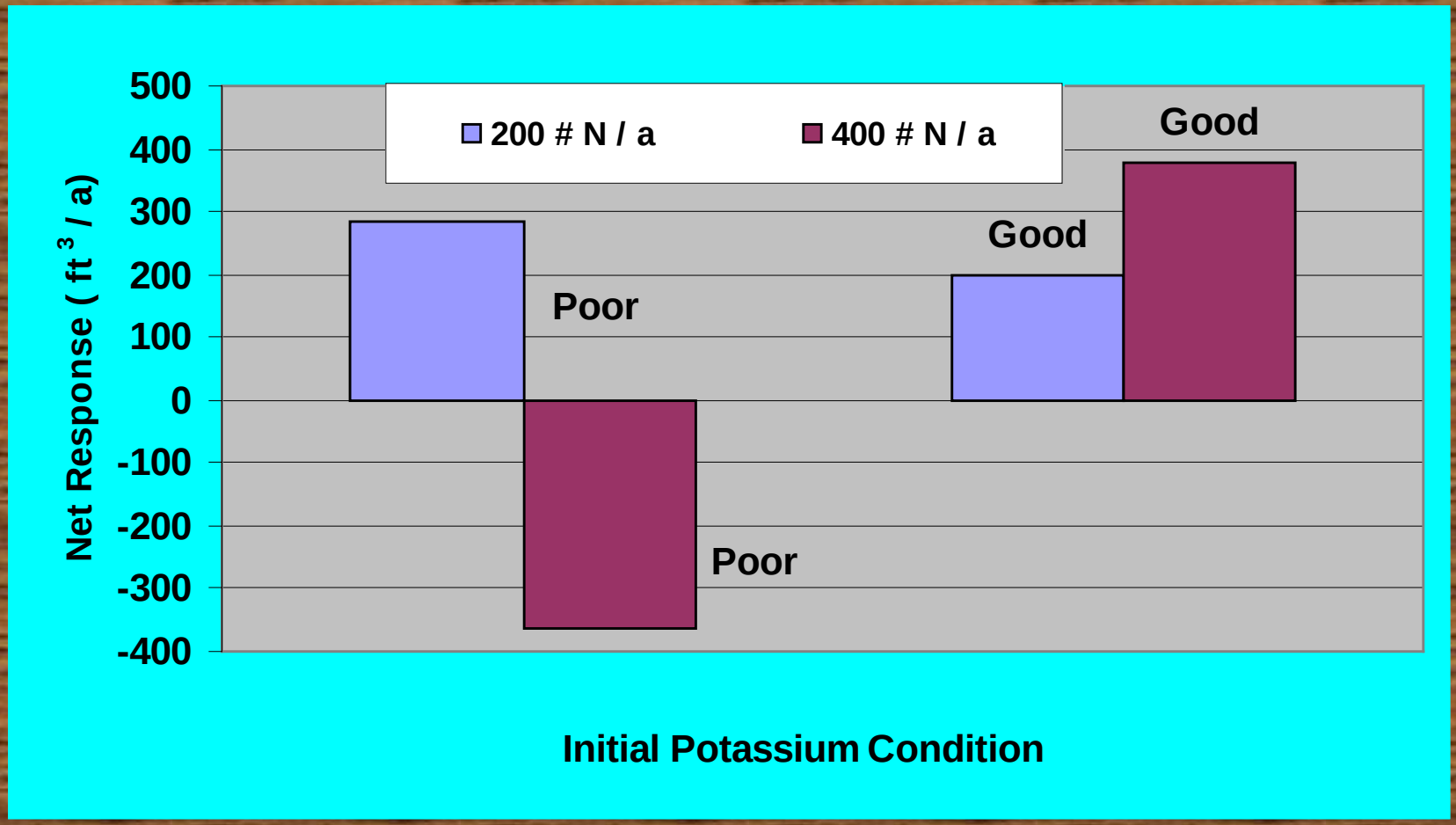
“Square Death”

Mortality Rates by Cause, Treatment, and Potassium Status



Poor: Foliar K<0.6%, K/N<50% Good: Foliar K>0.6%, K/N>65%

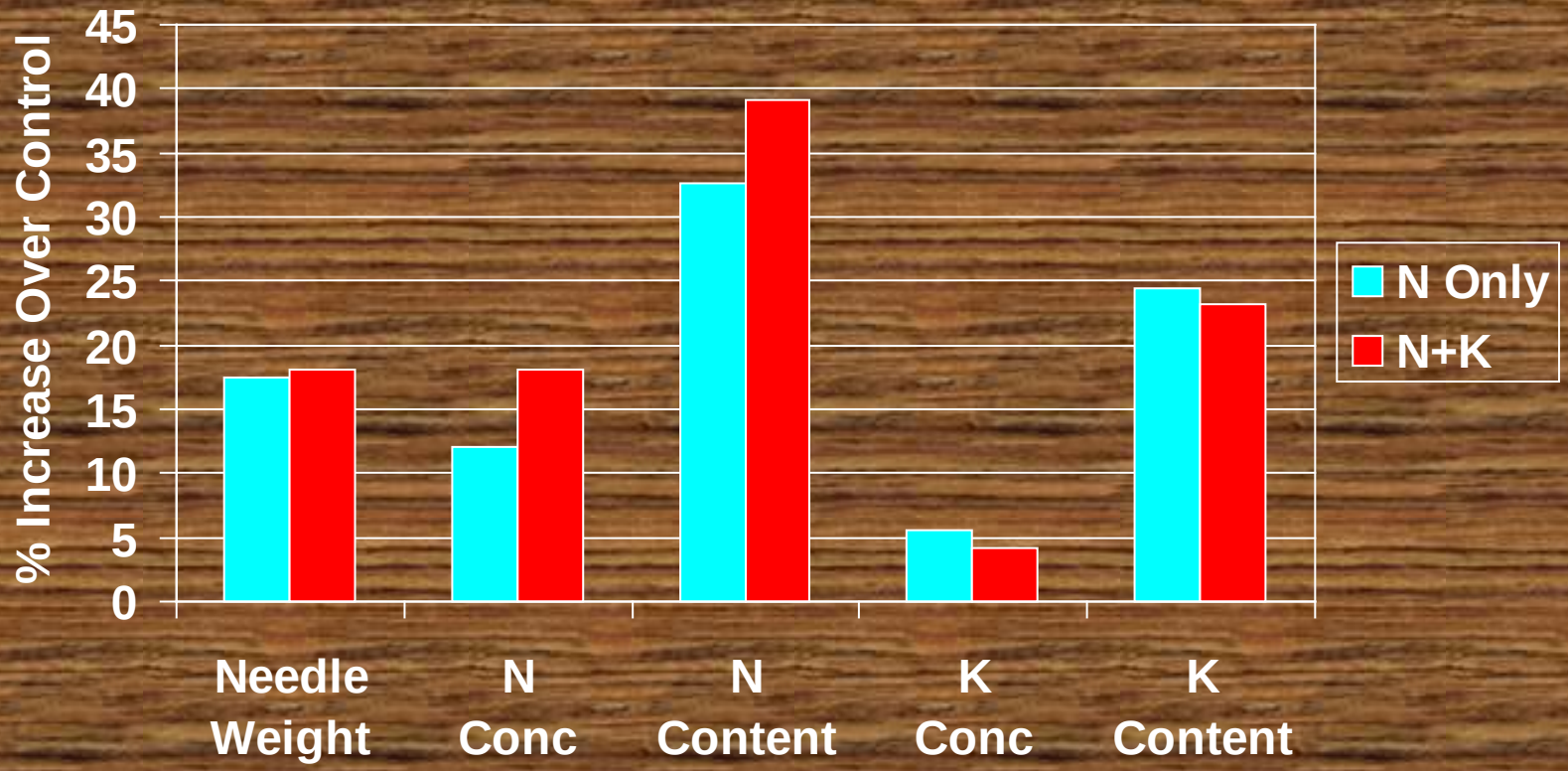
Ten Year *Net* Volume Response By Initial Potassium Condition from Douglas Fir Trials



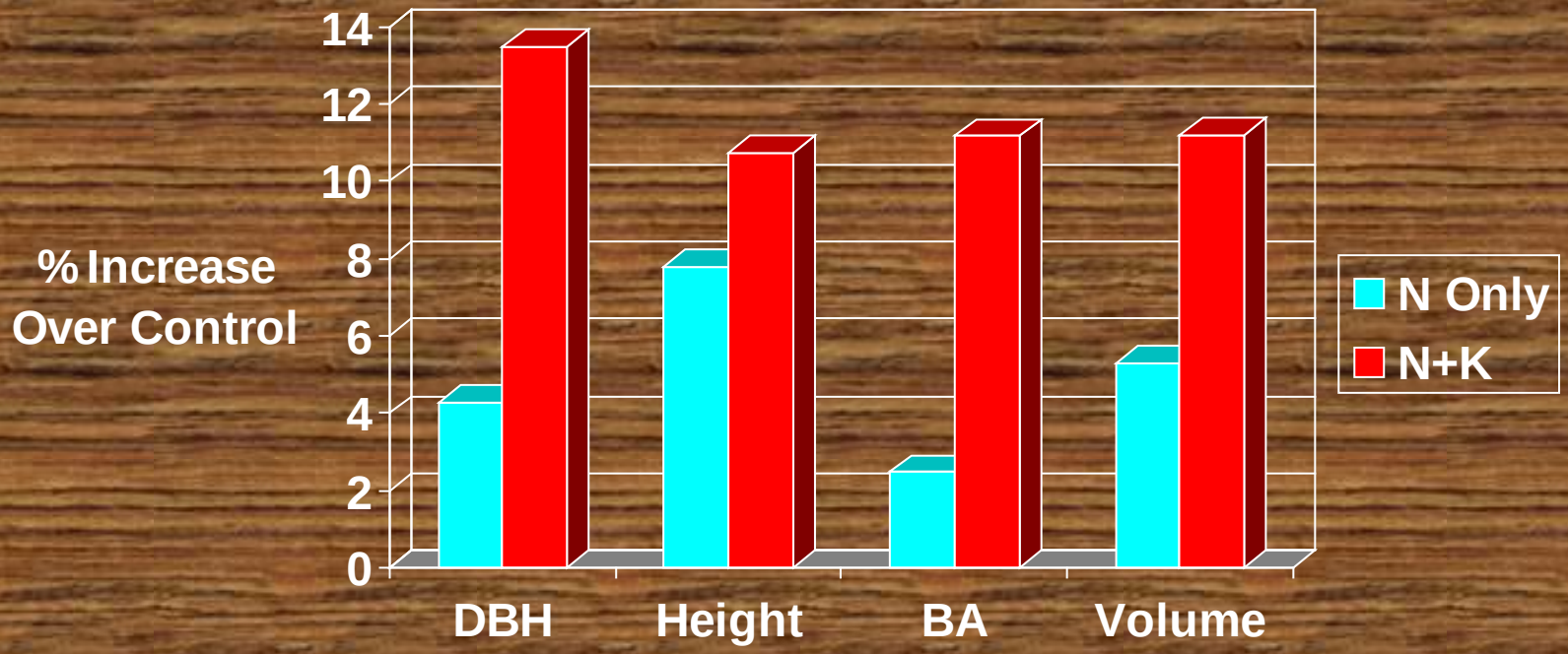
Poor: Foliar K < 0.6 %, K/N < 50 %

Good: Foliar K > 0.6 %, K/N > 65 %

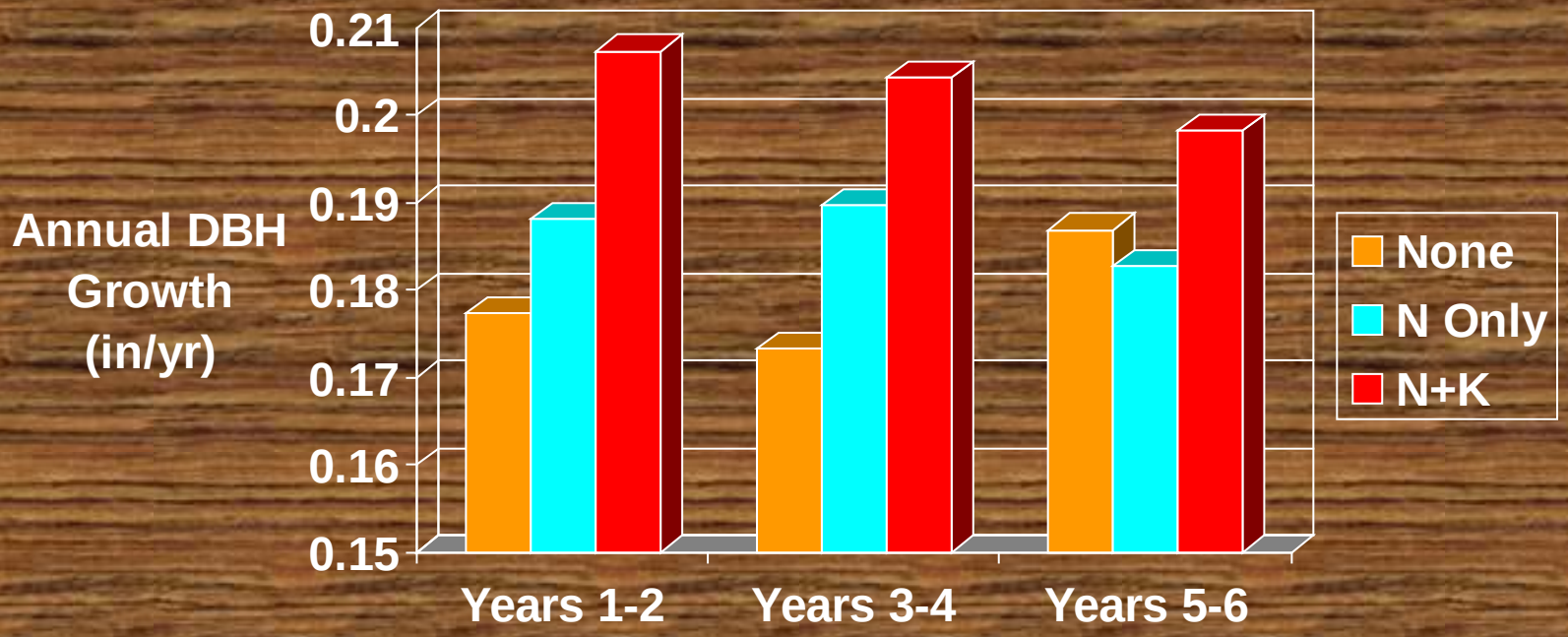
Klickitat N and K Study
Foliar Nutrient Response to Fertilizer



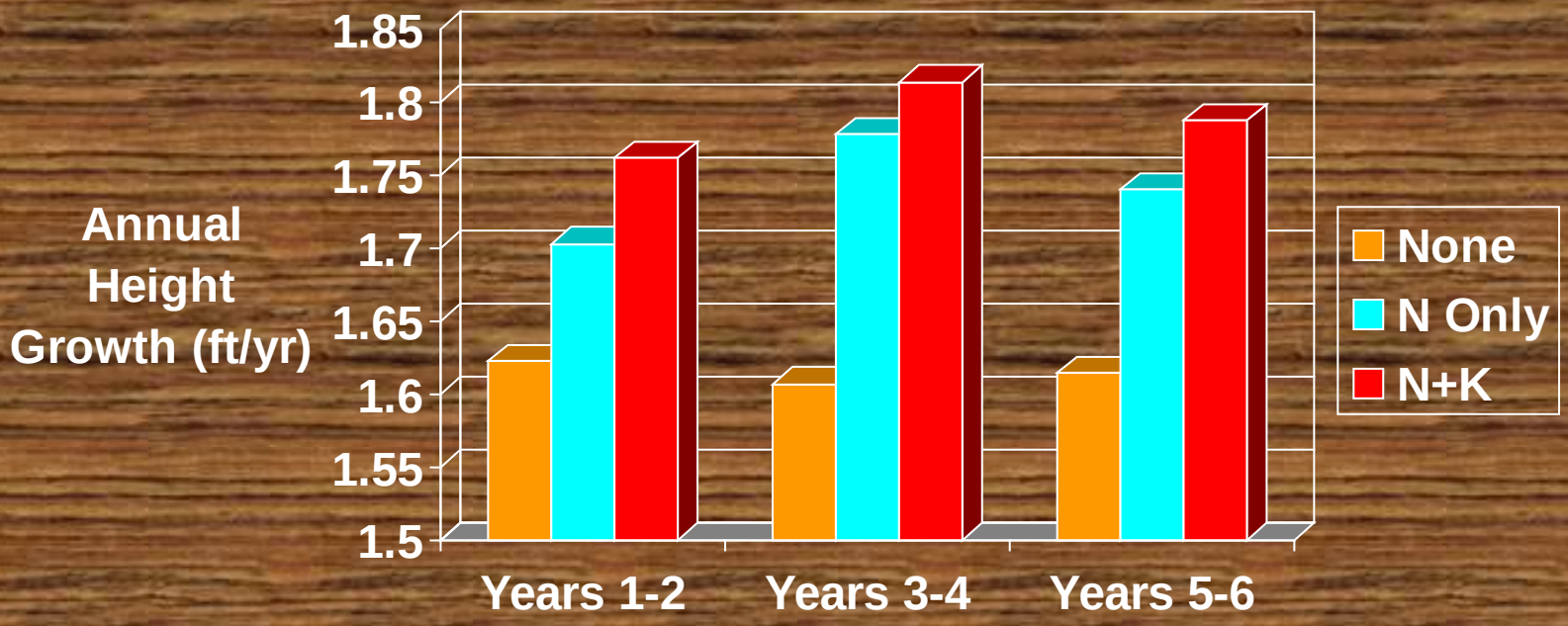
Klickitat N and K Study
6-Year Response to Fertilizer



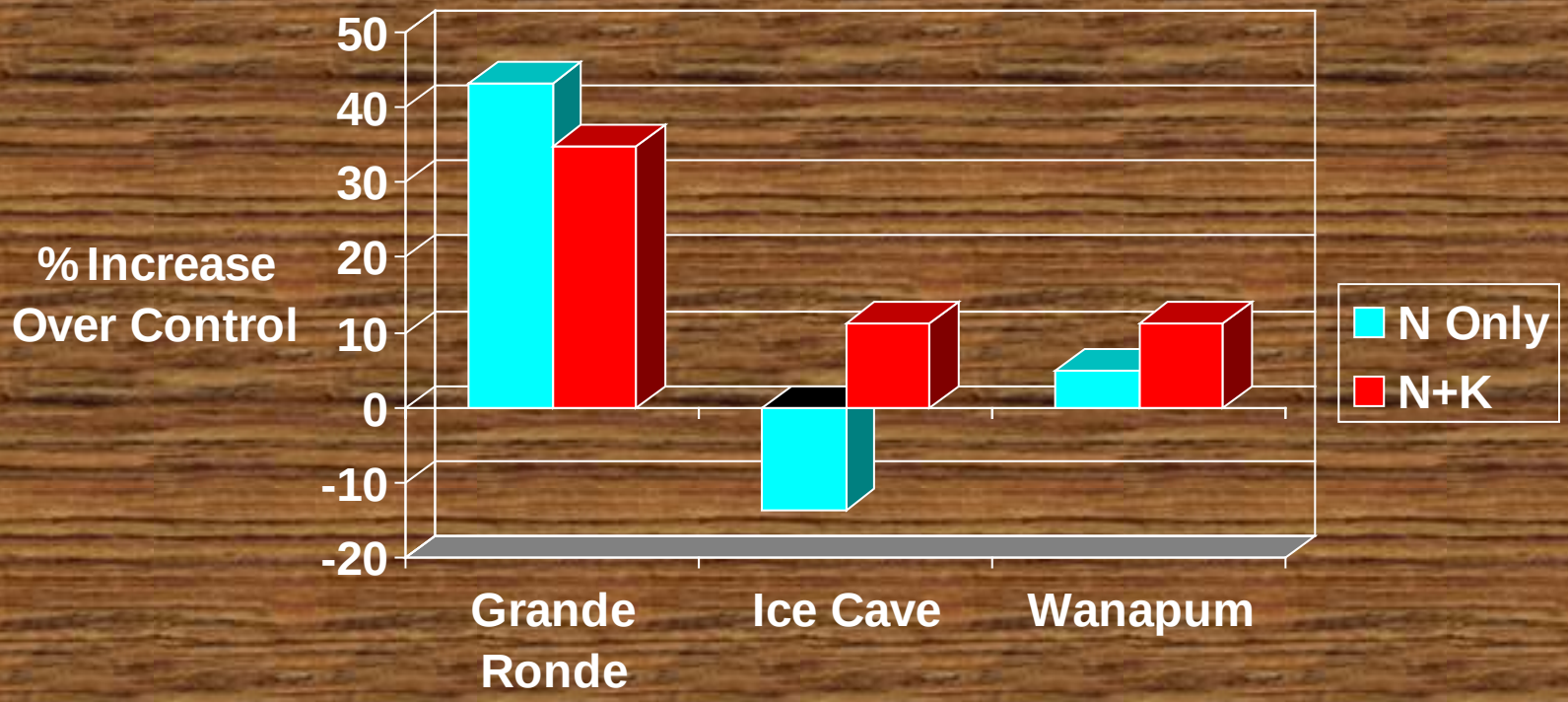
Klickitat N and K Study
Diameter Growth



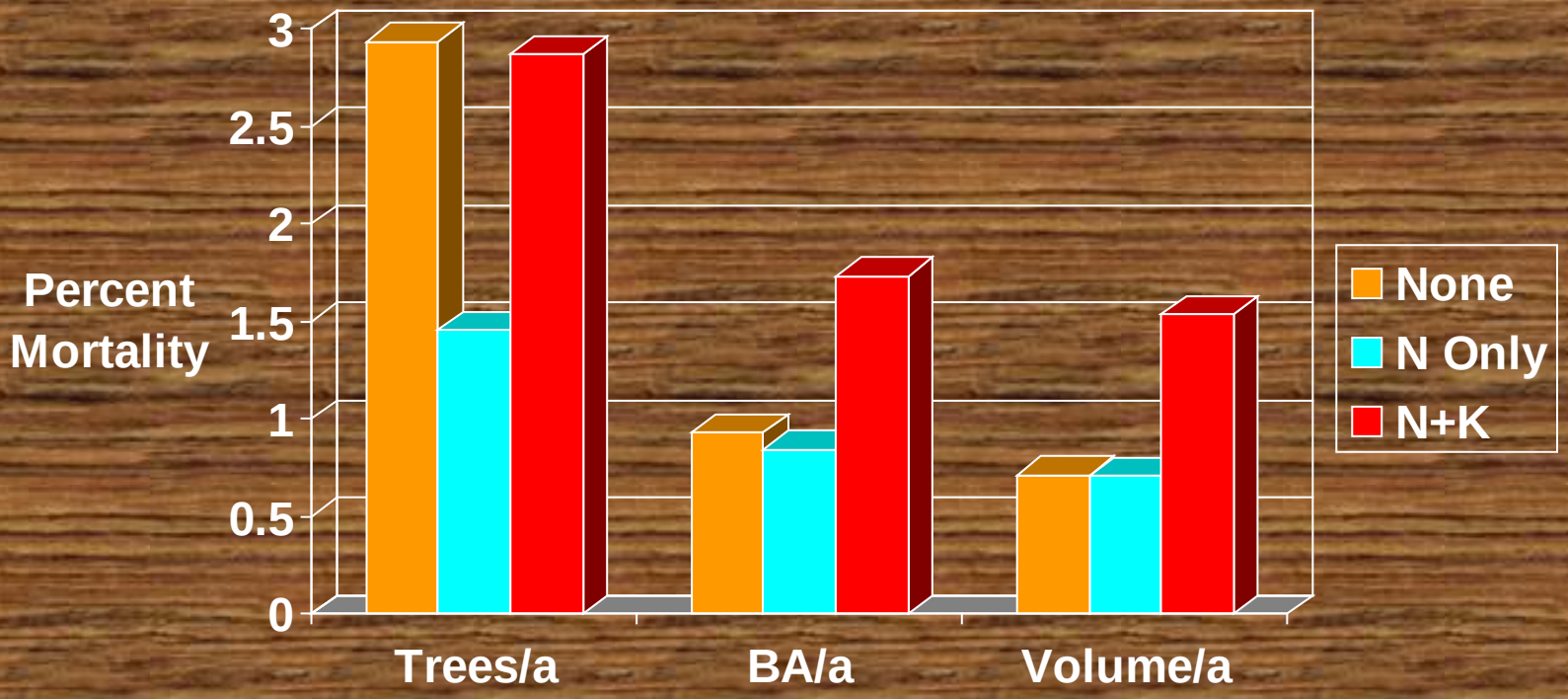
Klickitat N and K Study
Height Growth



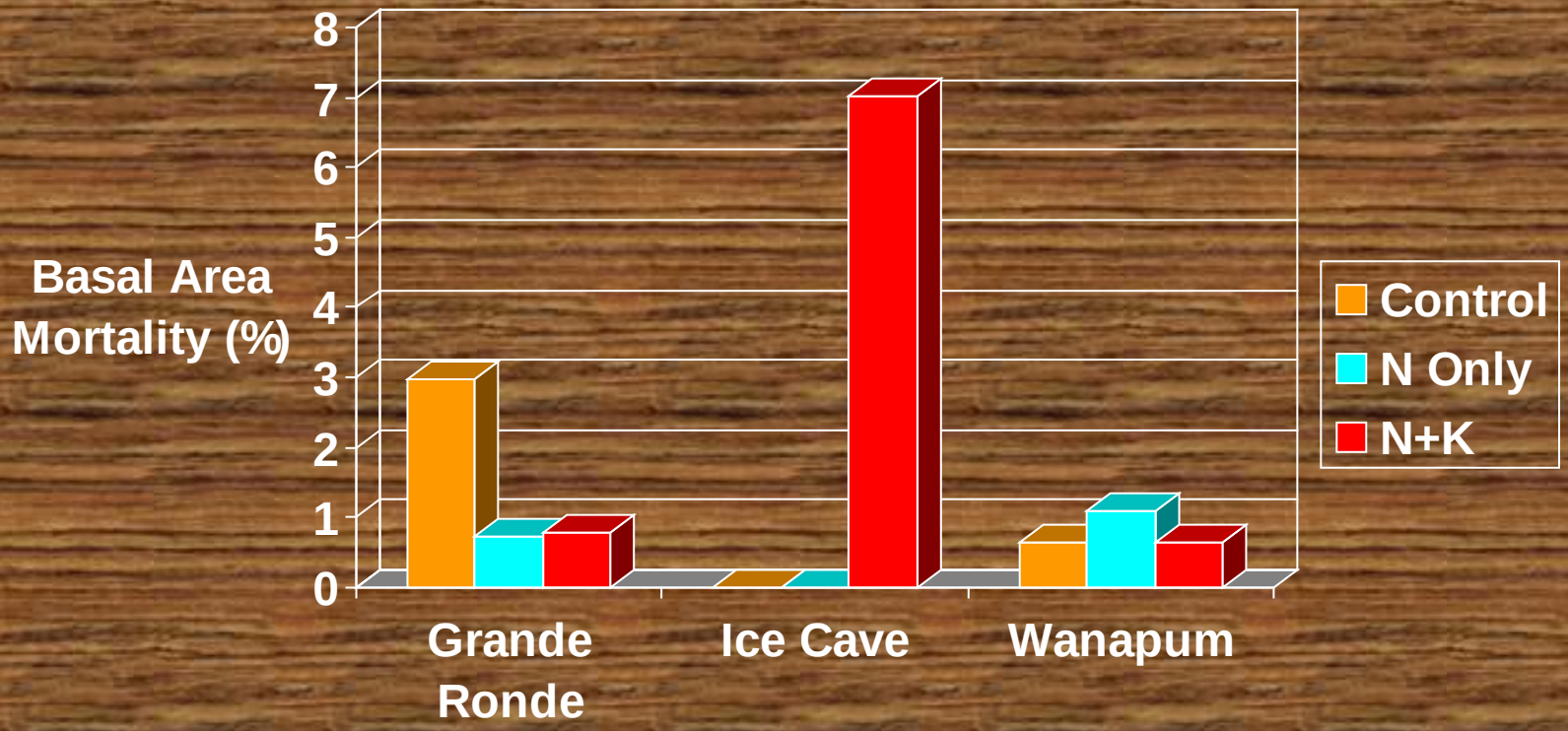
Klickitat N and K Study
6-Year Response to Fertilizer



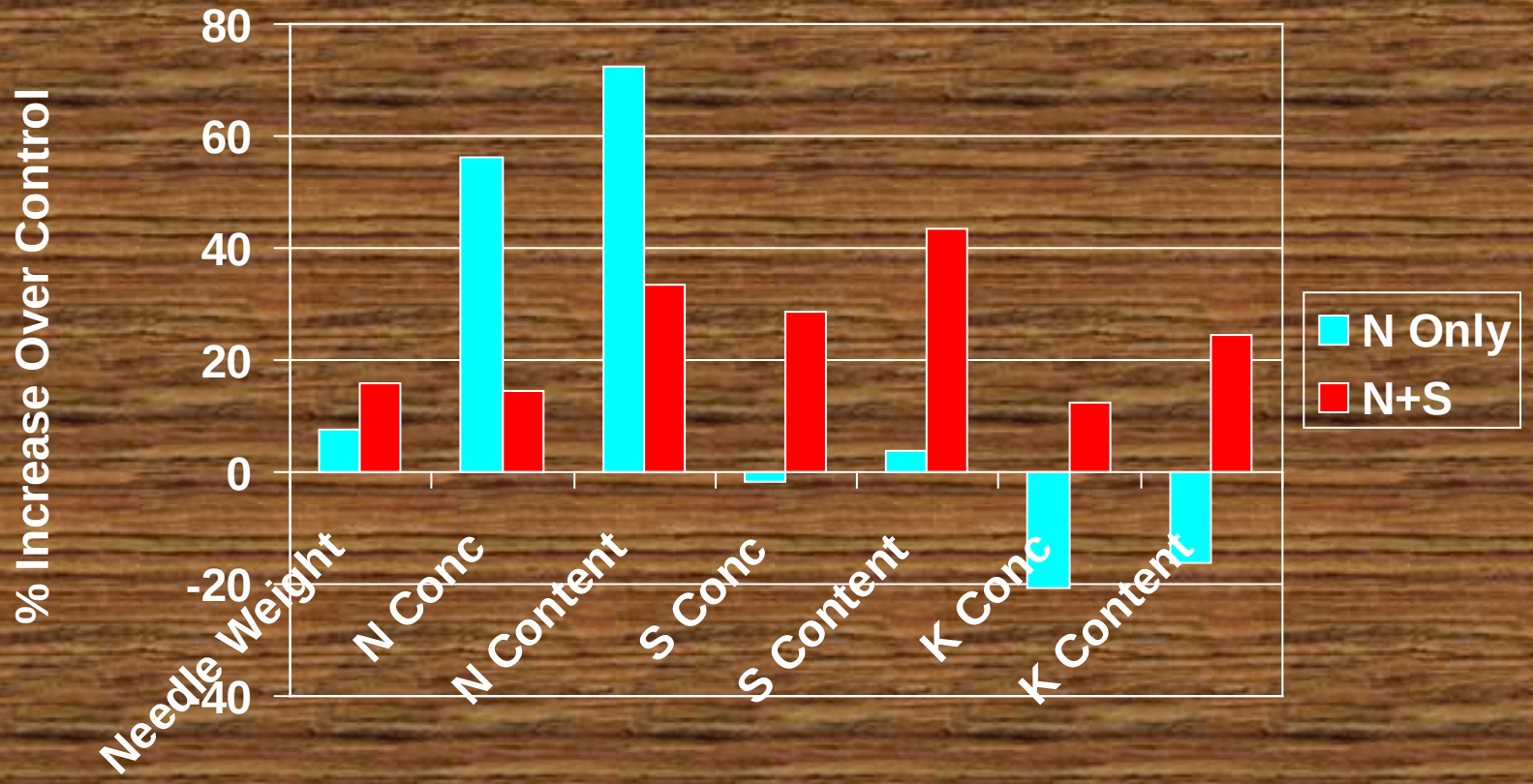
Klickitat N and K Study
6-Year Mortality



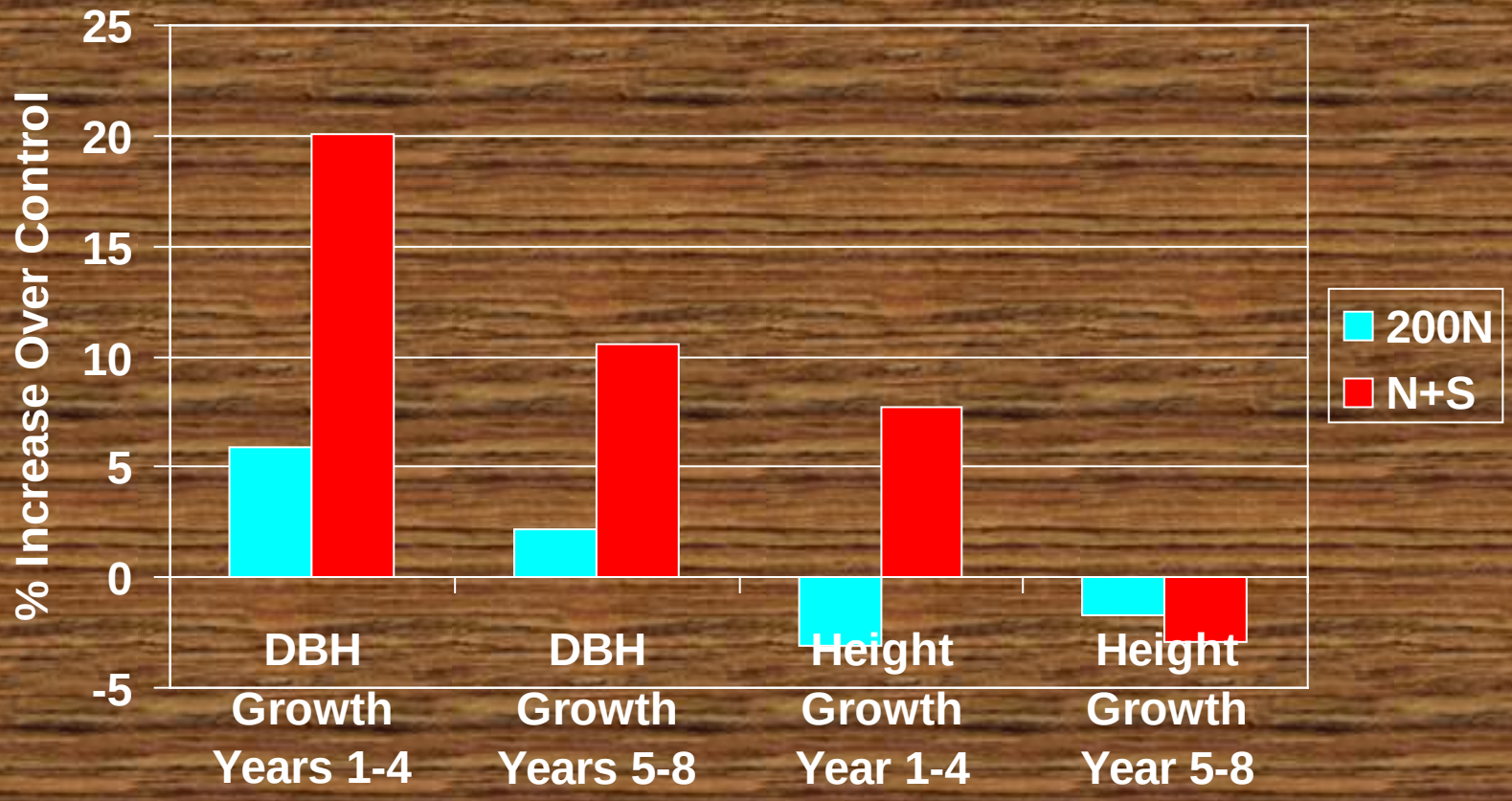
Klickitat N and K Study
6-Year Basal Area Mortality
By Treatment and Basalt Flow



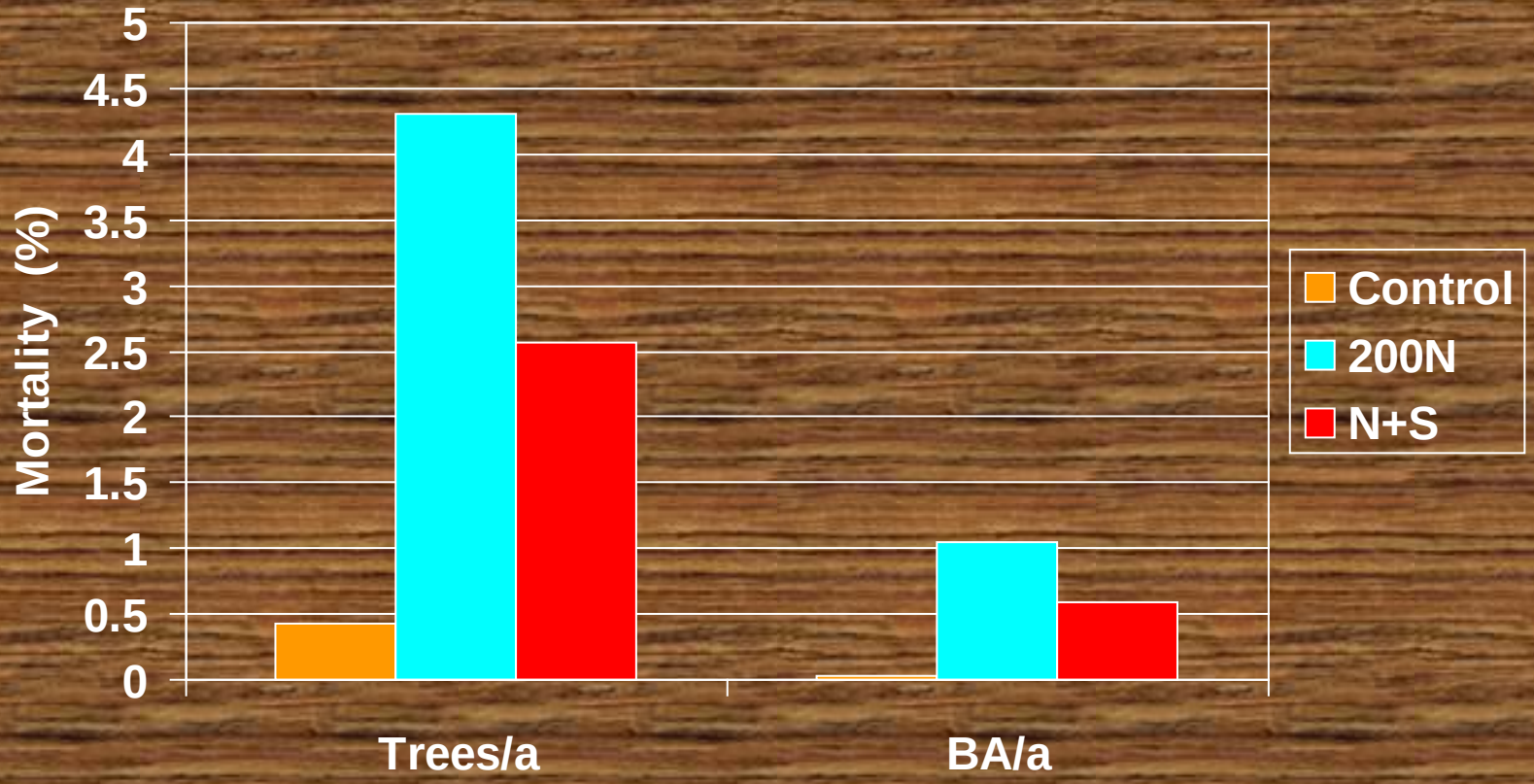
Umatilla N and S Study
Foliar Nutrient Response to Fertilizer



Umatilla N and S Study Periodic Annual Growth by Fertilizer Treatment



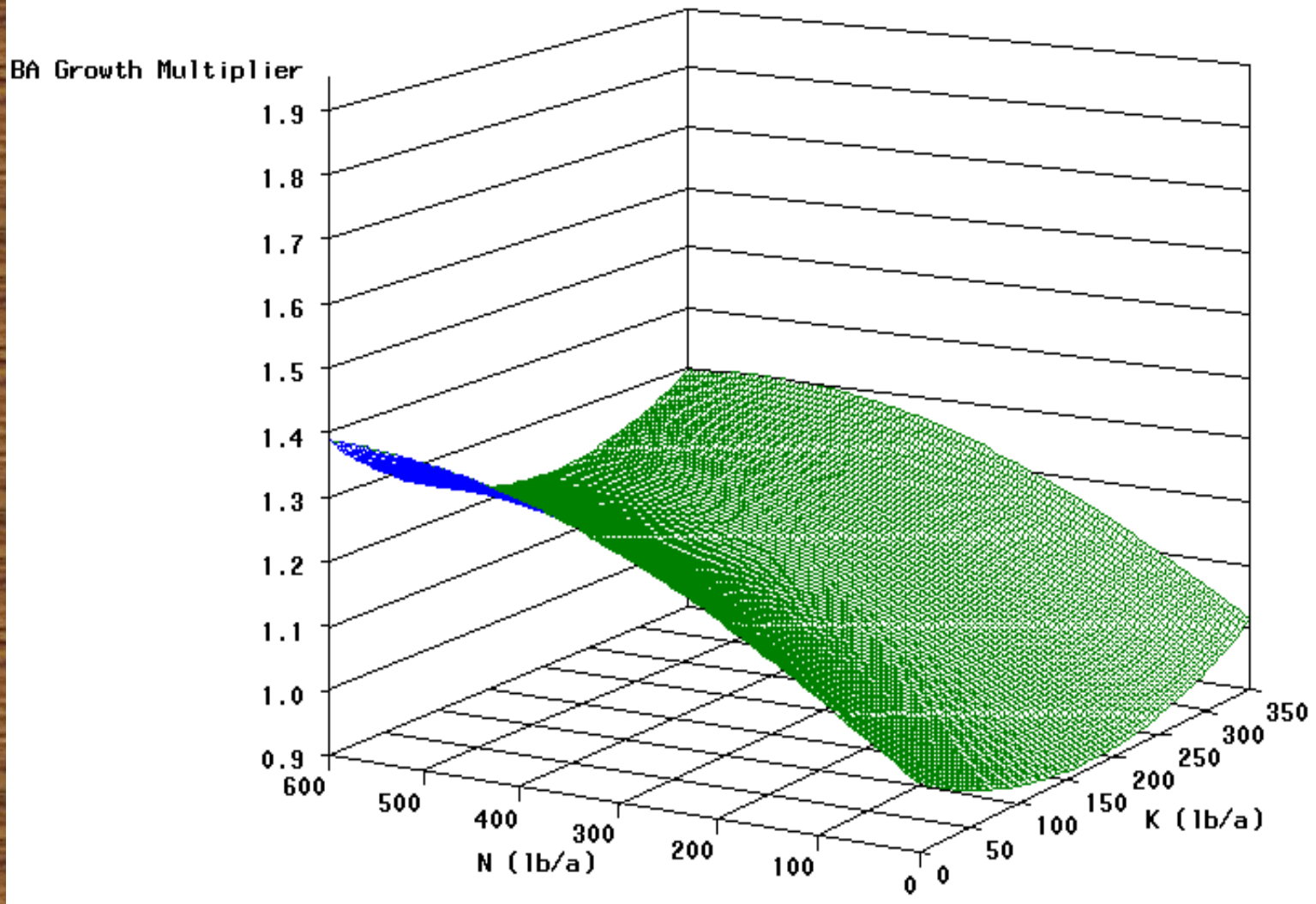
8-Year Mortality by Fertilizer Treatment



Forest Health Study
Foliar Vector Analysis Results

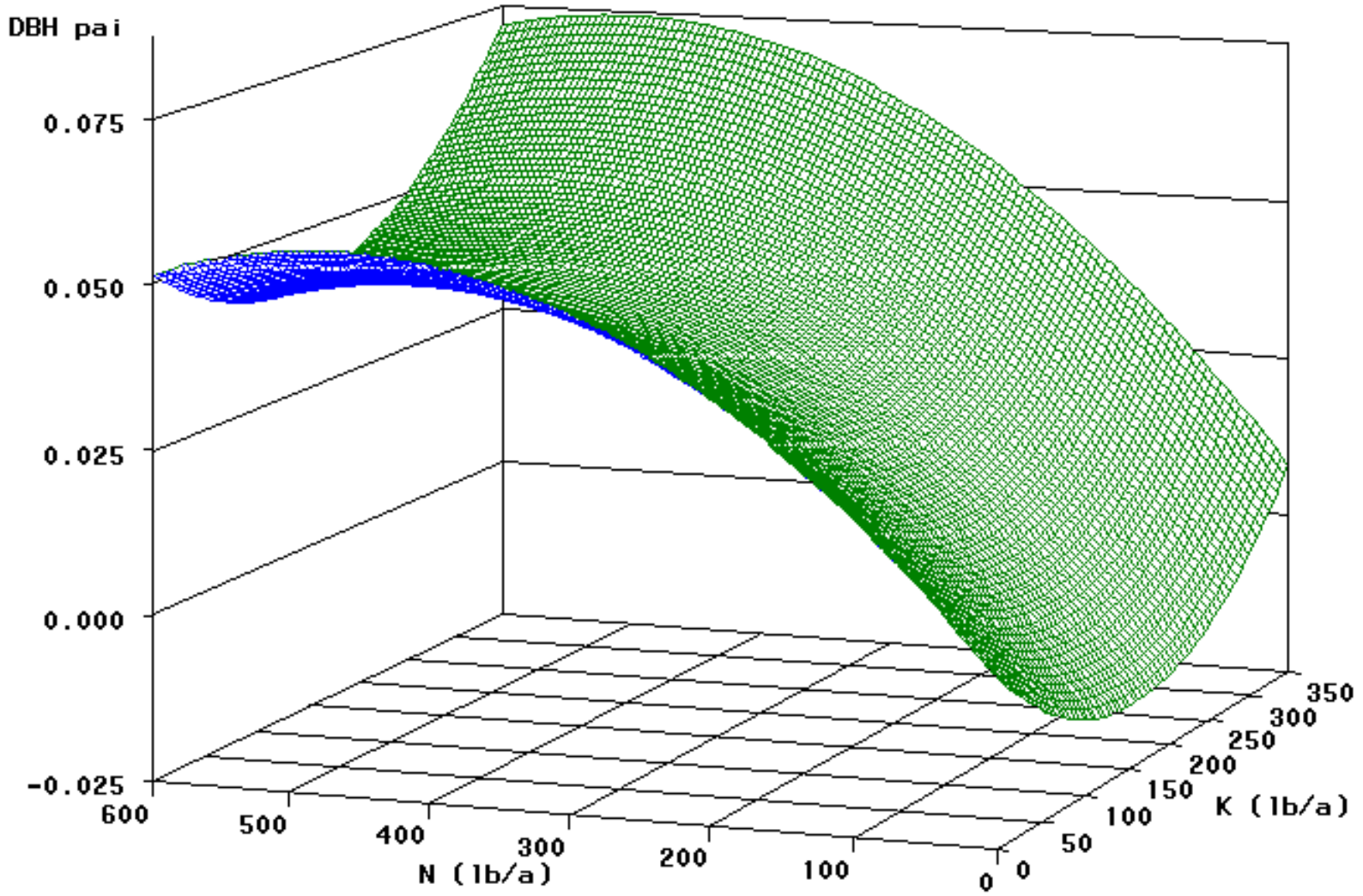
Results	Prognosis
N deficiency, even for high N application rates	Growth response to N, even at high rates
K dilution	No growth response to K expected
S deficiency	Growth response to S
No micronutrient (B, Cu, Zn, Mo) deficiency	No growth response to micronutrients

N and K Fertilizer Effects on 8–Year Gross BA Growth
Species= DF



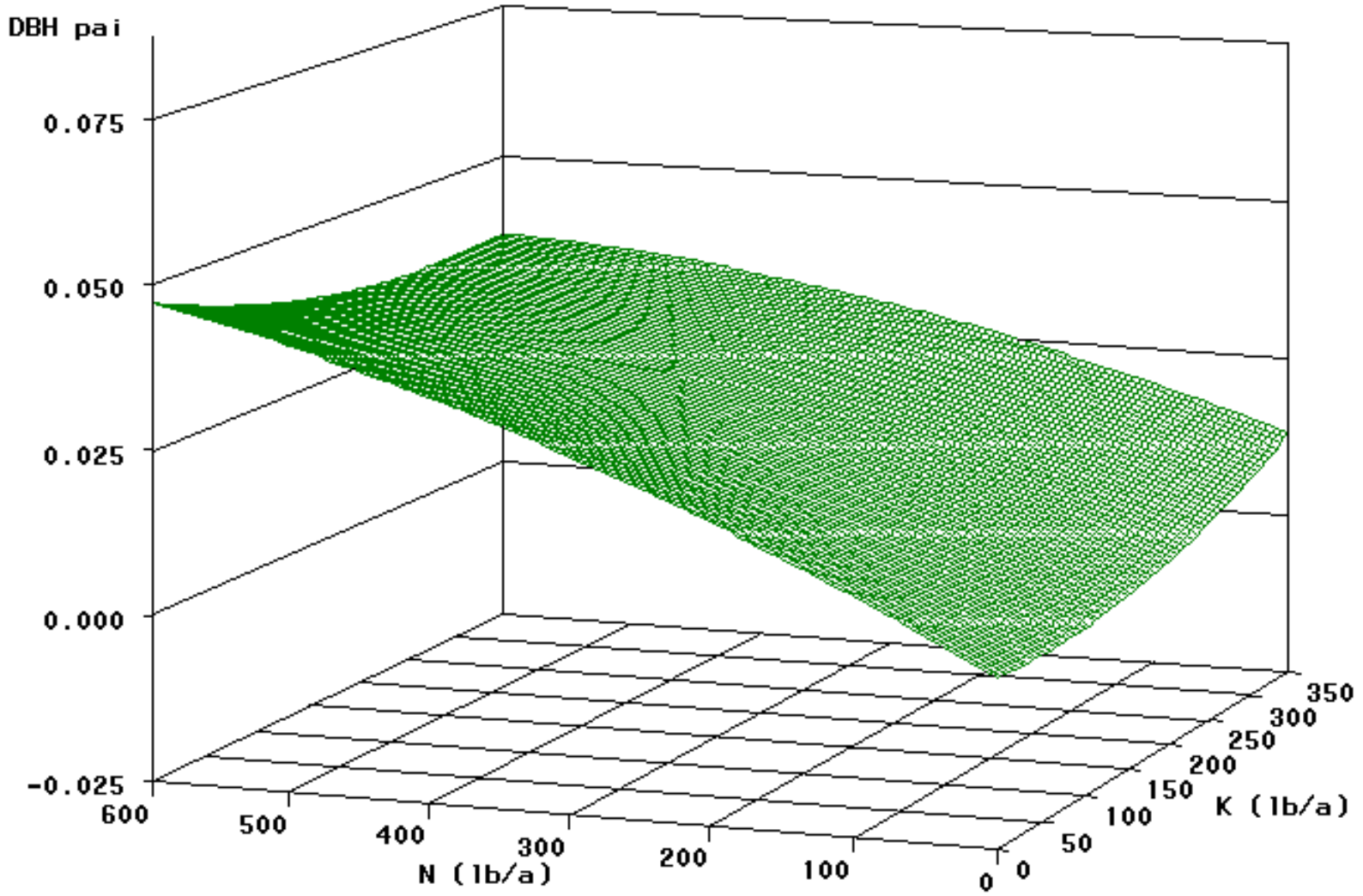
N and K Fertilizer Effects on Diameter Annual Increment

Years 1 to 4

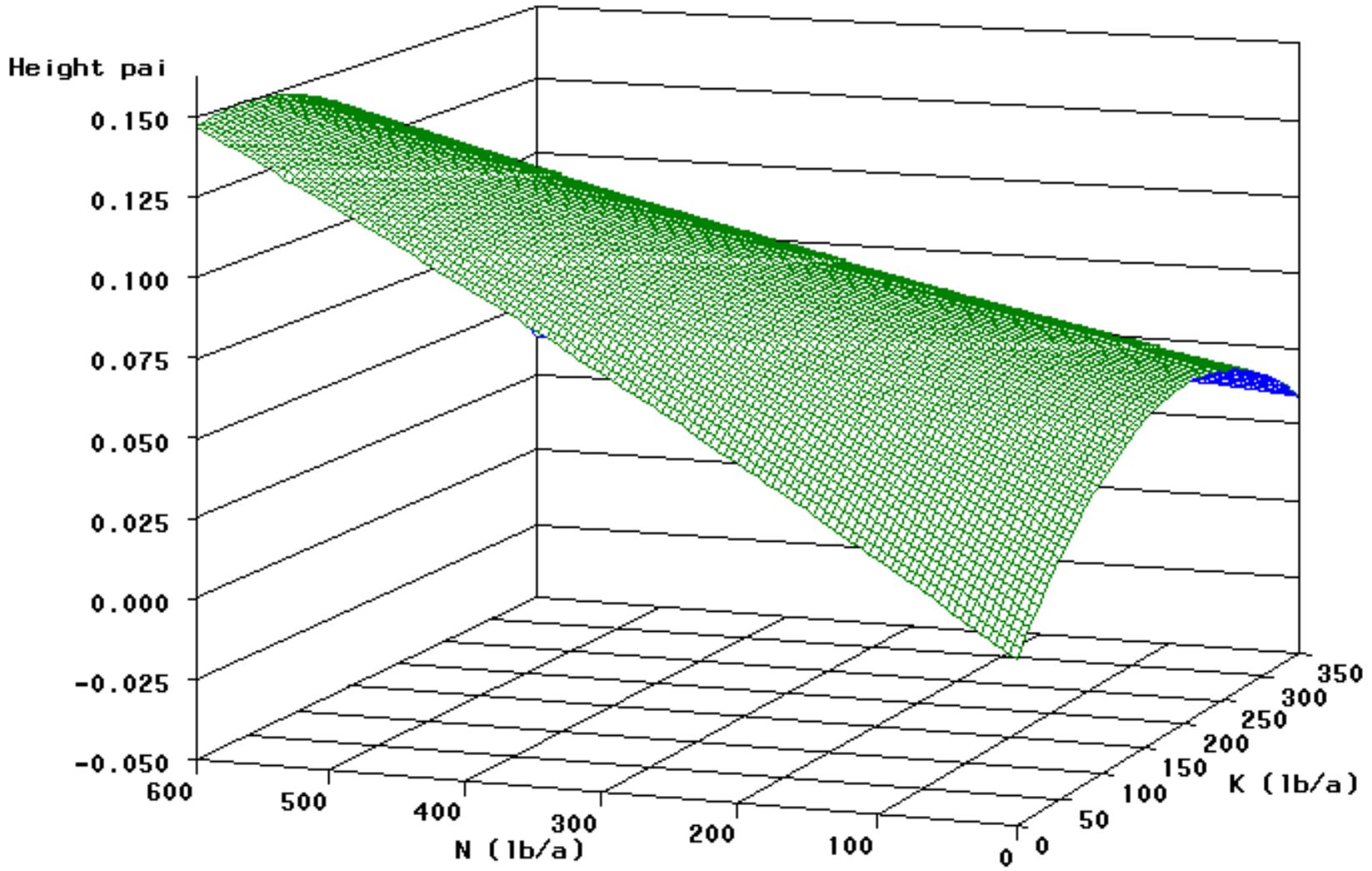


N and K Fertilizer Effects on Diameter Annual Increment

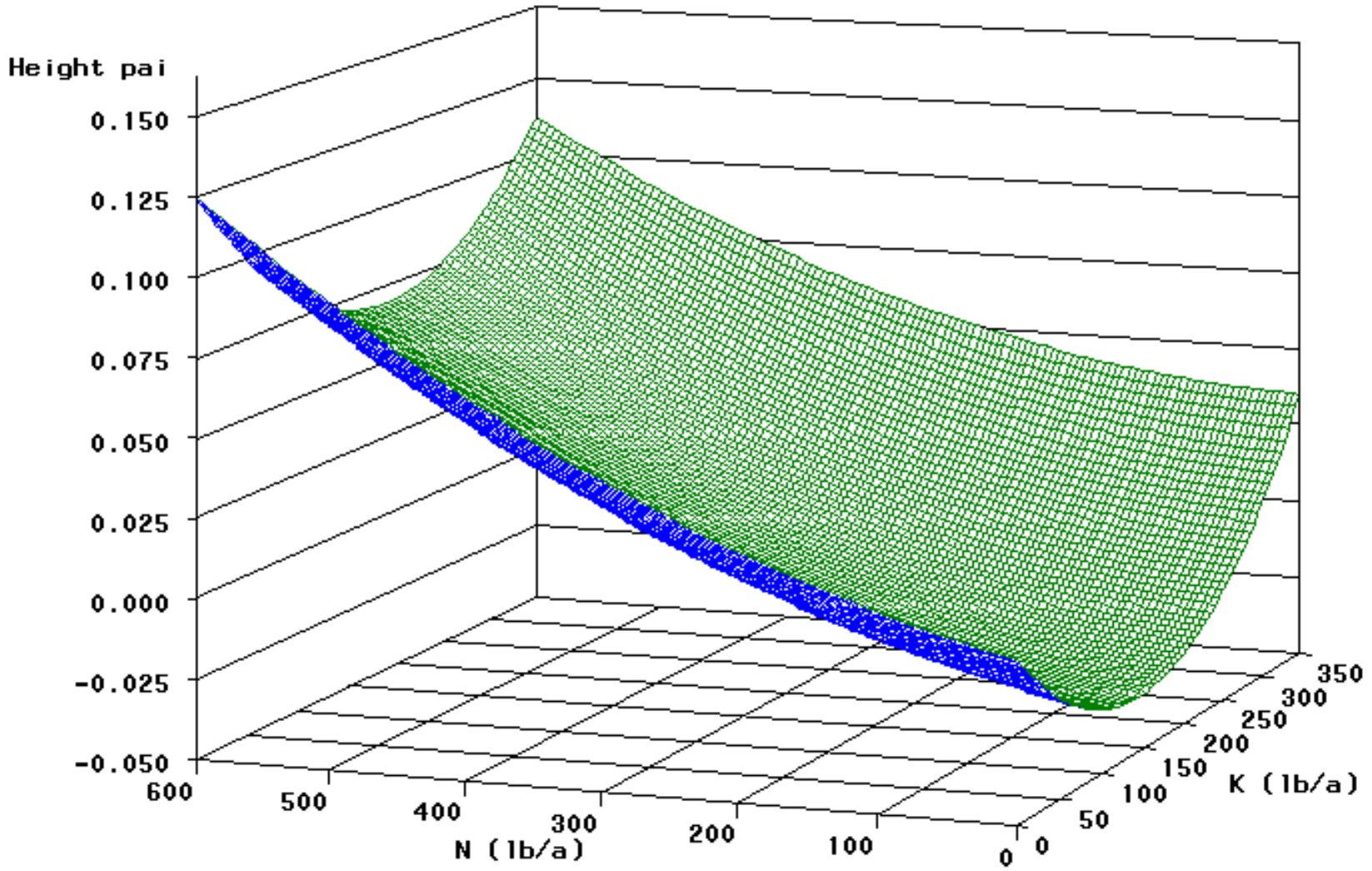
Years 5 to 8



N and K Fertilizer Effects on Height Annual Increment
Years 1 to 4



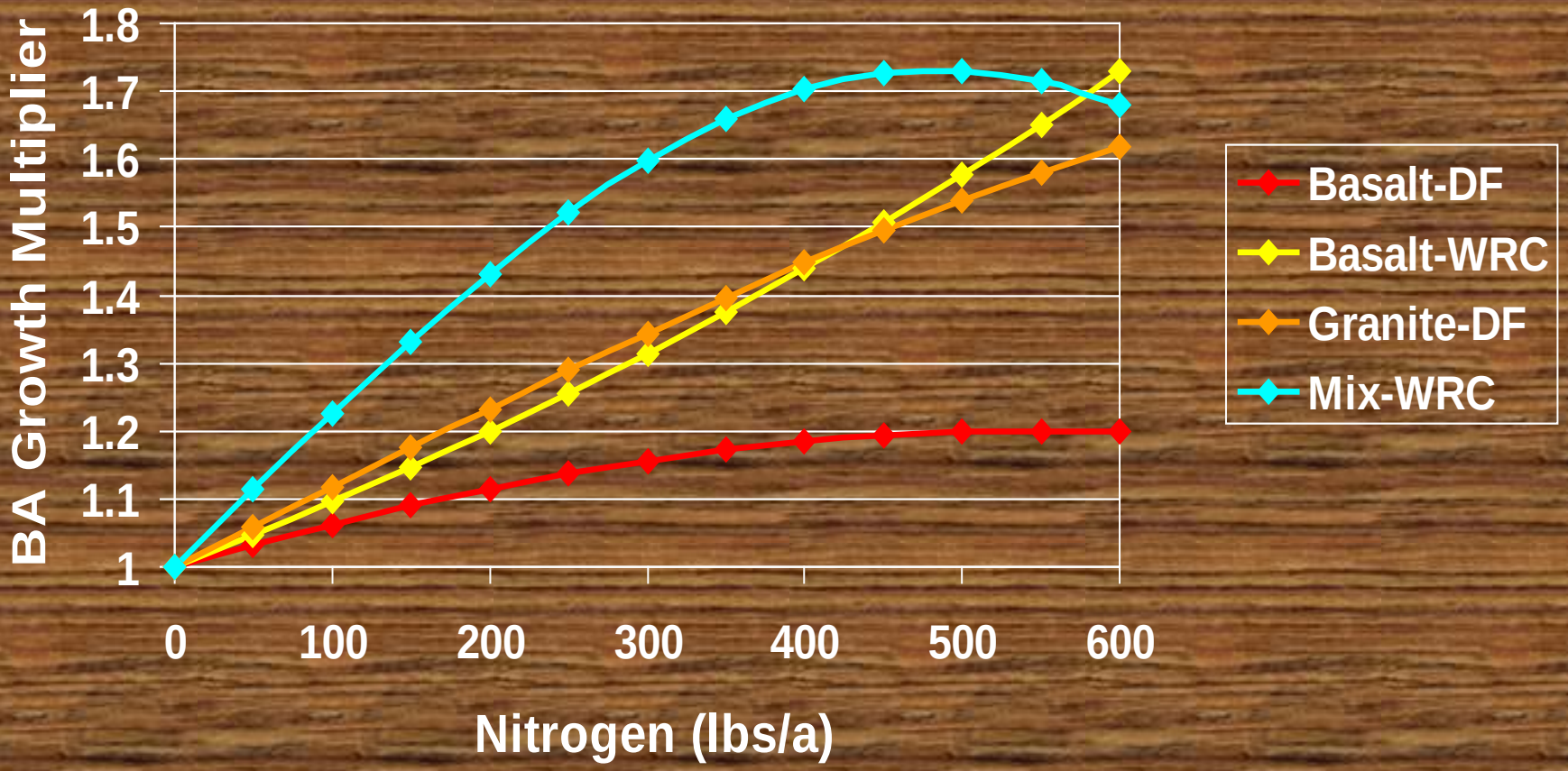
N and K Fertilizer Effects on Height Annual Increment
Years 5 to 8



Distribution of Growth Data by Rock Type and Vegetation Series

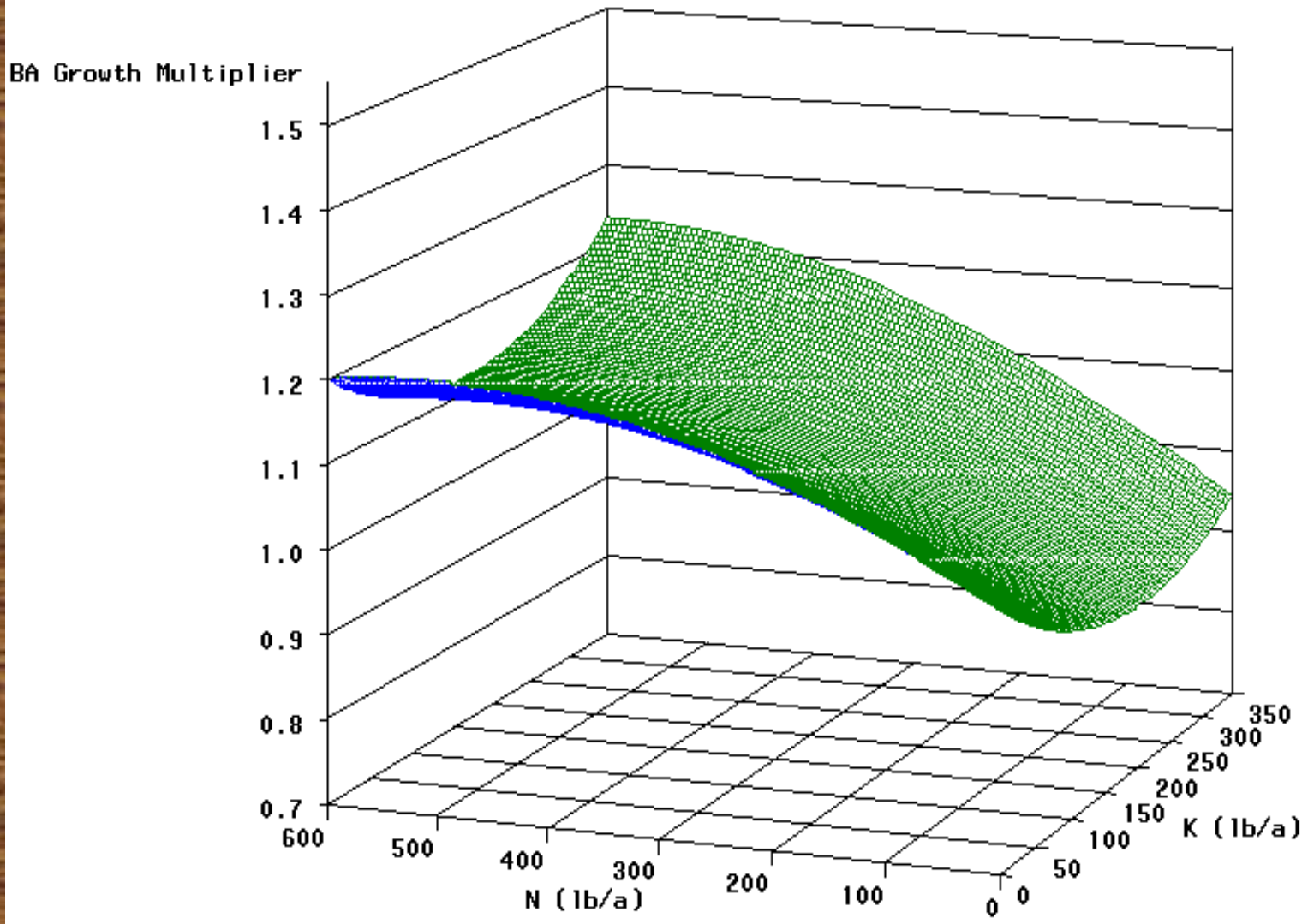
Series	Rock Type	# of Plots
DF	Basalt	35
	Granite	49
	Metasediment	0
	Mixed	7
GF	Basalt	42
	Granite	34
	Metasediment	22
	Mixed	5
WRC/WH	Basalt	35
	Granite	27
	Metasediment	35
	Mixed	35

N Fertilizer Effects on BA Growth by Rock Type and Vegetation Series



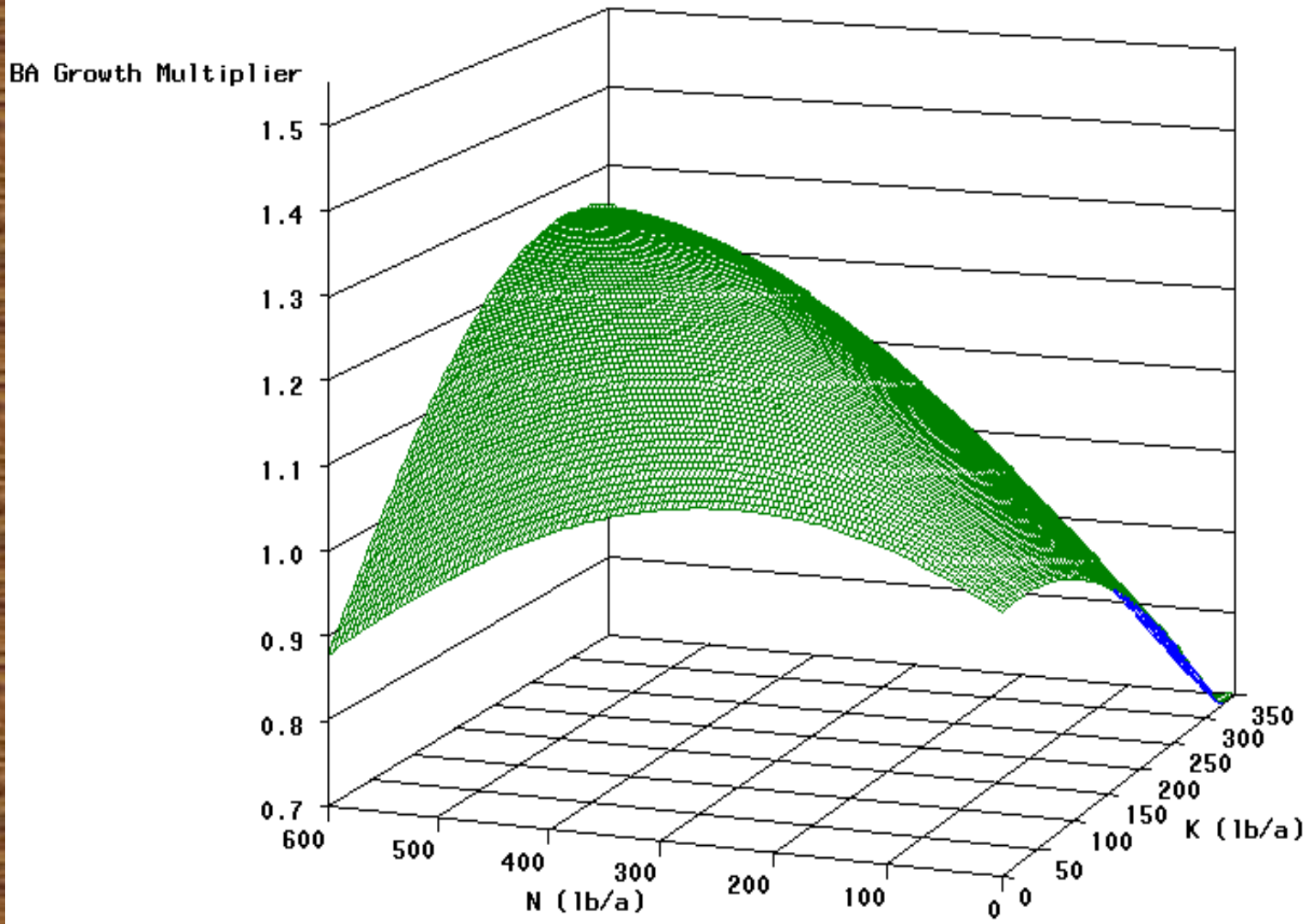
N and K Fertilizer Effects on 8–Year Gross BA Growth

Species= DF Rock Type= Basalt Vegetation Series= GF

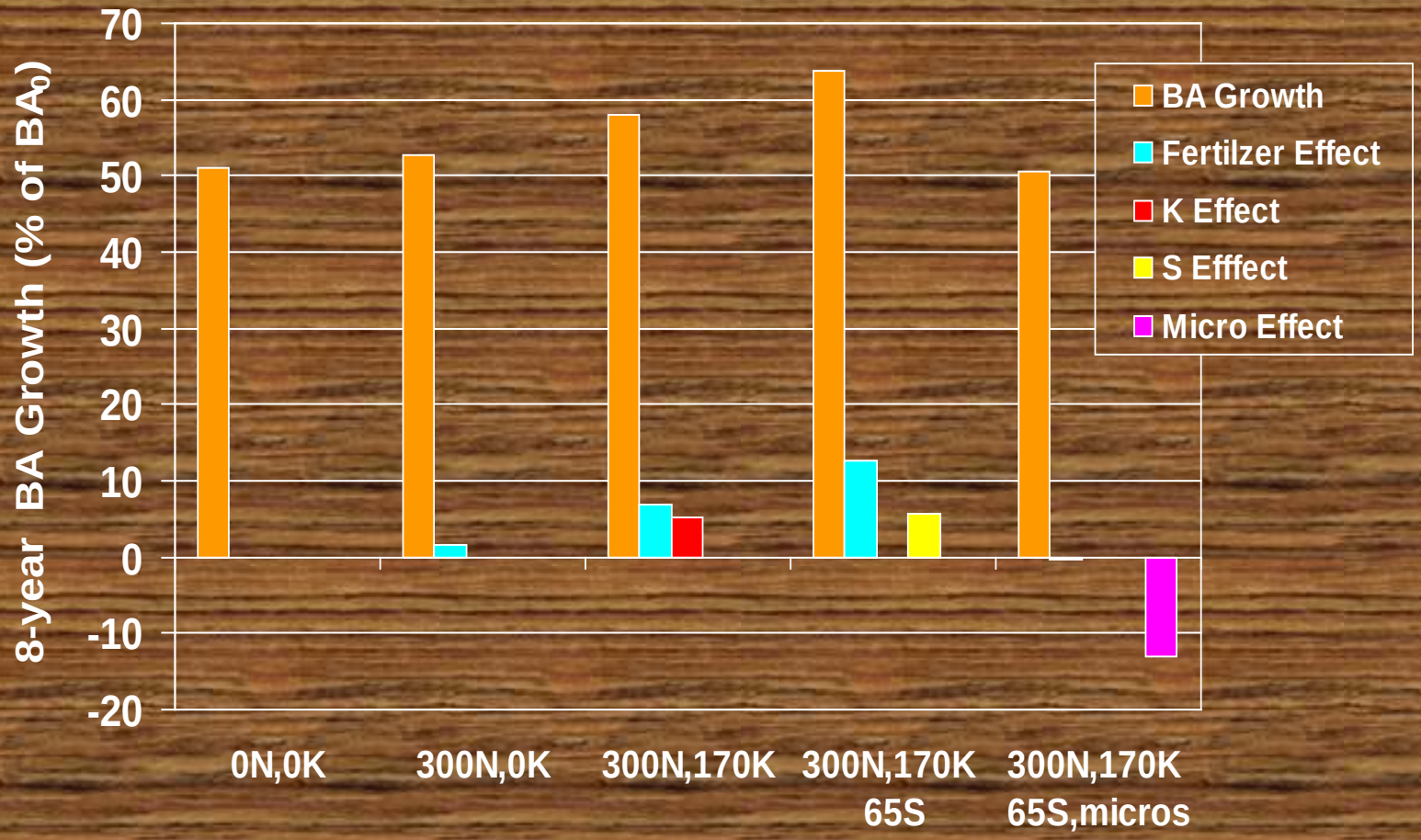


N and K Fertilizer Effects on 8–Year Gross BA Growth

Species= DF Rock Type= Metasediment Vegetation Series= WRC/WH



Sulfur and Micronutrients Effects: 8-year BA Response



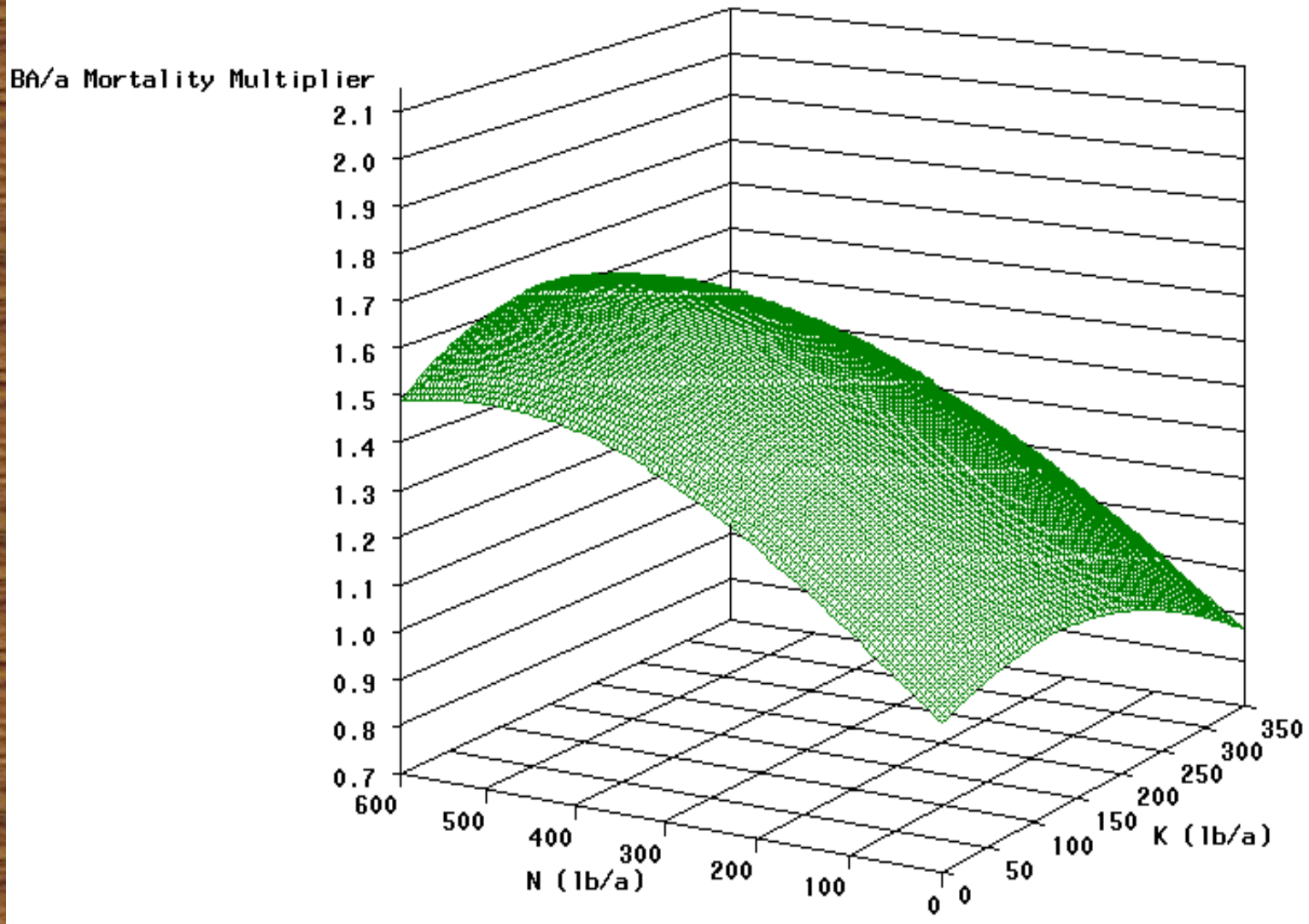
Summary of Growth Results

- Diameter and BA response were proportional to N rate at lower rates, but increases declined at N rates above 300 lbs/a. Height response did not decline at high N rates.
- Diameter and height response in the second 4 years was the same as during the first 4 years.
- K fertilizer additions affected growth, but the magnitude was small and was most evident in the first 4 year period.
- N and K effects varied by rock type and vegetation series.
- SO_4 increased the growth response, but micronutrients did not.

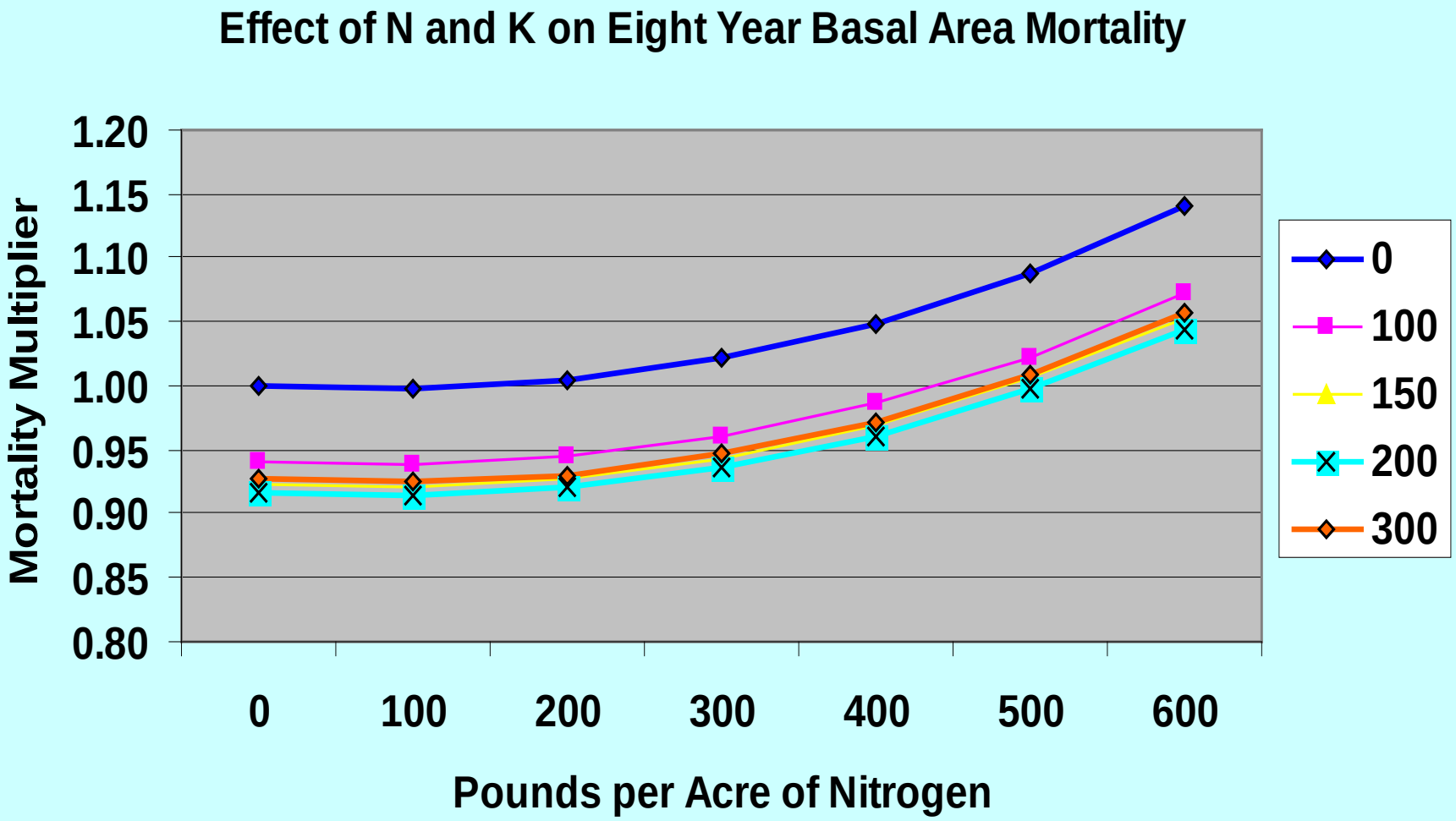
Causes of Mortality

N and K Fertilizer Effects on 8–Year BA/a Mortality

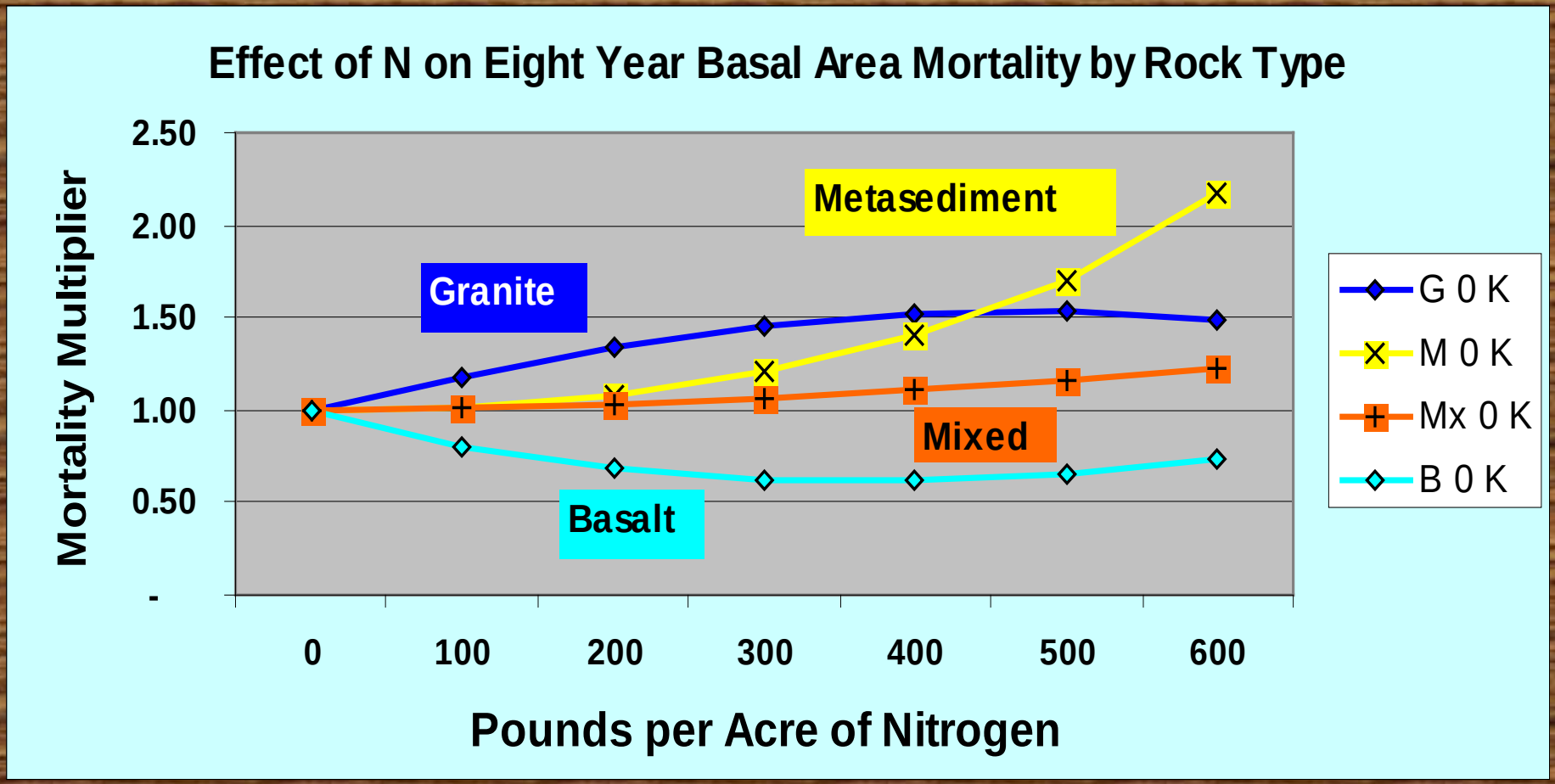
Species = DF



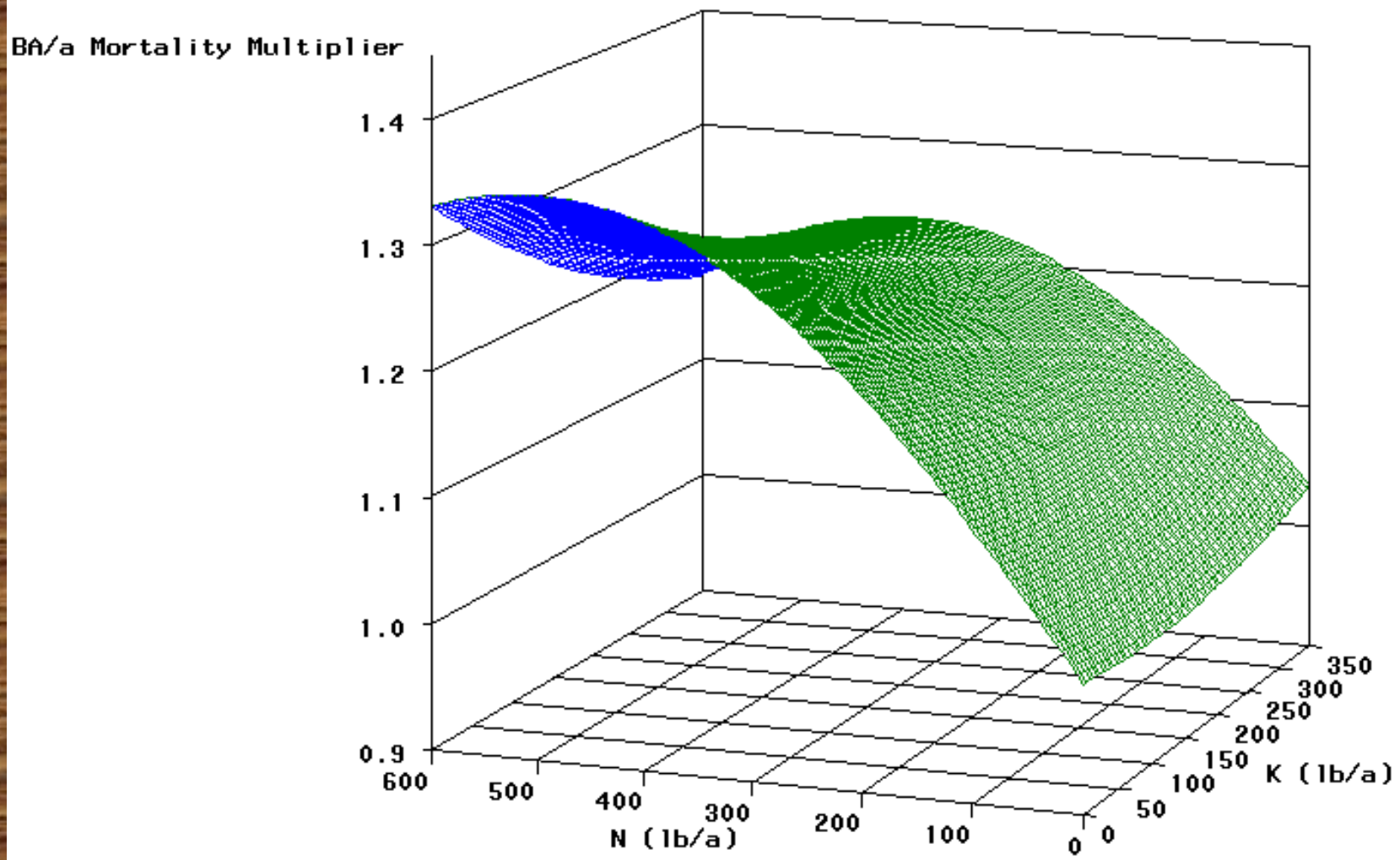
Overall Basal Area Mortality



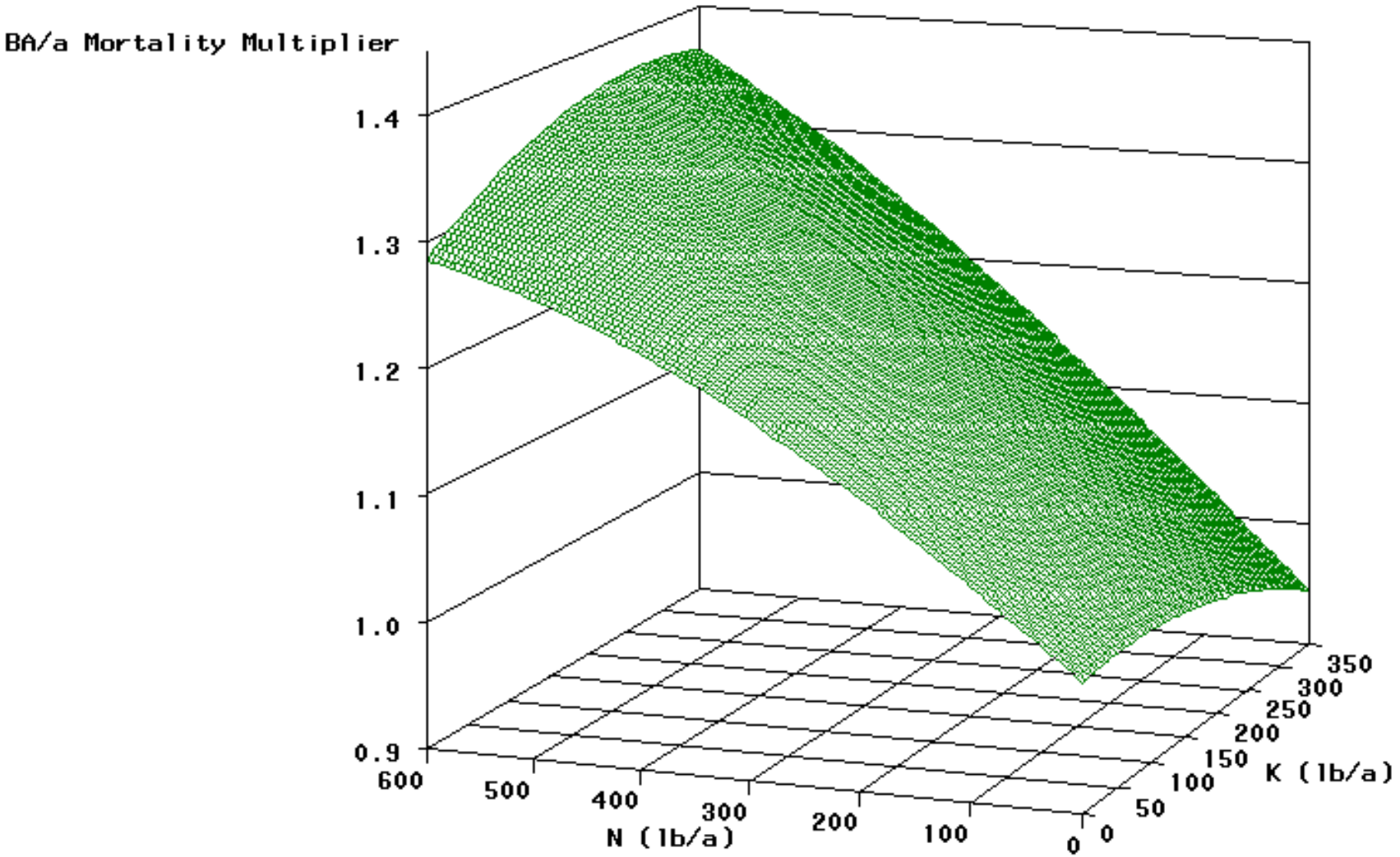
Basal Area Mortality
(No Potassium)



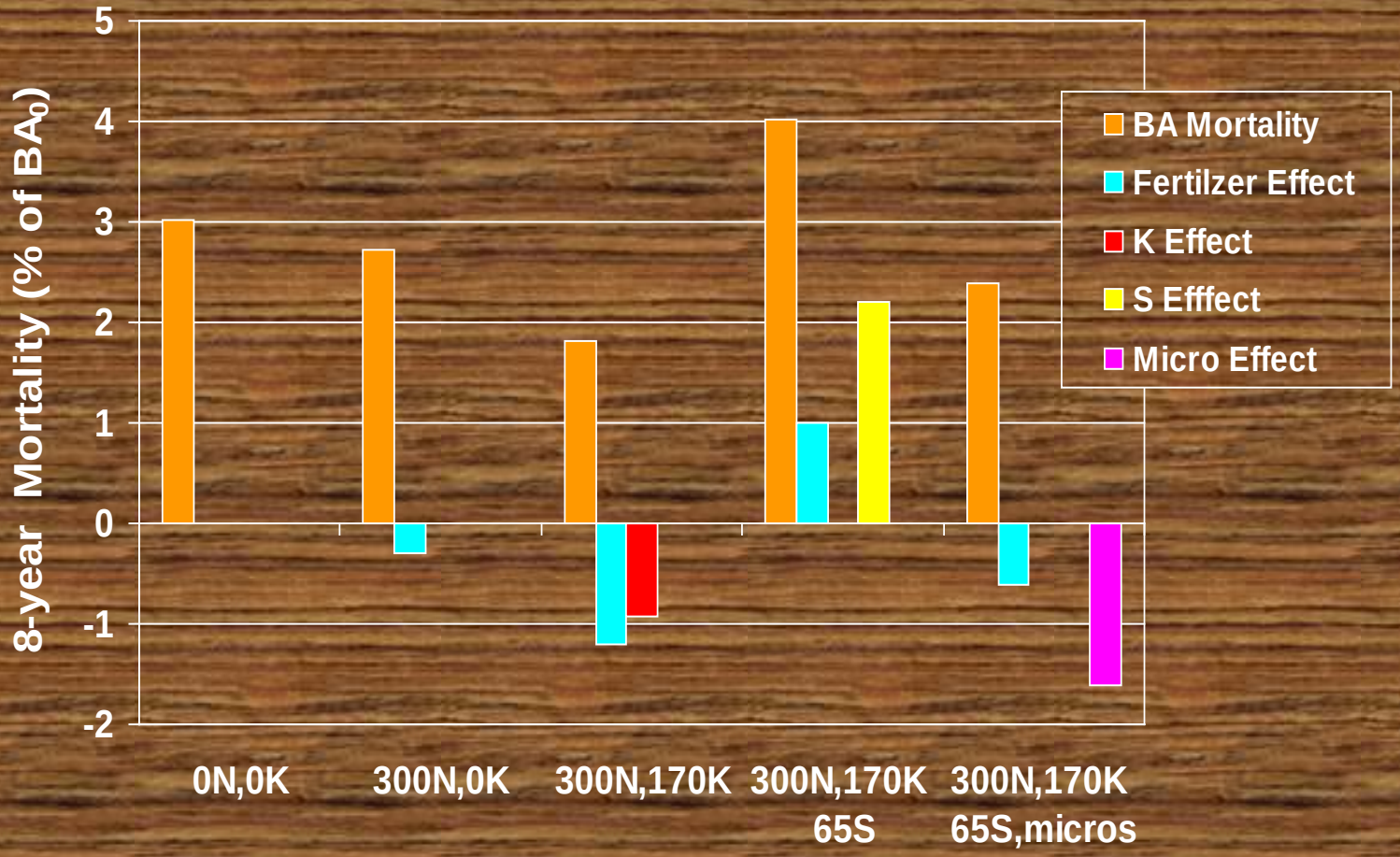
N and K Fertilizer Effects on 8–Year BA/a Mortality from Disease



N and K Fertilizer Effects on 8–Year BA/a Mortality from Weather



Sulfur and Micronutrients Effects: 8-year BA Mortality



Summary of Results: Mortality

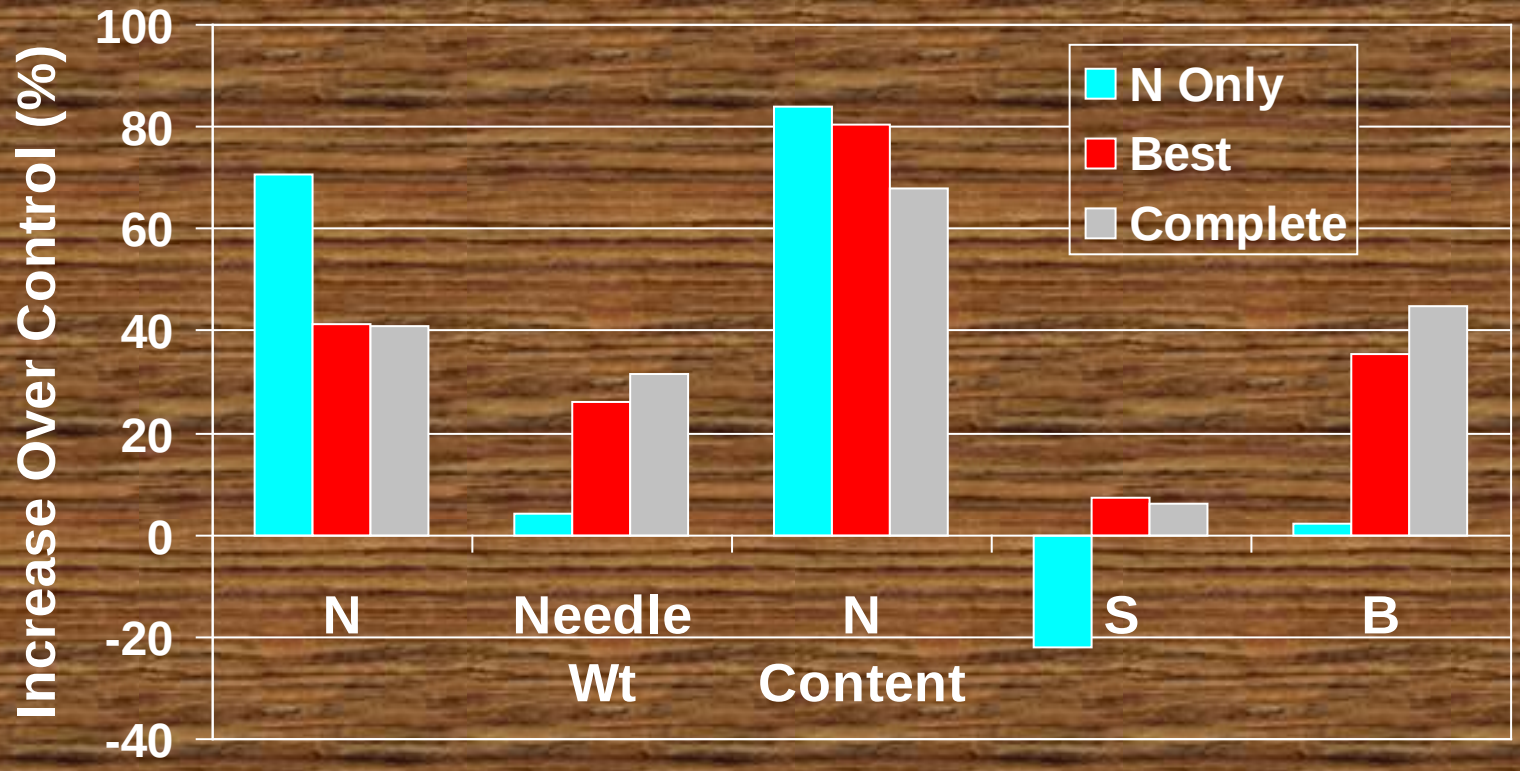
Response was proportionate to N rate at lower rates, but increases declined at N rates above 300 lbs./a

K fertilizer additions appeared to decrease mortality, at least at higher K rates. Disease-caused mortality seems to be the portion affected.

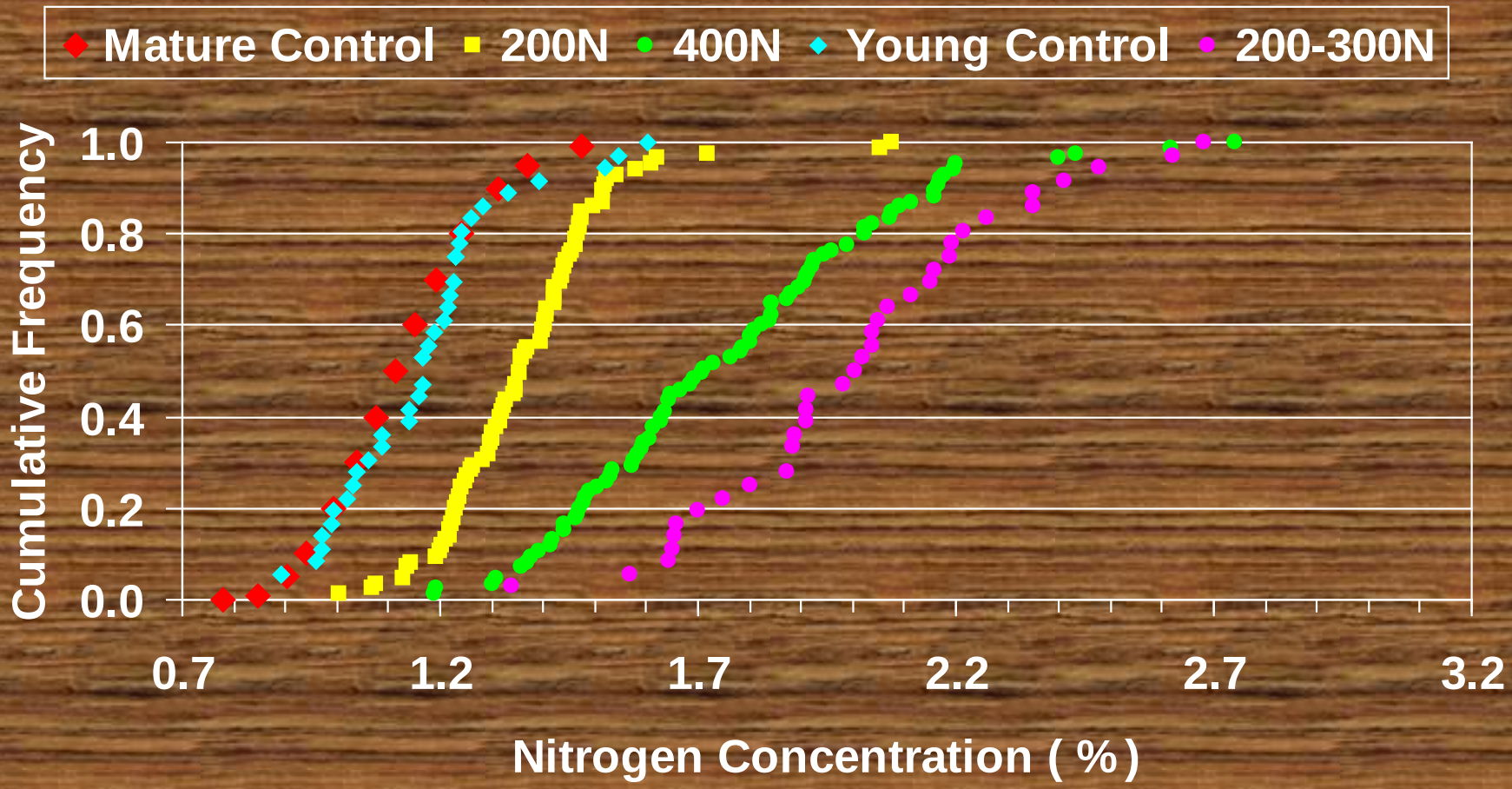
SO_4 increased mortality, micronutrients lowered it

Rock type and vegetation series both influenced background mortality rates, but fertilizer effects only differed by rock type. On basalt, N fertilizers do not affect mortality. On granite and metasediment, mortality increases as the N rate increases and declines with the addition of K at high rates. Mixed rock type sites follow similar patterns to granite and metasediment, although mortality rates are lower

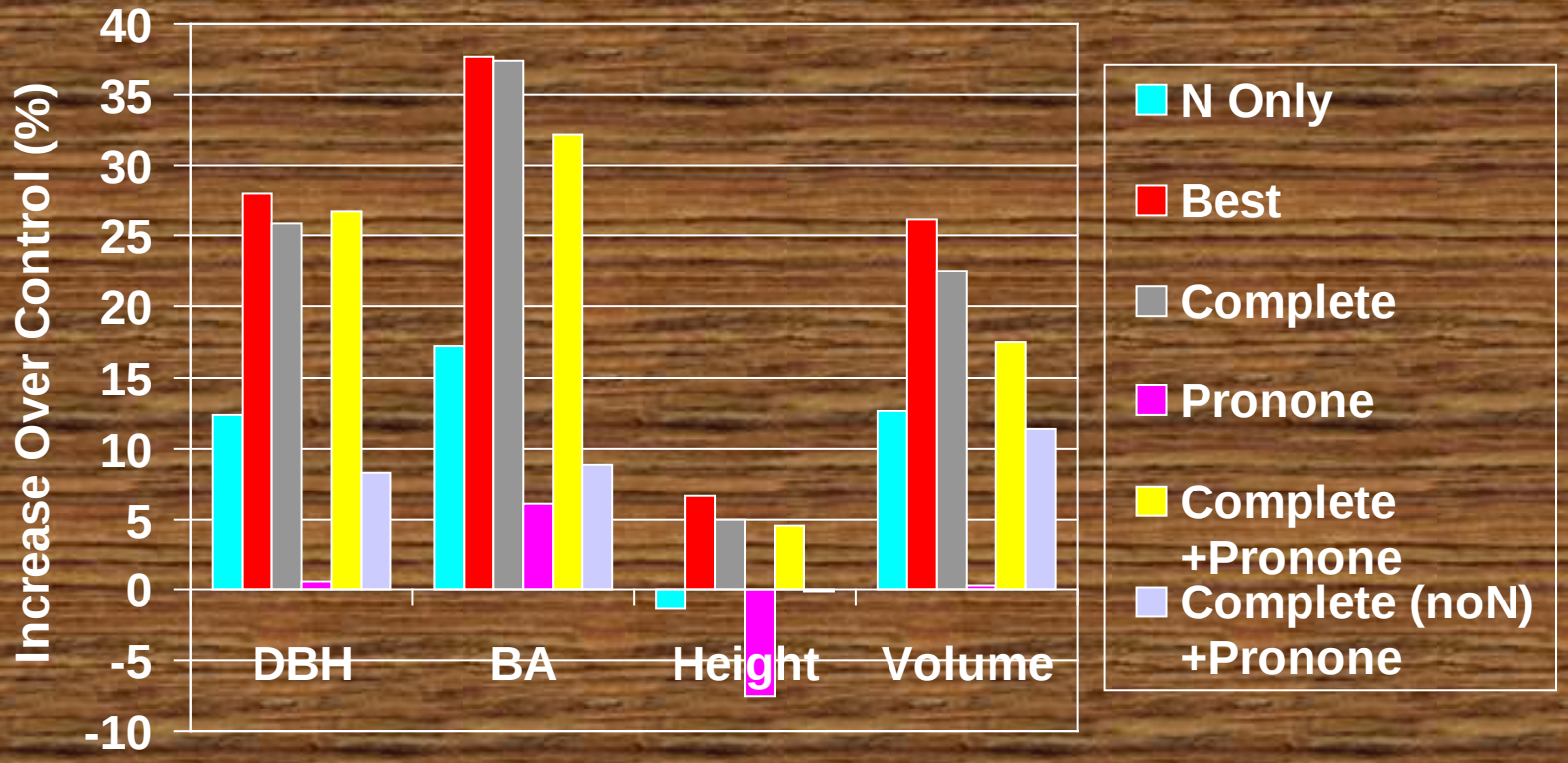
Fertilizer Treatment Effects on Foliar Characteristics for DF



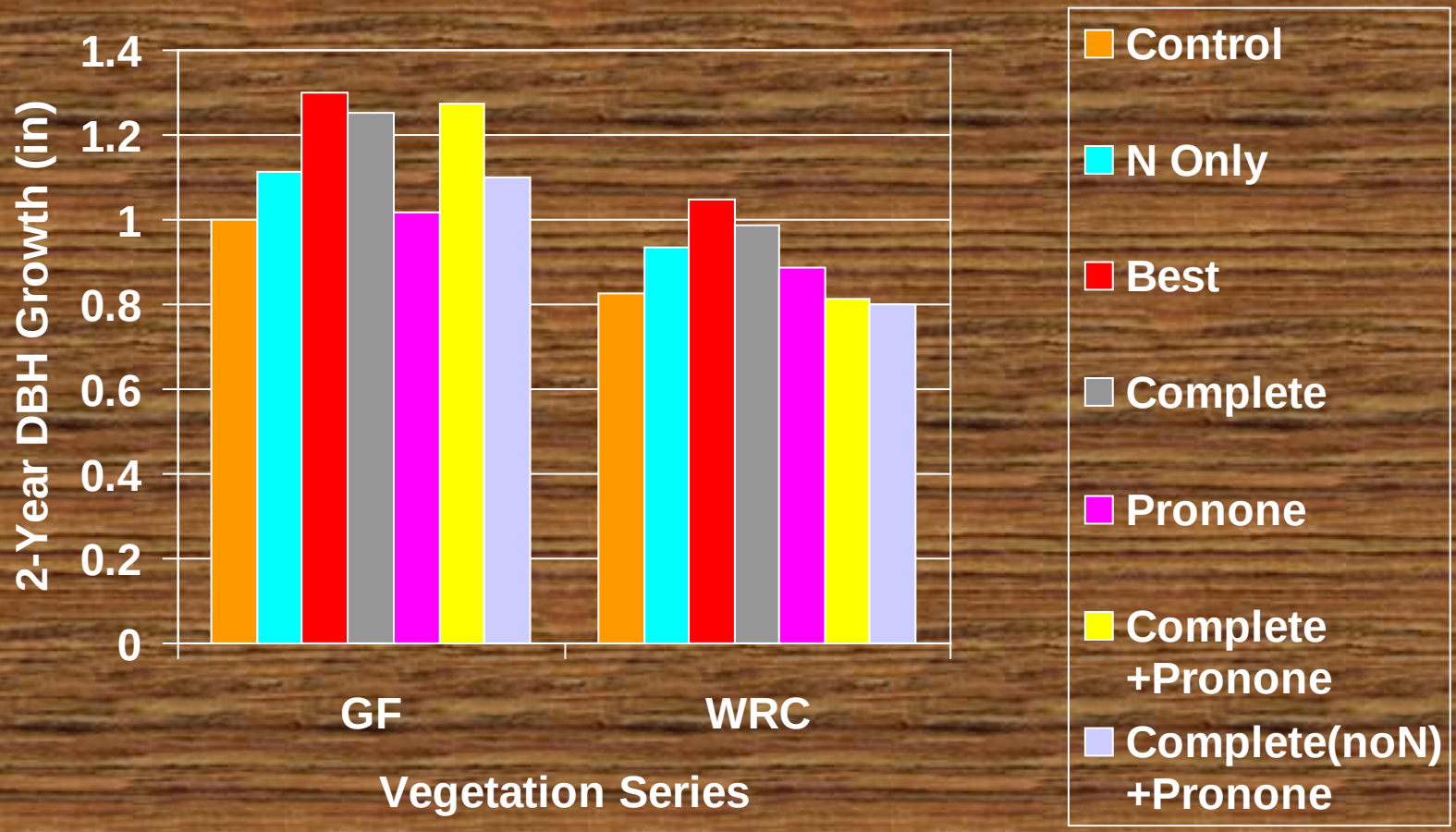
Distribution of Foliar N Concentration for Douglas-fir



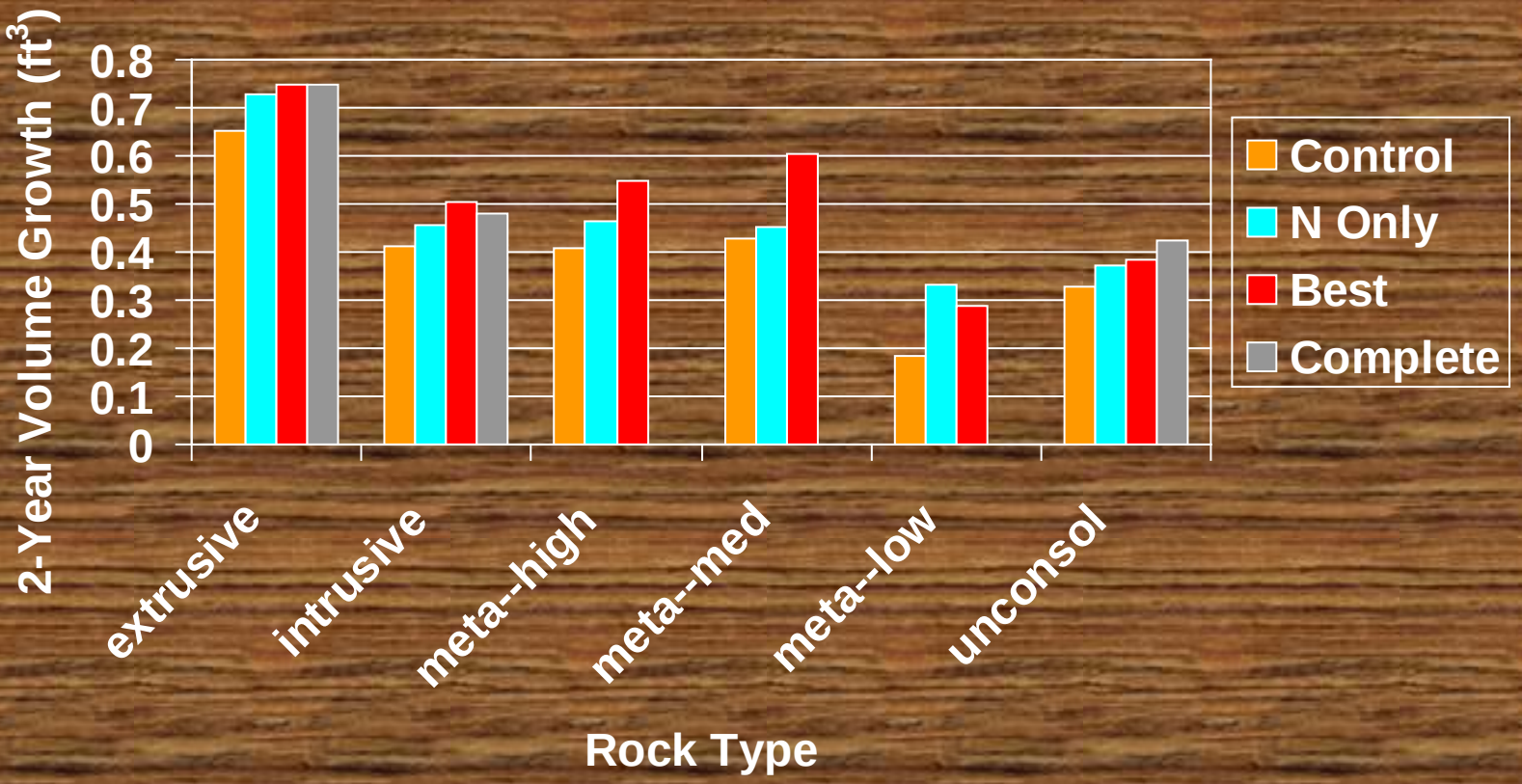
Treatment Effects on 2-Year Growth for Douglas-fir



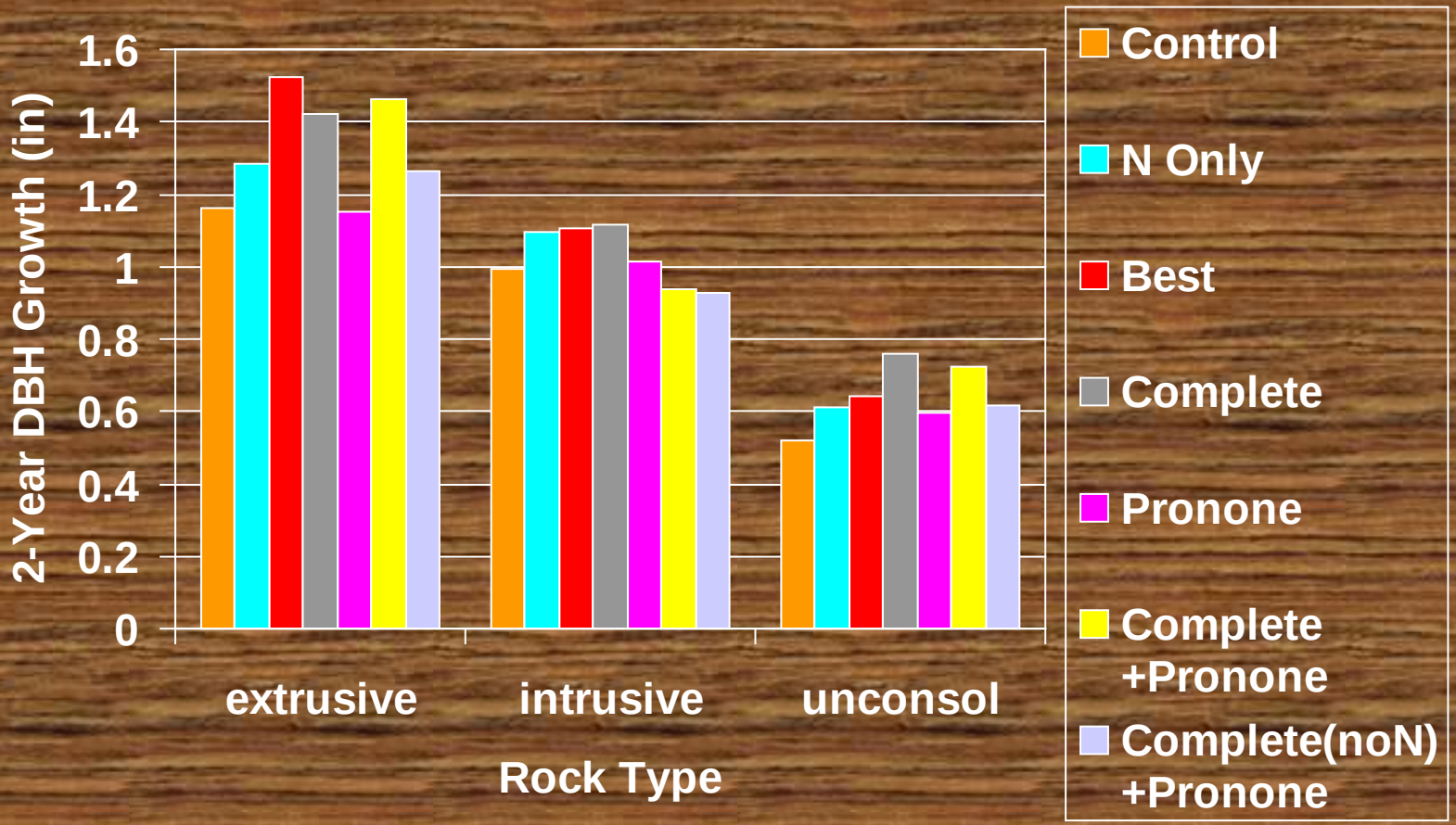
Fertilizer Treatment Effects on 2-Year DBH Growth by Vegetation Series Douglas-fir



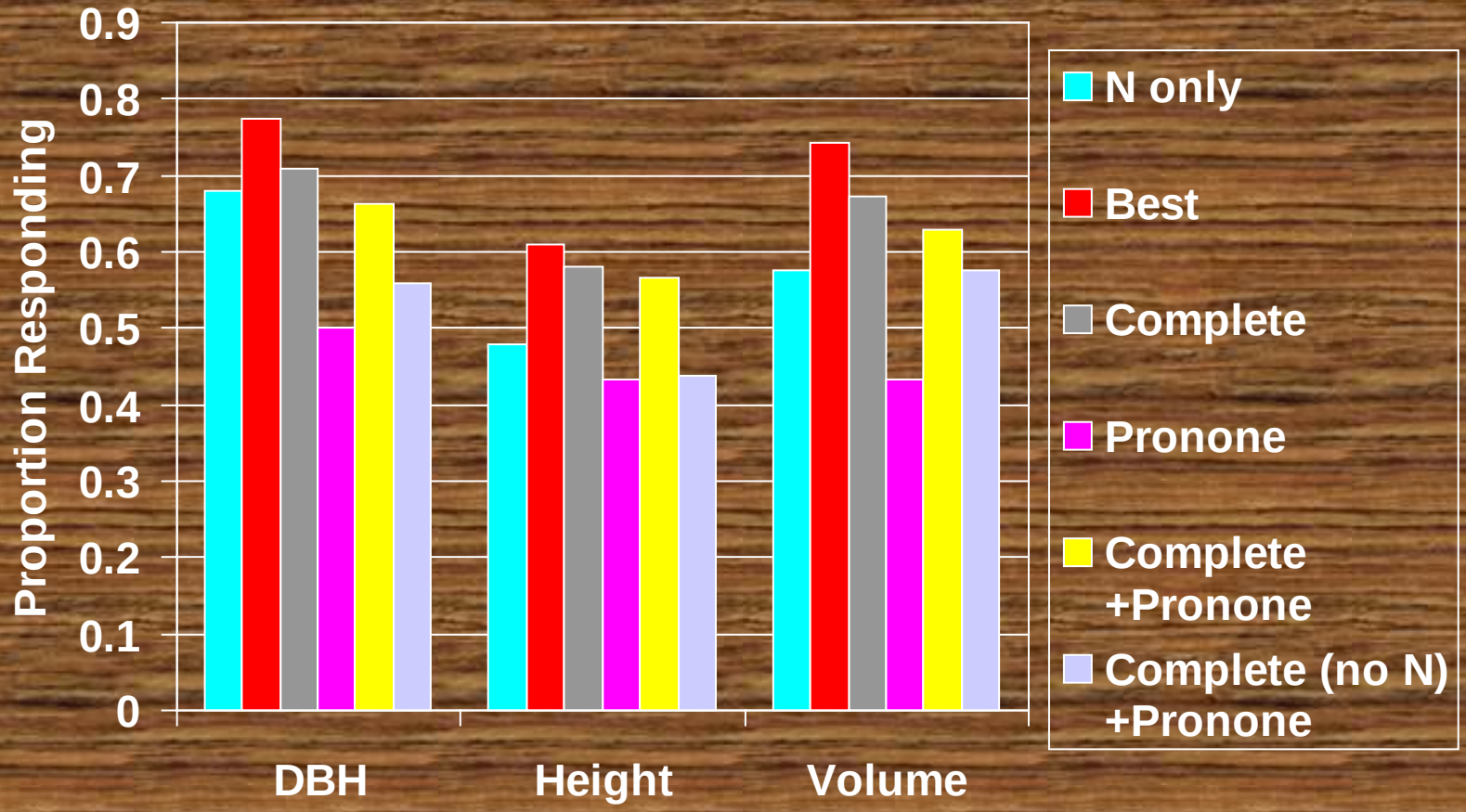
Fertilizer Treatment Effects on 2-Year Volume Growth by Rock Type Douglas-fir



Treatment Effects on 2-Year DBH Growth by Rock Type Douglas-fir



Proportion of Trees Responding By Treatment



General Conclusions

- Douglas-fir throughout the Inland Northwest is deficient in N. N fertilization brings consistent foliage response, less consistent growth response, and usually increased mortality.
- When N fertilizer is applied, addition of S and B to the fertilizer mix increases both the magnitude and proportion of response. Mortality may also be reduced.
- K additions to the fertilizer mix have produced mixed results—sometimes a growth gain and often a reduction in mortality. Interpretation is further clouded by lack of a classic foliar deficiency reaction.
- Rock type and vegetation series have strong influence on background growth and mortality rates, but less on fertilizer response.