Responses of flue-cured tobacco to the fertilization of phosphorus on sandy soils in South Africa

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Determination of plant-available P :

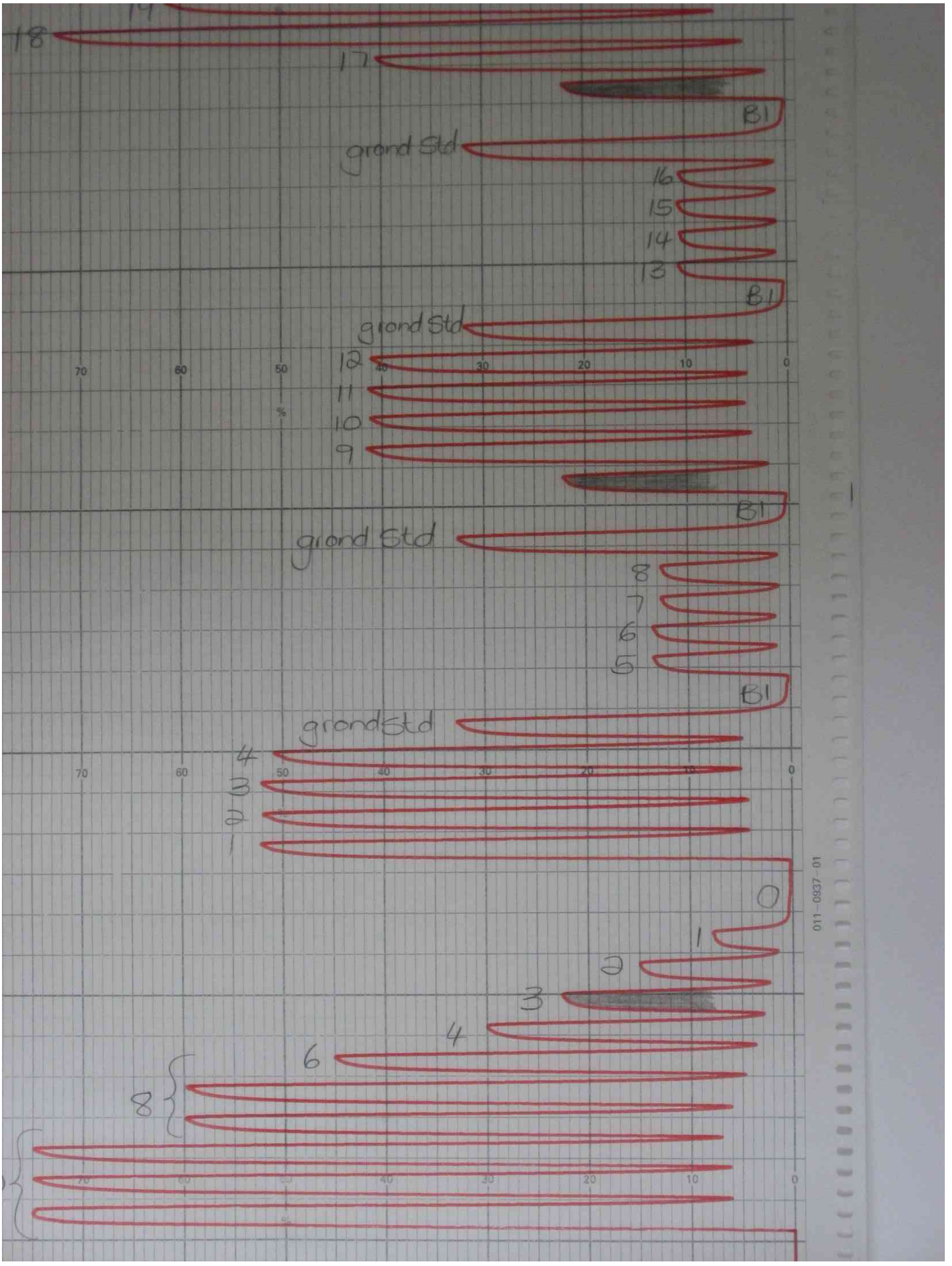
Bray 2 Extractant : 0.1 M HCl / 0.03 M NH_4F

- **8 grams soil + 60 ml Bray 2 extractant ~ (1: 7.5)**

  In erlenmeyer flask – swirl (40 seconds)~ filter

- **Analyse by segmented flow analyzer :**

1-amino-2-naphthol-4 sulfonic acid & ammonium molybdate/H2SO4

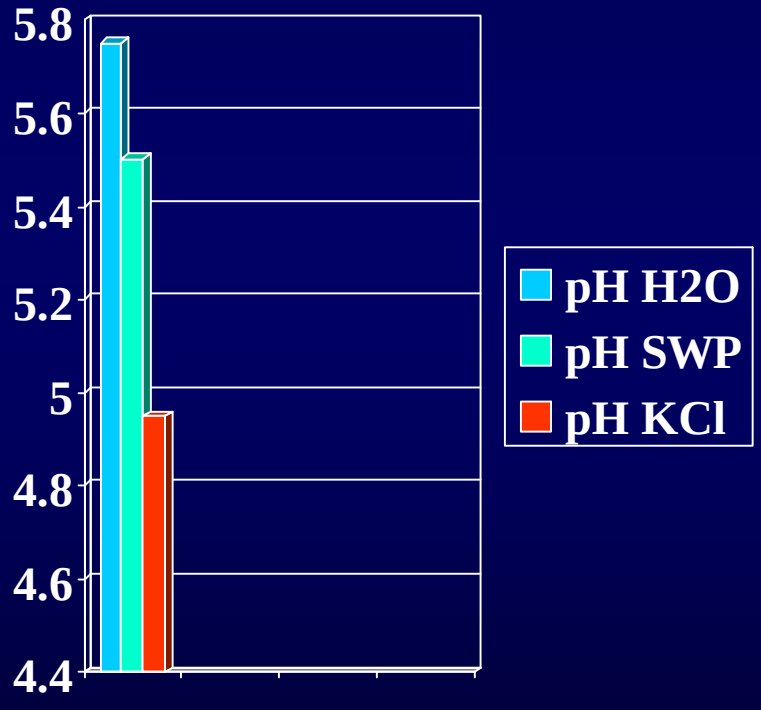


Soil reaction : .....

- As measured by

pH

- $- \log [H^+]$



pH (SWP) vs. the accessibility of P

- pH 7.9 … PO_4^{---}
- pH 7.5 … PO_4^{---}
- pH 7.1 … HPO_4^{--} PO_4^{---}
- pH 6.7 … HPO_4^{--} $H_2PO_4^{-}$
- pH 6.2 … HPO_4^{--} $H_2PO_4^{-}$
- pH 5.8 … $H_2PO_4^{-}$
- pH 5.5 … $H_2PO_4^{-}$
- pH 4.9 … $H_2PO_4^{-}$ $AlPO_4$

Crop response vs. P-status of soil

Bray 2 extractable P mg / kg (ppm)	Expectation
0 -12	Yes
13 -24	Probable / Likely
25 - 35	Improbable / Unlikely
> 35	None

Fertilization of Phosphorus (P) ! ! ? ?

- Why not fertilize according to the guidelines ?
- Is it because of doubt ?
- Is it because of people that say that phosphate is “fixed”, or that “freshly” applied P always be seen as beneficial ?

Demonstration plot
(Naboomspruit – 2005/2006)

Sandy soil - (Bray 2 extractable P: 45 mg/kg) :

Farmer was to apply 44 kg P/ha by band placement of 200 kg MAP(33)/ha

- **44 kg P/ha**
- **22 kg P/ha**
- **0 kg P/ha**

Sampling procedure
(on each of the three treatments)

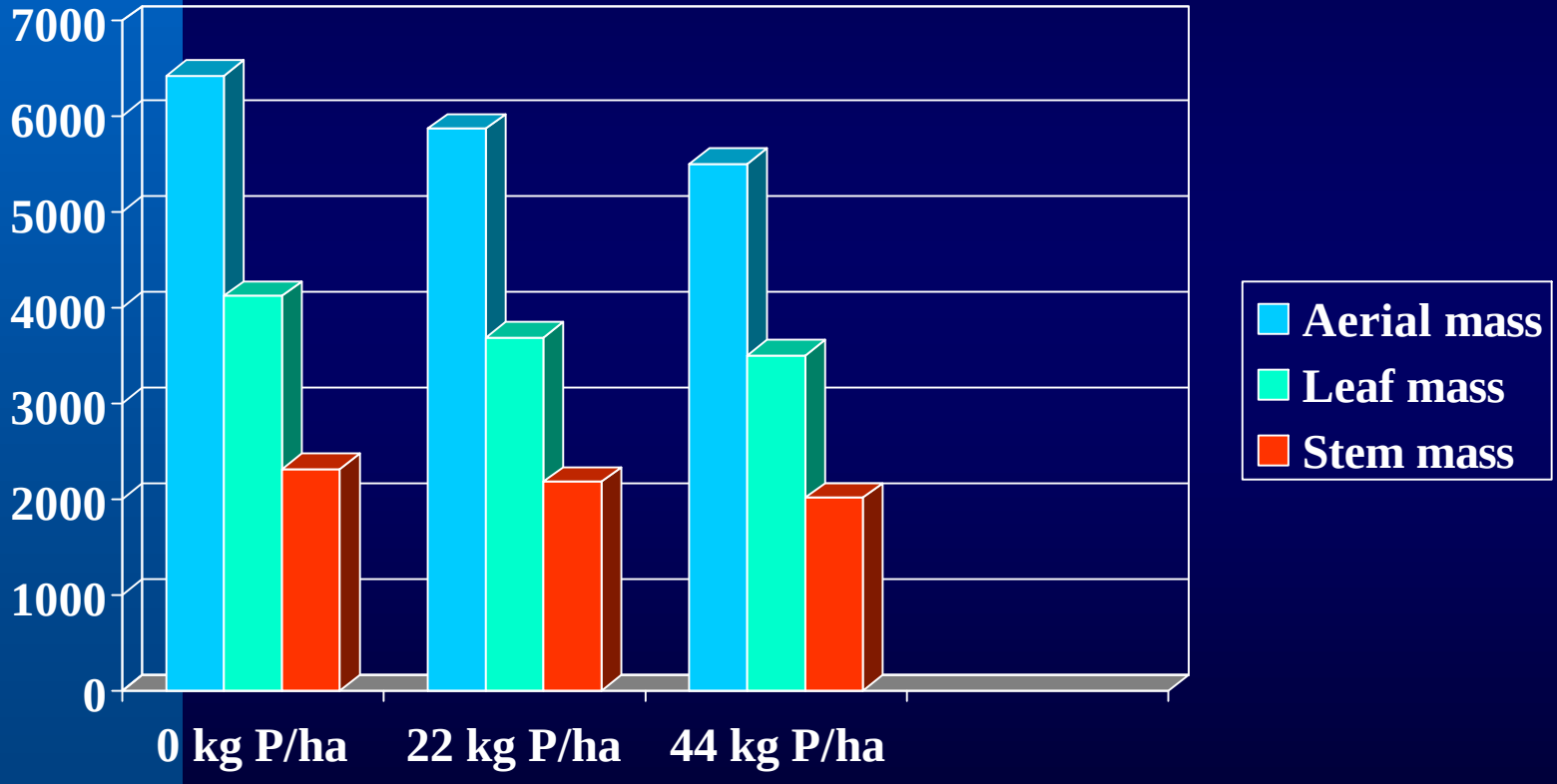
Stage			Plant division					
Weeks after planting	Plants sampled		Whole plant	Lower leaves	Middle leaves	Upper leaves	Stem	Number of samples
12-13	4		0	4	4	4	4	16

16 samples X 3 treatments = 48 samples

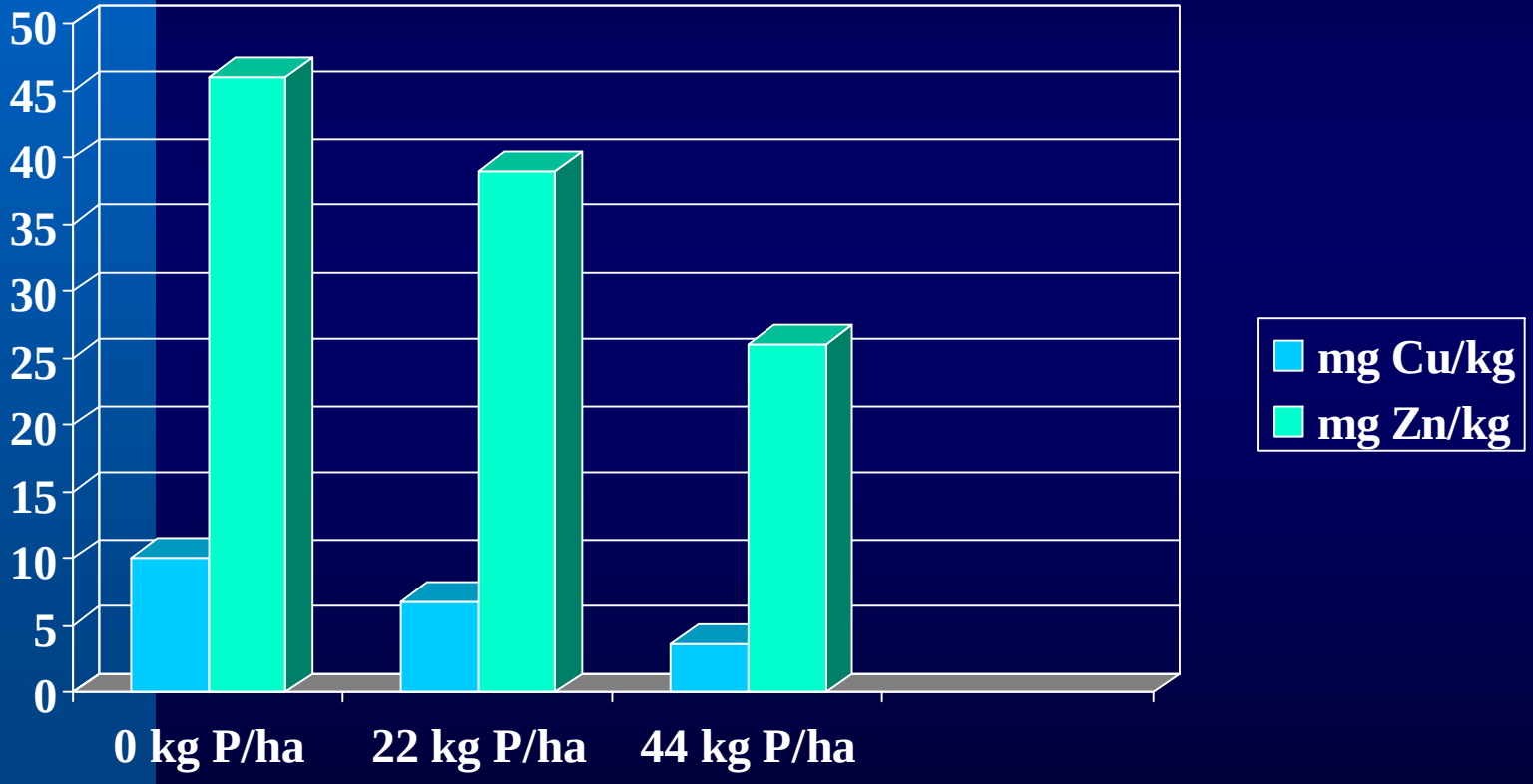
- **Washed with de-ionized water & dried (60^0 C)**
- **Dry mass determined**
- **Ground / milled**
- **Analyzed by standard methods for nutrient content**

(N, P, K, Ca, Mg, Cl, Fe, Cu, Zn, Mn, & B)

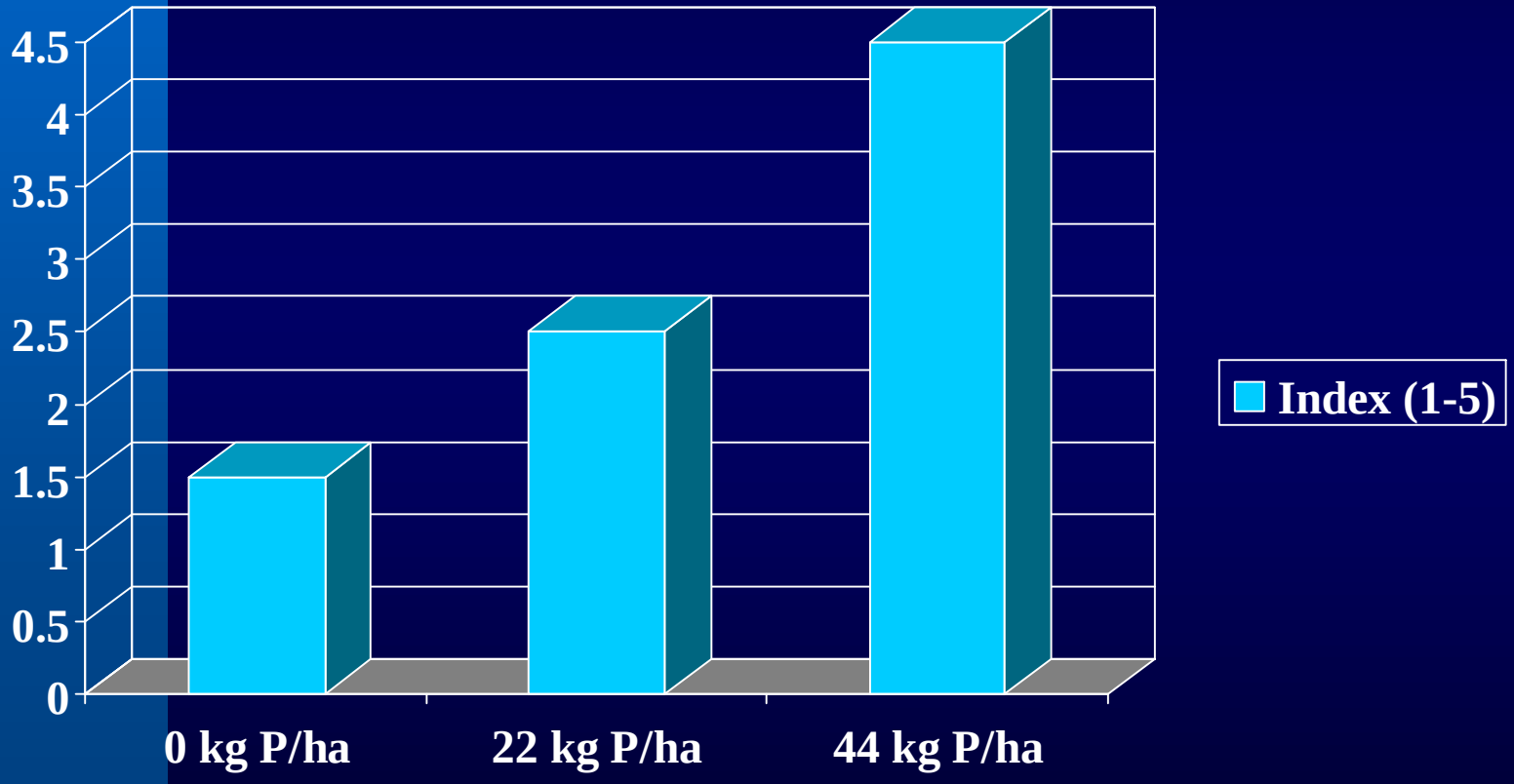
Yield : flue-cured tobacco (kg/ha) at three P-levels



[Micro-nutrient] of top leaves of flue-cured tobacco at 3 P-levels



Necrotic leaf disease complex (Index:1-5) at three P levels



These results were very disturbing ! !

- **Warranted a “new look” at the fertilization of phosphorus**

Resulted in an on-farm demonstration plot at Alma :

- **Where a well respected grower co-operated by planting a block of tobacco (OD1) without any P, so as to compare it to his commercial crop with P fertilized at 45 kg P/ ha**
- **This on a sandy soil with a Bray 2 extractable P of > 40 mg/kg**

Vaalwater 2007/2008

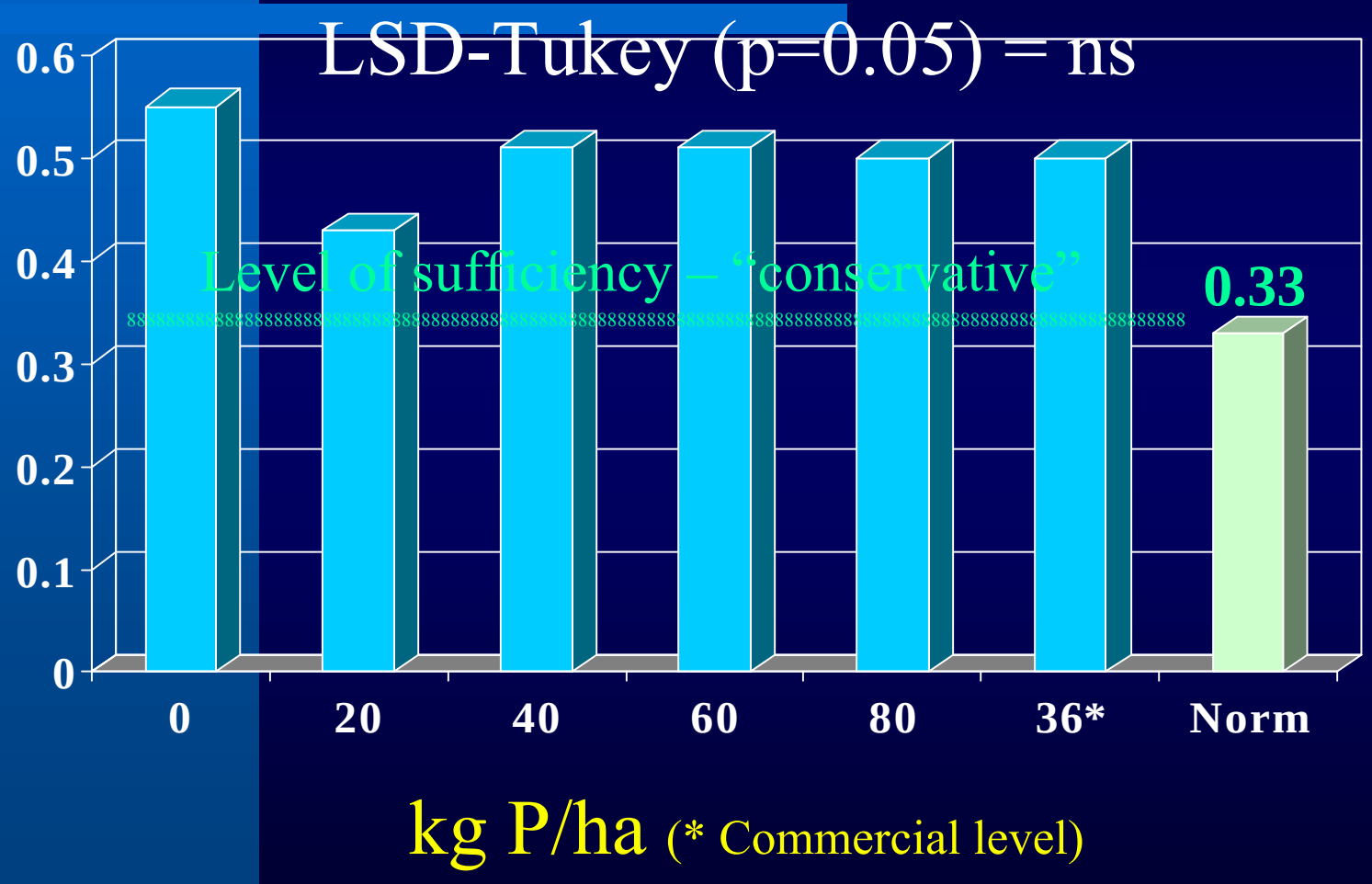
Demonstration plot with 6 levels of P ranging from zero to 80 kg P/ha

Sandy soil with Bray 2 extractable P: 36 mg/kg

[P] (g/100g) at P-levels – Vaalwater- 2007/2008

Sand (Bray 2 P – 36 mg/kg)

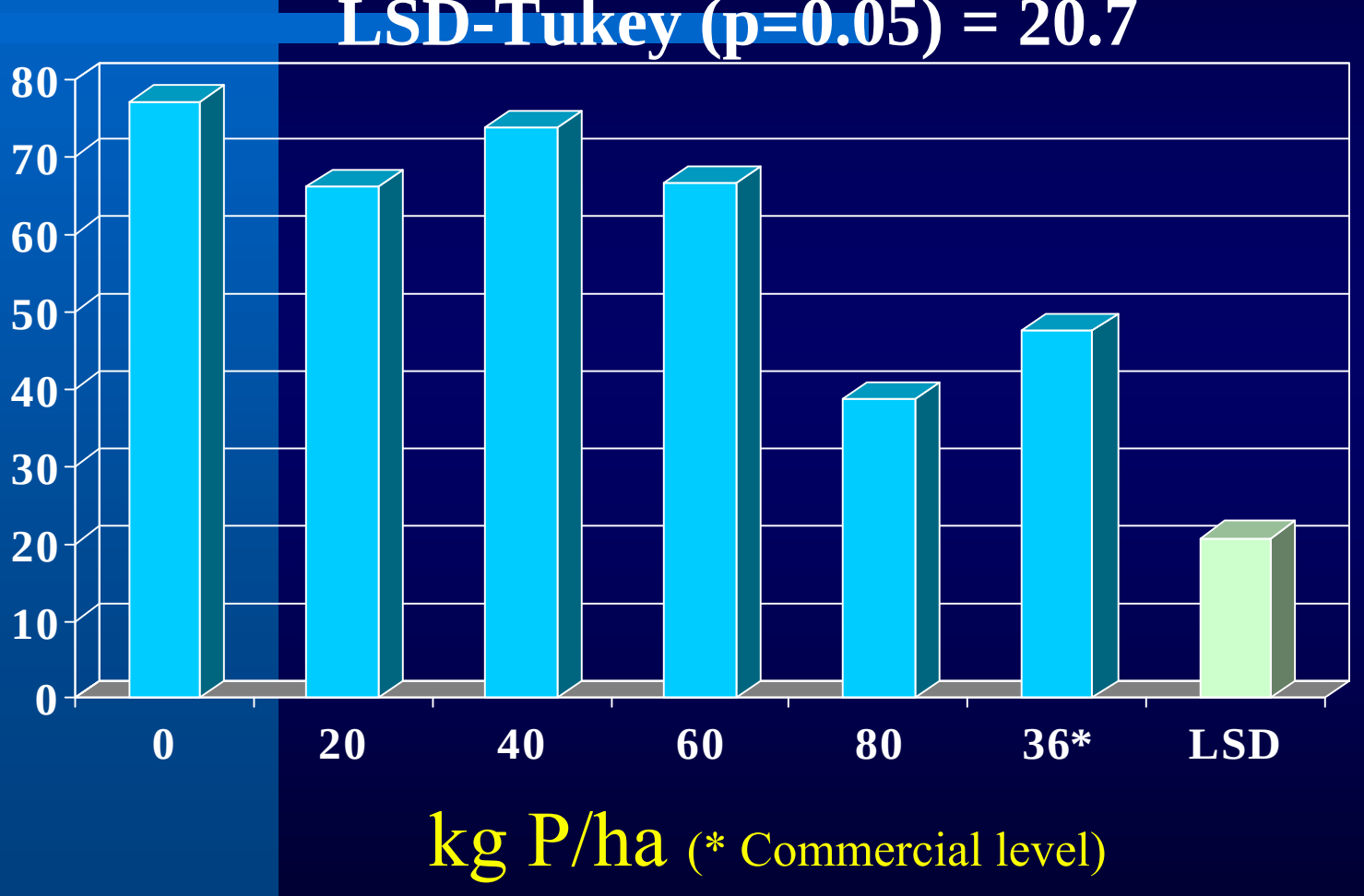
(Hail damaged top leaves)



[Zn] (mg/kg) at P-levels – Vaalwater- 2007/2008

Sand (Bray 2 P – 36 mg/kg)

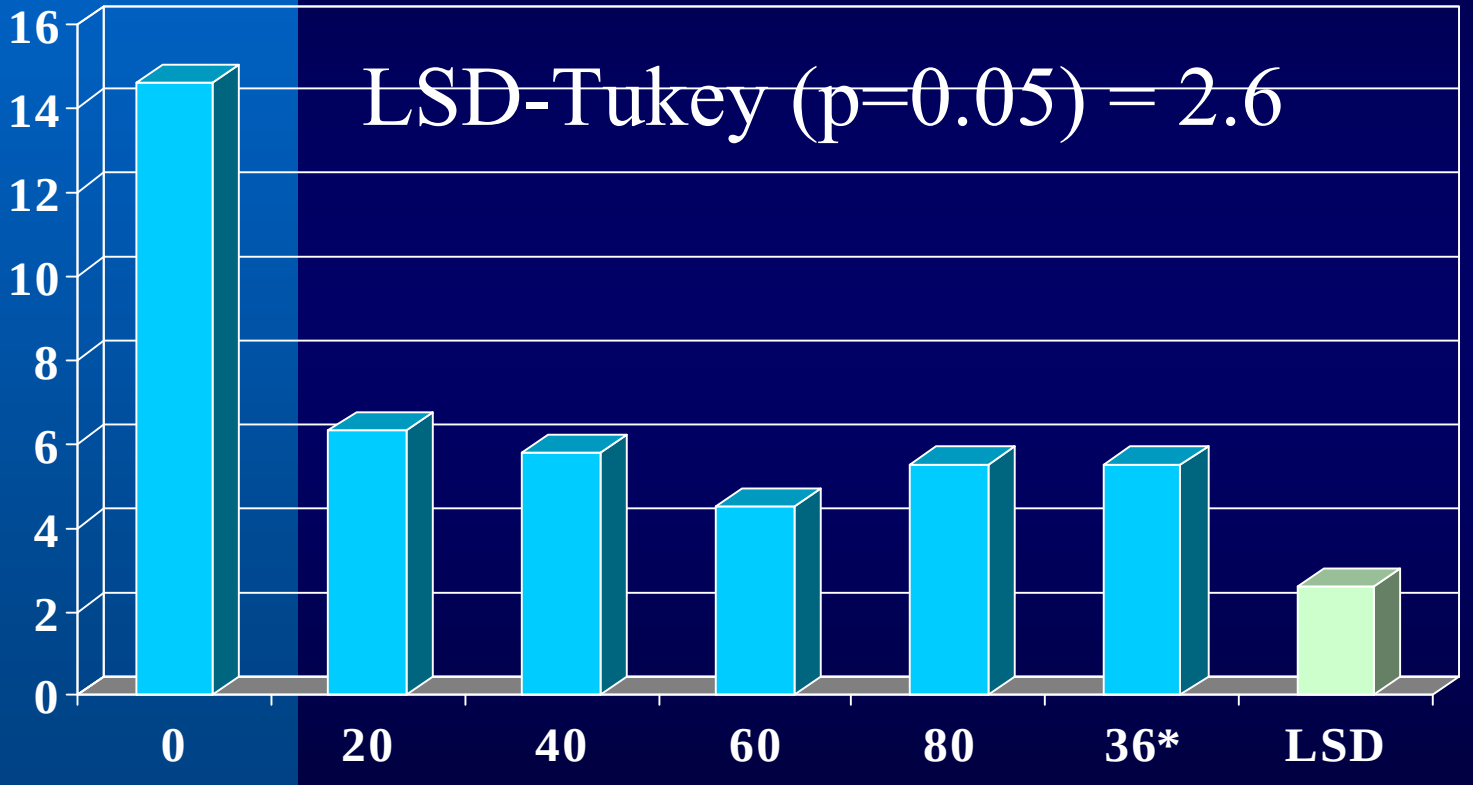
(Hail damaged top leaves)



[Cu] (mg/kg) at P-levels – Vaalwater- 2007/2008

Sand (Bray 2 P – 36 mg/kg)

(Hail damaged top leaves)



kg P/ha (* Commercial level)

Alma 2007/2008

Demonstration plot with 6 levels of P ranging from zero to 80 kg P/ha

Sandy soil with Bray 2 extractable P: 26 mg/kg

Growth within 5 weeks after planting became very sluggish and in spite of all possibly done sluggish growth continued and took 19 weeks from planting to reach 1st. picking stage with no visual differences between P-levels.

Alma – 2007/2008 (8 weeks) – 0 kg P/ha

Alma – 2007/2008 (8 weeks) – 20 kg P/ha

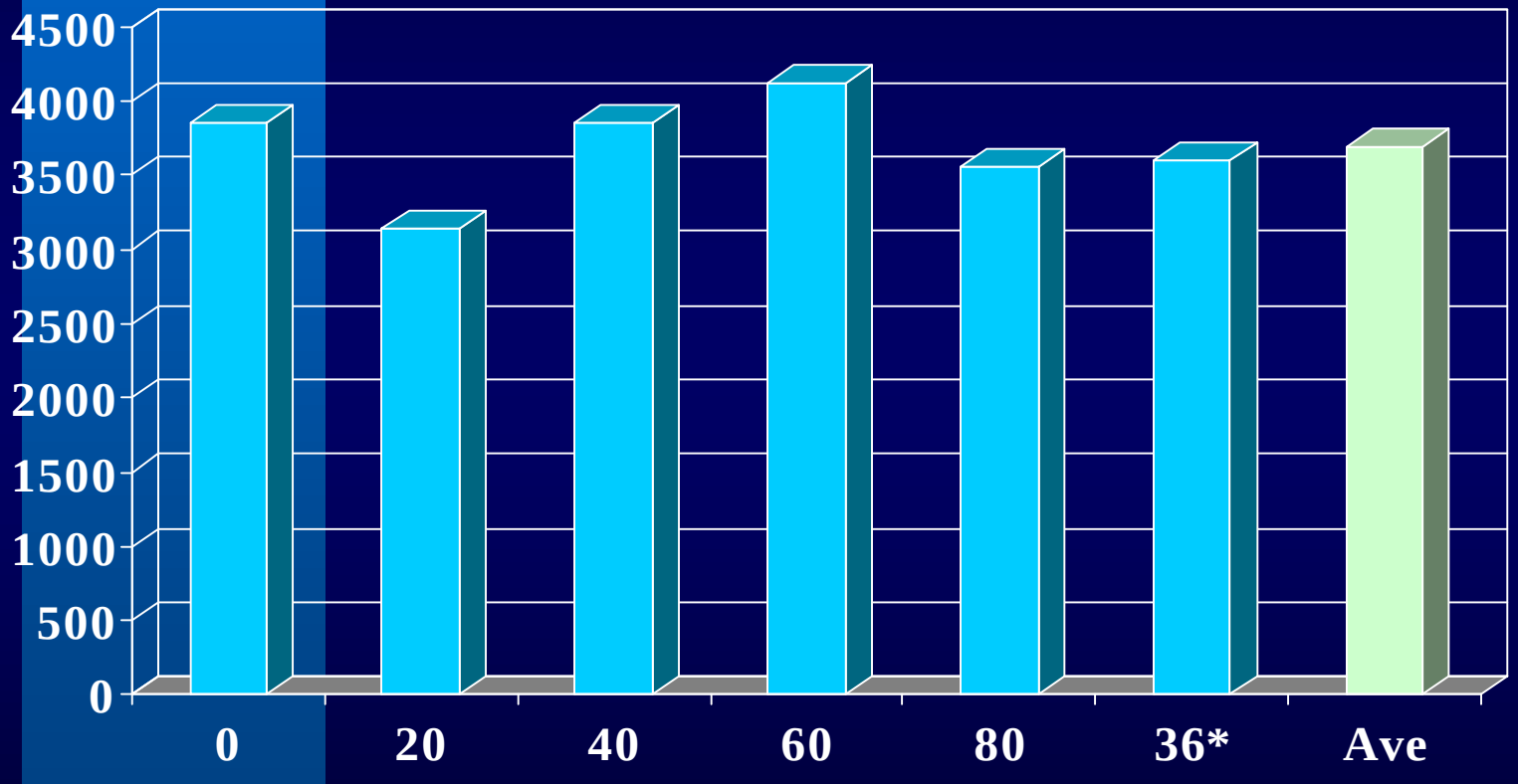
Alma – 2007/2008 (8 weeks) – 40 kg P/ha

Alma – 2007/2008 (8 weeks) – 60 kg P/ha

Locality H – Alma – (8 weeks) – 80 kg P/ha

Leaf yield (kg/ha-dry mass) at P-levels – Alma 2007/2008

(slow growth – 1st pick at 19 weeks after transplanting)



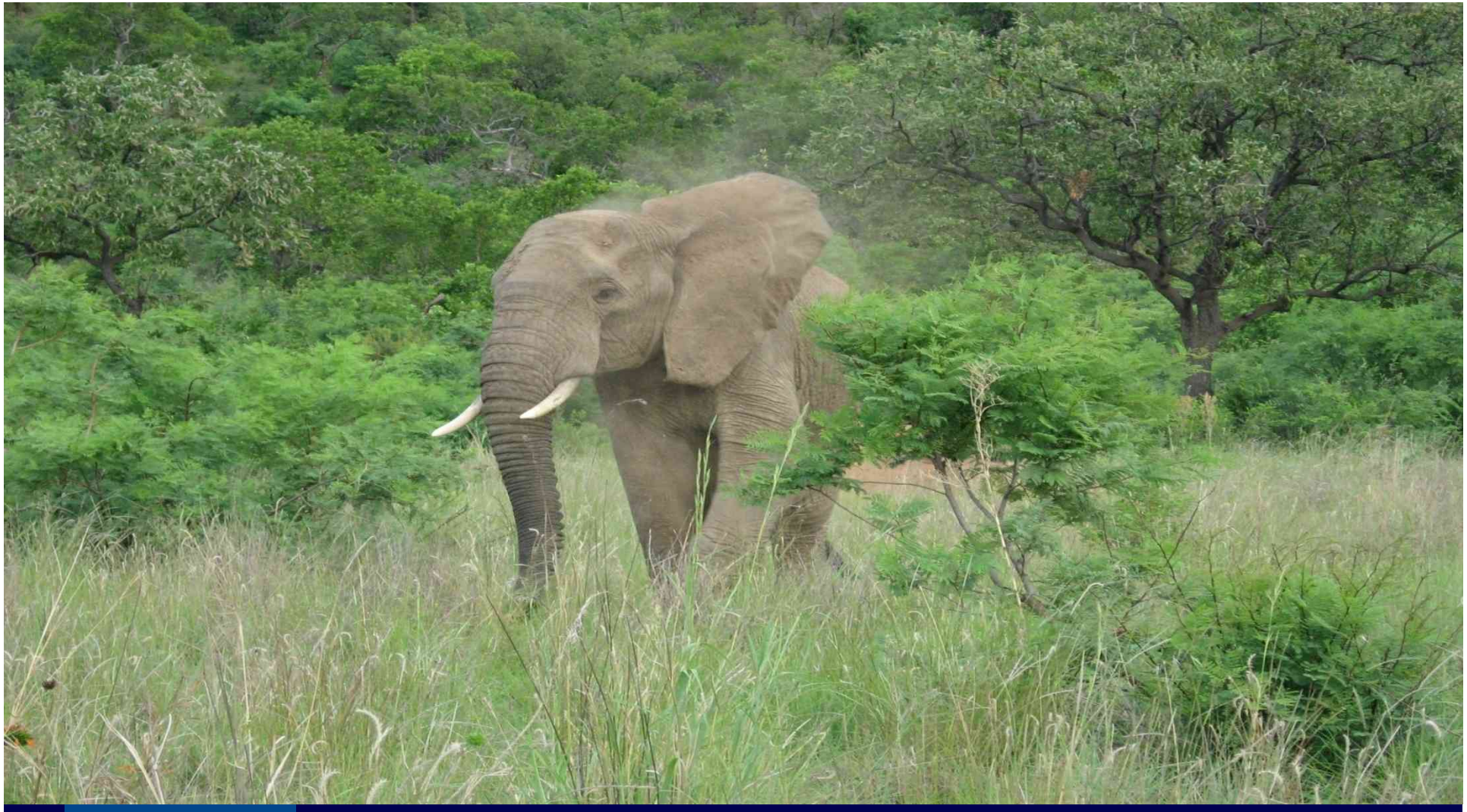
kg P/ha (* Commercial level)

[P] & P-uptake at P-levels – Alma 2007/2008

	Treatment : kg P / ha						NORM
	0	20	40	60	80	36*	
Plant part	g/100g (%) (Uptake: kg P/ha)						
Top leaves	0.18	0.18	0.19	0.19	0.19	0.19	0.33
Middle leaves	0.18	0.19	0.18	0.18	0.19	0.19	0.29
Bottom leaves	0.20	0.20	0.22	0.18	0.21	0.25	0.25
Stem	0.17	0.16	0.17	0.18	0.18	0.17	0.24
(kg P/ha)	10.1	8.2	10.2	10.8	9.5	10.1	>18

Results: Alma – 2007/2008

- **Contrary to expectation plant growth was sluggish on this sandy soil with a Bray 2 extractable P of 26 mg P/kg and no response to P-fertilization was found ! ! ! ! ! ! !**
- **This occurrence could only be attributed to a poor sub-soil reaction with pH 4.47 (saturated water paste) & an aluminium saturation of 24%.**
- **Points to the importance of rectifying sub-soil acidity**



Soil acidity – a Threat

In many cases claiming a large portion of the profits

Special attention needed when aluminium is associated in the soil acidity complex

Needs to be timeously rectified by liming

Rectification of sub-soil acidity is causing challenges

To Summarize:

- The omission of P- fertilizers on soils with good P- reserves & good soil reaction showed no adverse effect.
- Application of P on soils with good P-reserves & good soil reaction : Reduced Yield & lowered Zn & Cu concentrations in cases to less than norms of sufficiency & increased the incidence of leaf diseases.
- On sandy soils with poor sub-soil reaction (pH 4.47 & Al saturation 24%) : no response to P-fertilization – points to the importance of rectifying sub-soil acidity

Development of fertilizer guidelines are challenged by:

- Heterogeneity of soils
- Water quality
- Production area
- Crop rotation
- Residual soil nutrients
- Confusing talk
- Traditional methods of fertilization

Continued research : important -

- To streamline the guidelines for the fertilization of tobacco.
- To evaluate the response of tobacco to applied fertilizers.

In concluding : Responsibility :

- Create sound fertilizer guidelines to meet crop requirement and be of direct benefit to the farmer for the production of high-yielding, good quality tobacco.
- Not under fertilizing / Not over fertilizing ! !
- Conserving our natural resources & controlling pollution

Thank you !

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