ABSTRACT: 281

SOYBEAN PRODUCTIVITY AND QUALITY AS AFFECTED BY PHOSPHORUS AND POTASSIUM

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Soybean is a vital cash, oil and protein crop. It reacts positively to adequate amounts of essential nutrients. Application of P and K plus inoculation with *Rhizobium* bacteria can have positive results and should therefore be included in the general production of soybean. However, the practice in South Africa is not to apply P and K when producing soybeans since farmers rely on residual P and K from the previous cropping season. The objective of this study was to prove that P and K applied to a soybean crop can have positive results in terms of productivity and quality.

A field trial was conducted at the Hatfield Experimental Farm of the University of Pretoria. The soil used was a sandy loam soil. The experimental treatments were 3 levels of P (0, 20 and 40kg P ha^{-1}) and 3 levels of K (0, 50 and 100kg K ha^{-1}). Phosphorus and K was applied as super-phosphate (10.5%) and KCl (50%), respectively. A complete randomized block design with 4 replications was used. The cultivar LS 6161 was established at 400 000 plants ha^{-1} under rainfed conditions. Seeds were inoculated at planting with *Bradyrhizobium japonicum*, without additional N. Composite soil samples were collected from each plot and analyzed for pH (H_2O) and plant-available nutrients. Fertilisers were broadcast on each plot after which they were incorporated with a rotovator. During the growing season, plants were sampled for Leaf Area Index. Measurement of canopy closure and plant height were done for plants in the middle rows of each plot. Harvesting was done when soybean leaves senesced and pods turned brown. The data recorded was on the number of pods per plant, number of seeds per pod, 100-seed mass and total seed yield. The soybeans were threshed and seeds were allowed to dry to a moisture content of 12.5%.

Potassium significantly affected plant height and 100-seed mass, while the number of pods per plant was affected by P only. Canopy closure under controlled conditions was significantly lower than where P and K were applied. Leaf Area Index was not affected. A significant variation in grain yield was observed at the highest K level (100kg K ha^{-1}). An application of 50kg K ha^{-1} resulted in statistically similar, but relatively lower, yield than with 100kg K ha^{-1}. The lowest grain yield was observed where no K fertilizer was applied. Grain yield was not significantly affected by P nor the P*K interaction. However, a positive trend in yield was observed with increased levels of P and P*K.

The trial showed that yield increased significantly with increased rates of K, but not by applying P. There were no P*K interaction effects. This suggests that K can play an important role in increasing soybean yield.

THE EFFECT OF DIRECT PHOSPHORUS AND POTASSIUM FERTILIZATION ON SOYBEAN (*Glycine Max* L.) YIELD AND QUALITY

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LAYOUT

- **INTRODUCTION**
  - PROBLEM STATEMENT
  - HYPOTHESIS
  - OBJECTIVES
- **MATERIALS AND METHODS**
- **RESULTS AND DISCUSSION**
- **CONCLUSIONS**

IMPORTANCE OF SOYBEAN

Globally

- Food
  - Soy meal
  - Soy oil (30%)
- Industrial
  - Bio-diesel

South Africa

- Feed
  - Soy oilcake
  - Whole plant





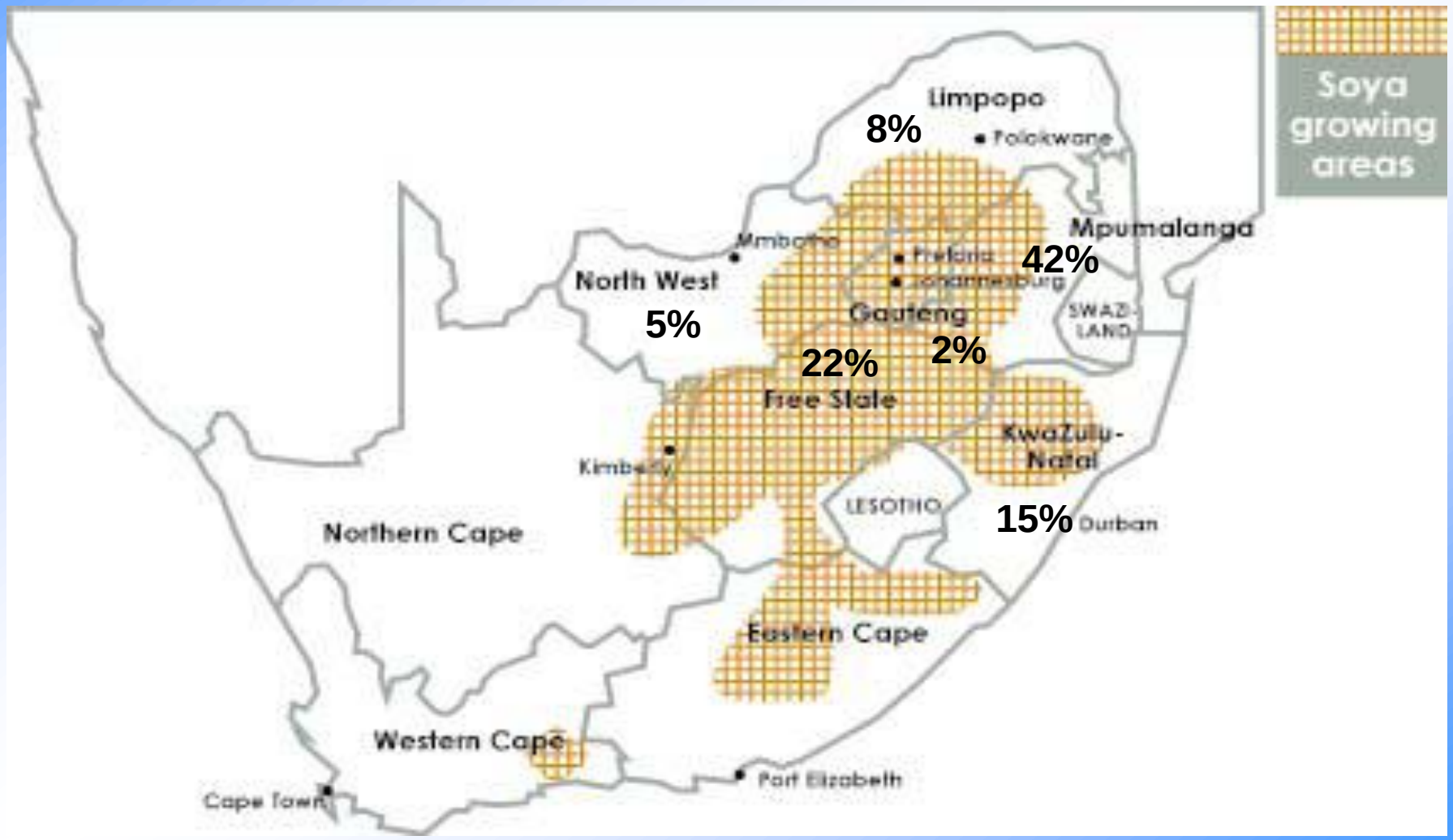






AREAS OF PRODUCTION IN RSA

SA Soy Production Average = 1.39 t ha^{-1}



Soybean production areas (2013)

Province	Area planted (ha) 2012	Area planted (ha) 2013	Change in area (%) 2013 vs. 2012	Distribution area per province (%) 2013	Final yield (t) 2012
Western Cape	-	-	-	-	-
Northern Cape	500	500		0.09	1 500
Free State	175 000	215 000	+22. 9	40.64	192 500
Eastern Cape	500	500	-	0.09	750
KwaZulu-Natal	34 000	34 000	-	6.43	81 600
Mpumalanga	200 000	215 000	+7.5	40.64	263 050
Limpopo	22 000	22 000	-	4.16	50 600
Gauteng	19 000	20 000	+5,3	3.79	28 500
North West	21 000	22 000	+4.8	4.16	31 500
Total	472 000	529 000	+12.1	100	650 000

FERTILITY MANAGEMENT

- Soil fertility
- Best soil for soybean production
  - Medium to high fertility with a pH of 6.5
  - Loose, well drained loam soil
  - Good aeration
  - Good water-holding capacity
  - Balanced nutrient content
- Soybean N-fixation



FERTILITY MANAGEMENT

IMPORTANCE OF PHOSPHORUS:

- Enhance photosynthesis
- Enzyme activity
- Root development
- Seed germination

P – DEFICIENCY:

- Reduced leaf area
- Stunted growth
- Reduction of nodules



FERTILITY MANAGEMENT

IMPORTANCE OF POTASSIUM:

- Water and nutrient transport
- Water-vapour and CO_2 exchange

K – DEFICIENCY:

- Yellow leaf margins
- Impaired transpiration and photosynthesis.
- Stunted growth of aerial parts



PROBLEM STATEMENT

Fertilization with P and K fertilizers is neglected due to:

- Soybean's symbiosis with N-fixing bacteria
- The practice in South Africa is not to apply P and K directly to a soybean crop, but rather to rely on residual P and K from the previous crop (Maize).

HYPOTHESIS

In season application of P and K fertilizer at different rates will affect soybean growth and yield positively

OBJECTIVES

GENERAL OBJECTIVE

- The main objective of this study is to prove that in season application of P and K to a soybean crop can have positive results in terms of crop productivity

SPECIFIC OBJECTIVES

- To evaluate the effect of each nutrient element (P and K), on the growth rate of soybeans
- To compare the yield and yield components of soybean in response to applied P and K
- To evaluate the effect of each nutrient element (P and K), on soybean quality

MATERIALS AND METHODS

STUDY SITE (Field Trial)

- Field area = 800m^2 (40m long x 20m wide)
- Hatfield Experimental Farm (Pretoria) on a Hutton soil
- Lat: 25^{o}45’ S, Long: 28^{o}16 E, altitude 1327m
- Annual rainfall: 738.8 mm, mainly from October to March

	2010			2011			
	October	November	December	January	February	March	April
Min. Temperature (^{o}C)	12.91	15.35	15.94	16.93	16.16	15.85	12.42
Max. Temperature (^{o}C)	29.49	28.95	28.17	27.72	28.59	29.24	23.84
Rainfall (mm)	16.30	107.40	147.70	135.80	41.20	292.40	46.30

EXPERIMENTAL DESIGN

Factorial experiment with two factors (P and K)
Number of levels for each = 3

FACTOR	RATES (Treatments) kg ha^{-1}		
Phosphorus	0	20	40
Potassium	0	50	100

Number of replications = 4

Experimental Design = Completely randomized block design

METHODOLOGY CONTINUE

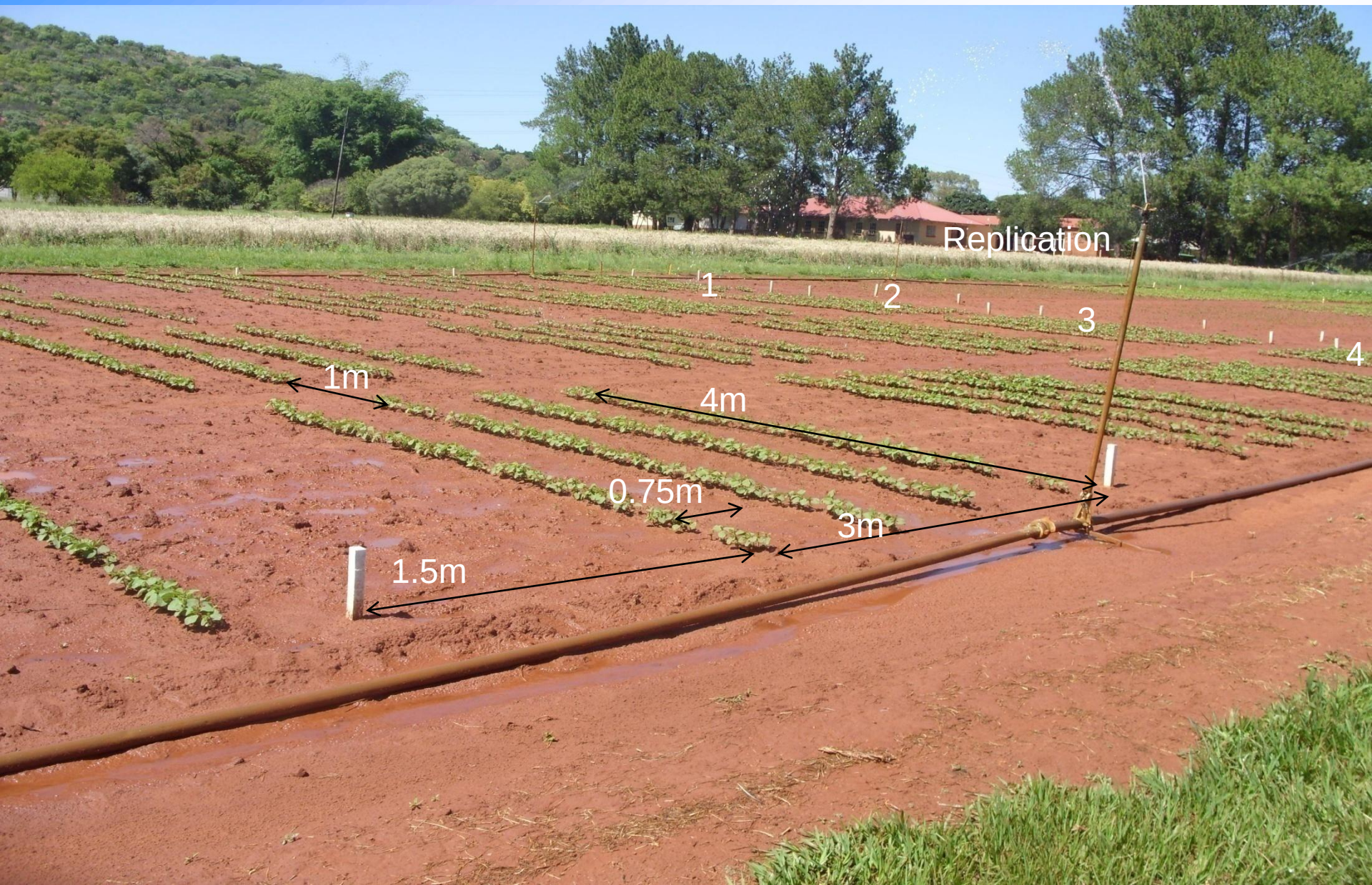
- Fertilizer sources: P = Superphosphate (10.5%) & K = Potassium chloride (50%)
- Cultivar = LS 6161R
- Plant density = 400 000 plants ha^{-1}
- Plot size: 4m x 3m = 12.0 m^2
- Row width: 0.75m (four rows/plot)
- Row length: 4 meters
- Planting method:
  - By hand (120 seeds/4m) = 3.34cm apart in row

Bradyrhizobium application





View of Field Trial layout



PARAMETERS DETERMINED

Leaf Area



Number of nodules

100-seed

- Counting (seed counter)
- Seed moisture (moisture meter)



Leaf area Index

$$LAI = \frac{\text{Leaf area plant}^{-1}\ (m^2)}{\text{Land area occupied by the plant}\ (m^2)}$$

METHODOLOGY CONTINUE

$$\text{Yield} = \frac{(100 - \text{Moisture \%})}{(100 - 12.5} \times \text{seed mass}$$

Where: 100 = Constant

12.5 = Adjusted moisture %

Other parameters measured

- Oil content
- Protein content

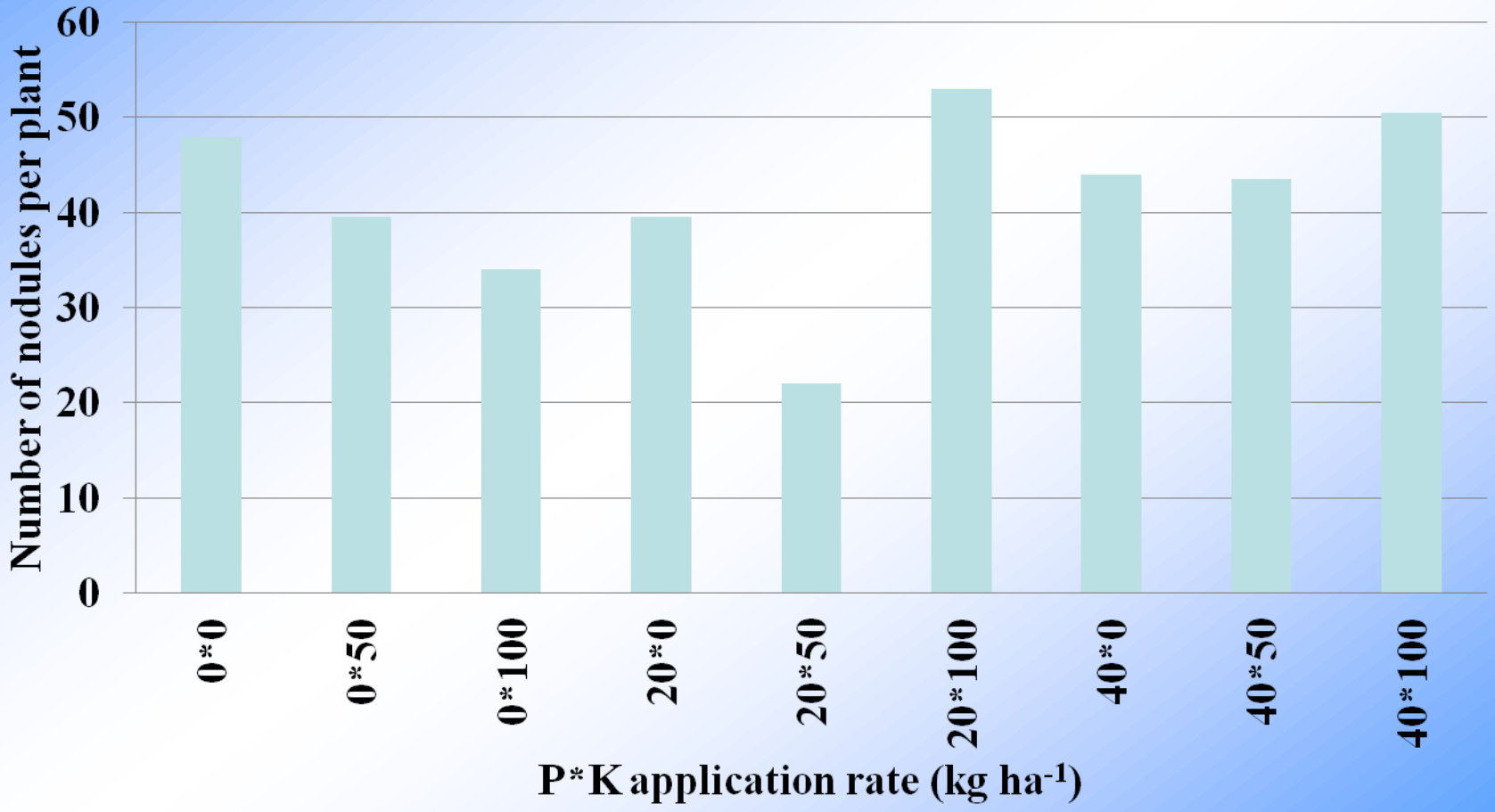
STATISTICAL ANALYSIS

- Linear model producer of statistical analysis (SAS) was used for variance within and between treatment

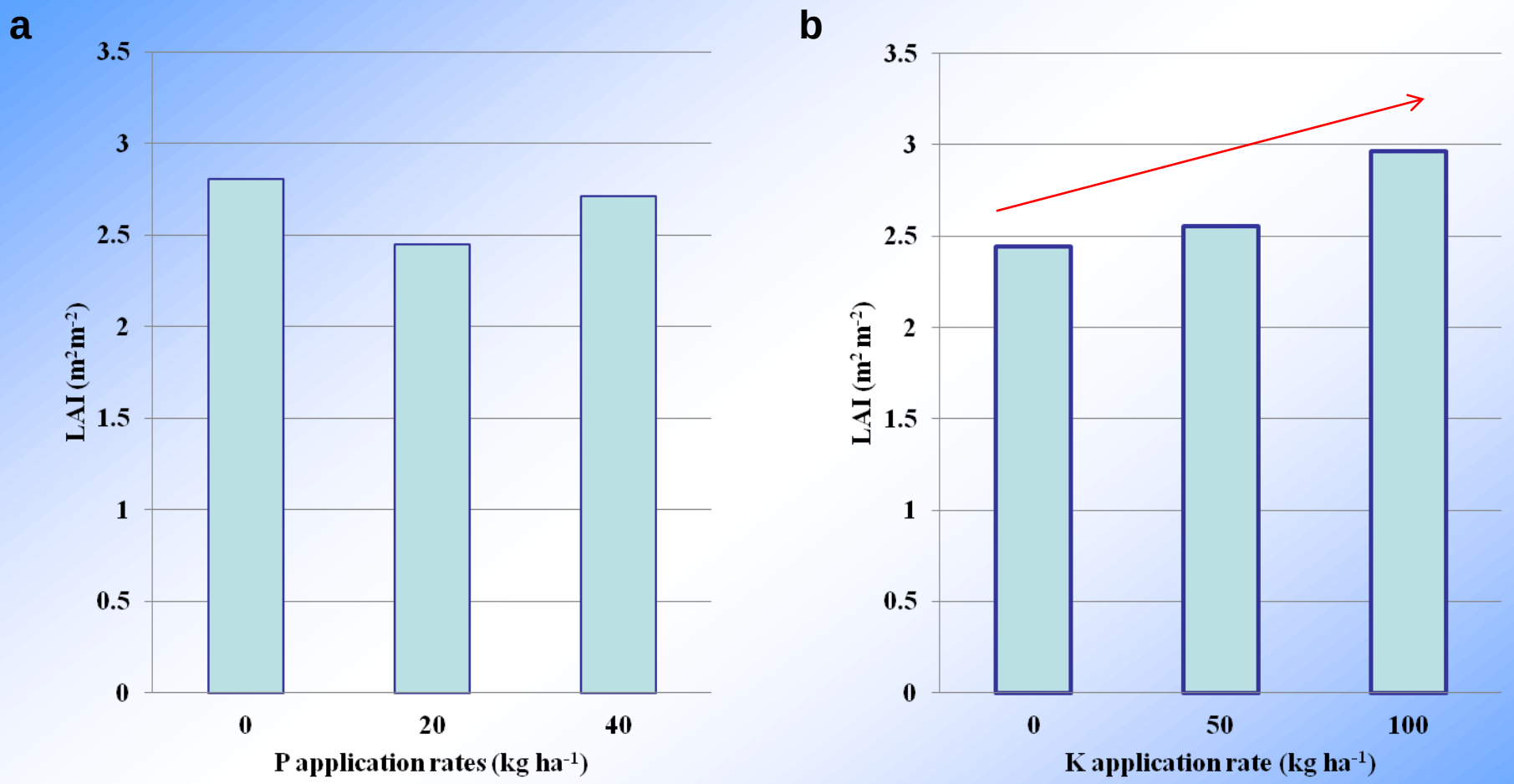
- Least Significant Test were used for determining significant treatment effects

Results and discussion

Number of nodules as affected by Phosphorus and Potassium (P*K)



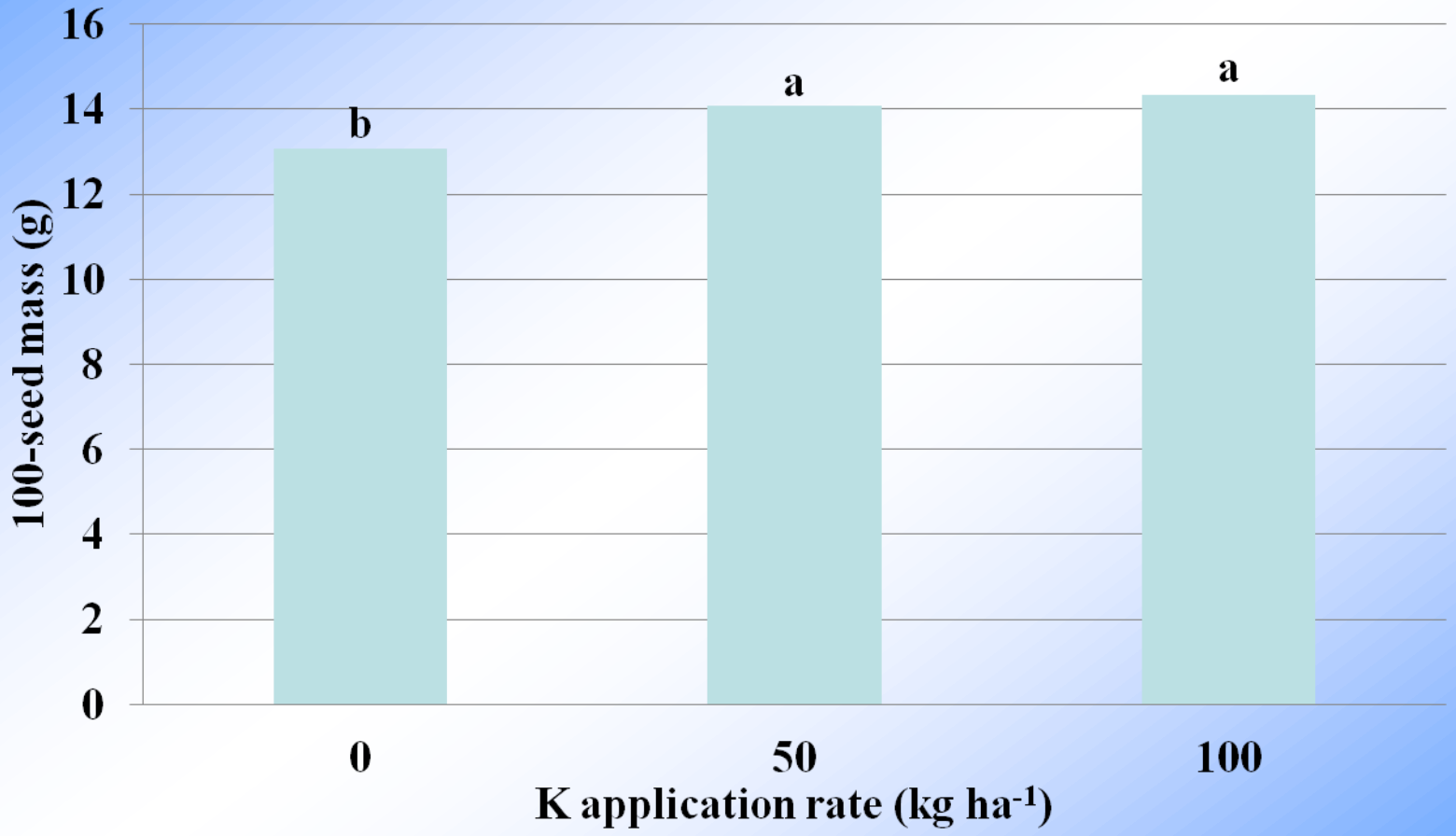
Leaf area index as affected by (a) Phosphorus and (b) Potassium



P and K did not significantly influence LAI

Tendency that increased K application rates increase LAI

100-seed mass as affected by Potassium



Yield of soybean as affected by Phosphorus and Potassium

P:K level (kg ha^{-1})	Mean Yield (kg ha^{-1})
40*100	2653^{a}
20*100	2451^{a}
0*100	2263^{abc}
40*50	2316^{ab}
20*50	2135^{abcd}
0*50	1878^{bcde}
40*0	1749^{cde}
20*0	1635de
0*0	1431^{e}
LSD = 559.49	

Oil content of the soybean as affected by (a) Phosphorus and (b) Potassium

a

P application rate (kg ha^{-1})	Mean Oil content (%)
0	19.39a
20	18.52b
40	18.69b
LSD	0.4889

b

K application rate (kg ha^{-1})	Mean Oil content (%)
0	18.45b
50	18.80b
100	19.35a
LSD	0.4889

Protein content of the soybean as affected by (a) Phosphorus and (b) Potassium

a

P application rate (kg ha^{-1})	Mean Protein content (%)
0	41.21b
20	43.08a
40	42.24ab
LSD	1.0384

b

K application rate (kg ha^{-1})	Mean Protein content (%)
0	43.51a
50	41.88b
100	41.13b
LSD	0.4889

CONCLUSIONS

- K alone resulted in lowering of number of nodules, while a combination of P and K increased the number nodules
- LAI were not significantly affected by P and K
- P did not affect the 100-seed mass, while K significantly increased it
- P alone didn’t contribute to higher yields than the control, but in combination with K, yield was increased
- Where K alone was applied, yields were higher than that of the control

CONCLUSIONS

- P application irrespective of the rate decreased the oil content below that of the control, while having the opposite effect on protein content

- Potassium regardless of the rate resulted in increased oil content while it decreased the protein content as compared to the control

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➢ Almighty 

God

Thank you

