Assessment of Nutrient Deficiency and Nutrient-induced Yield Gaps in Soybean Production in Western Kenya.

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INTRODUCTION

- Soybean (*Glycine max*) is a sp. of legumes native to East Asia and belongs to family *Fabaceae*.

- It's important for its high protein (35-40%) and oil (15-22%) content.

- Uses: hand lotion, biofuel (USB, 2004), as a high protein meal and vegetable oil source, preparation of products like soybean milk, tofu, soy sauce and bean sprouts.

Intro cont'

- 80% consumed by livestock industry; human consumption accounting for 20-30%. Demand expected to rise to about 150,000 tons per year over the next 10 yrs (Jagwe and Nyapendi, 2004; MoA, 2006)

- Constraints; average yield of 800kg/ha nationally, which has been stagnant since 1990 FAO (2008), this can be attributed to biophysical conditions like soil fertility depletion.

- Currently about 6000-7000 MT being produced in Kenya against an annual local demand of 50,000 MT, deficit met thro'imports.

Problem statement and Justification.

- Nationally an average yield of soybean is estimated at 800kg/ha & has been stagnant since 1990, FAO (2008), with a regional variability ranging from 450kg/ha (Western province) to 1100kg/ha (Eastern province) against a possible 3000-3600kg/ha.

- Productivity of soybean in Kenya particularly western province is low (450kg/ha) compared with Brazil and USA; 2941kg/ha & 2922kg/ha respectively (Chinau, et al. 2009), FAOSTAT (2010).

Problem statement and justification cont'

- Soil fertility depletion is a fundamental biophysical root cause for low productivity in Kenya and entire SSA, (Sanchez et al., 2002), per capita food production will continue to decline unless soil fertility depletion is effectively addressed.

- With a popu growth rate of 3% which supersedes agricultural production rate of 2% in SSA, (Bationo et al., 2006), the increasing decline in soil fertility with a resultant decreasing crop yields, increases food insecurity.

Problem statement and justification cont'

- Apart from N and P wide spread limitations across the widely distributed weathered soils in SSA, low organic matter content and soil acidity also contribute to low crop yields (Mbakaya, 2007).

- Most work has focused on N & P in soybean plant nutrient management, but little work has been done on K, S, Ca, Mg and micronutrients which are critical in soybean production

- In view of this problem there's need to assess for nutrient deficiencies and the yield gaps they cause by determining the response of soybean to nutrient application.

Objectives

Broad objective:

- To increase soybean production through improved plant nutrient management.

Specific objectives:

- To diagnose for nutrient deficiencies in soybean production

- To determine soybean yield response to macro and micronutrients.

- To assess effect of macro and micronutrients on N-fixation potential in soybean.

Materials and Methods

Sites: 1 on-station-Kabete field station & 4 on-farm:

Butere district- Lolwe & Eshisa (Fertile)

Khwisero district- Ashirali & Masaba (Infertile)

Design and treatments:

- 1 variety of soybean (SB 132-Squire) will be planted in plots measuring 6m by 6m at a spacing of 45cm by 5cm.

- Eight treatments will applied as follows:
  1. Control-without Biofix inoculant and fertilizers.
  2. Inoculation with Biofix alone

Materials and methods cont'

3. NPK

4. PK (-N)

5. NP (-K)

6. NK (-P)

7. N+P+K+S+Ca+Mg+Zn+Mo

8. N+P+K+S+Ca+Mg+Zn+Mo+Manure+Lime

- Treatments 2-8 will be planted with inoculated soybean at the rate of 10g/kg of seed of Biofix inoculant.

Materials and methods cont'

Nutrient application rates per ha		
	Rate	Source
N	20 kg/ha	Urea
P	30 kg/ha	TSP
K	60 kg/ha	Potash
S	23 kg/ha	Sympal fertilizer + Mg/ZnSO4
Ca	20 kg/ha	Sympal fertilizer
Mg	5kg/ha	Sympal fertilizer + MgSO4
Zn	3 kg/ha	Sympal fertilizer + ZnSO4
Mo	3 kg/ha	NaMoO4
Manure	10 t/ha	Cattle manure
Lime	5 t/ha	Dolomitic lime
	Source; Shamie Zingore, IPNI	

Materials and methods cont'

Nutrient application rates per plot Based on a plot size of 6 x 6 m	
Treatment	Basal Fertilizer at Planting
1. Control	-
2. Inoculation	-
3 NPK	Urea 156 g TSP 540 g Potash 314 g
4. PK	TSP 540 g Potash 314 g

5. NP	Urea	156g
	TSP	540 g
6. NK	Urea	156 g
	Potash	314 g
7. N+P+K+S+Ca+Mg+Zn+Mo	Sympal fertilizer	1,274 g
	Urea	156 g
	Potash	160 g
	MgSO4	115g
	ZnSO4	36 g
	Na2Mo4	27 g
8. N+P+K+S+Ca+Mg+Zn + Mo+manure + lime	Sympal fertilizer	1,274 g
	Urea	156 g
	Potash	160 g
	MgSO4	115g
	ZnSO4	36 g
	Na2Mo4	27 g
	Manure	36 kg
	Lime	18 kg

Materials and methods cont'

- Trial will be laid out in a RCBD with 8 treatments and 3 replications.

- All fertilizers will be applied by banding at time of planting.

Data collection:

- Site information; GPS readings, land use history and rainfall records using portable rain gauges.

- Crop emergence; date and No. of plants.

- Crop phenology; days to flowering, 50% podding and maturity.

- Score for insect pests and diseases.

Materials and methods cont"

- Soil samples collected at a depth of 0-20cm before planting and after harvesting. Lab analysis done to measure; soil organic carbon, soil inorganic carbon, soil bulk density, total N, extractable ammonium N, extractable nitrate N, extractable P, extractable K, soil pH (water), EC and particle size distribution.

Yield and yield components:

- Biomass assessment: harvested after 4 wks and at 50% podding. Both fresh and dry weights recorded after being oven dried at 65^0 C for 24hrs.

- No. of plants in net plot counted at harvest, all pods in net plot will be harvested and fresh weight determined. Random sub-samples of pods will be taken & their weights determined. Oven dried at 65^0 C then dry weights taken.

Materials and methods cont'

- Stover/haulms from net plot will be harvested and weighed. Sub-sample fresh and dry weights will also be determined.

- Number of seeds per pod, weight of 100 seeds, oil content.

<u>Nodulation and nodule assessment</u>: done at 50% podding.

- Destructive sampling done outside net plot from an area of 0.5m by 0.45m.

- Nodule scoring will be done at a scale of 1-5 (Developed by N2Africa)

- Nodules separated from roots and their fresh weights determined. Total number of nodules counted.

Materials and methods cont'

- Sample of nodule taken for characterization, 10% of total taken if more than 100, less whole sample will be used. Characterized as active (red, pink, brown) and inactive (white, green, black).

- Nodules and roots will be oven dried at 65^0 C for 24hrs then their dry weights determined seperatly.

Data analysis:

Data will be subjected to analysis of variance (ANOVA), treatment means separated using LSD at 95% confidence interval and correlations will be made using Genstat software.

Materials and methods cont'

Expected output:

- Deficient nutrients will be determined.

- Nutrient induced yield gaps determined.

- Nutrient effect on N-fixation potential documented.

- Thesis and 2 peer-reviewed publications.

Work plan

Activity	2012										2013								
	March	April	May	June	July	August	Sept	October	Nov	Dec	January	Feb	March	April	May	June	July	August	Sept
Proposal development	■																		
Land preparation & planting	■	■																	
Data collection		■	■	■	■														
Data entry and analysis			■	■	■	■	■												
Season two																			
Site selection						■	■												
Land preparation & planting							■	■											
Data collection								■	■	■	■								
Data entry and analysis									■	■	■	■	■						
Thesis writing												■	■	■					
Submission															■				
Defence and graduation																		■	

Budget

Item	Amount (Ksh)
Leasing land	60,000.00
Land preparation	20,000.00
Labour	130,000.00
Instruments and equipment	20,000.00
Fertilizers and seed	30,000.00
Transport	60,000.00
Thesis writing	80,000.00
Others	50,000.00
Total	**450,000.00**

THANK YOU