Response of Soybean (Glycine max (L.) Merr.) to Fertilizer and Rhizobium Inoculant in Northern Ghana

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Introduction

- Nitrogen and P deficiencies in most tropical soils are the underlying causes of low crop productivity.
- Phosphorus is critical to legume yield because it stimulates growth, initiates nodule formation and enhances the efficiency of the rhizobium-legume symbiosis.
- Commercial inoculants provide effective rhizobium strains that stimulate N fixation, growth and yield in legumes.
- Limited information exists on how commercial inoculants and different fertilizer sources affect the growth and yield of soybean in Ghana.

Objective

- To evaluate the effects of fertilizer regimes and rhizobium inoculant on the growth and yield of soybean.

Materials and Methods

- Study Location: Nyankapala, Ghana (09º 23" 22.4 " N,01º 00 " 12.1 " W)
- Soil Type: Ferric Luvisols (Tingoli series)
- Soil Texture: Sandy loam
  - Sandy (68%),Silt (24%) and Clay (8%)
- Experimental Design: Split plot in a randomized complete block design (RCB)
- Main plot : 2 levels of Legumefix inoculant (*Bradyrhizobium japonicum* strain 532c)
  - No-inoculation = -Ino
  - Inoculation = +Ino
- Sub plot: 5 fertilizer regimes consisting of both mineral and organic fertilizers
  - No P fertilizer = None
  - Single Super Phosphate = SSP
  - Triple Super Phosphate = TSP
  - Triple Super Phosphate +Fertisoil (Compost) = TSP+Fert
  - Triple Super Phosphate + Fertisoil + Boost'Xtra + (Micronutrients compound) = TSP+Fert +Bo
- Test crop: Soybean cultivar Jenguma (TGX 1448-2E)

Analyses

- Baseline soil physical and chemical analyses
- Enumeration of native rhizobia population
- Yield (Biomass and Grain)
- Yield components (Pod dry weight and Pod load)
- Nodulation (Nodule number and Nodule dry weight)

Table 1: Properties of the soil at the study site

Soil property	Value
pH (1:2.5 H_2O)	5.5
Soil organic carbon (g kg^{-1})	9
Total N (g kg^{-1})	0.5
Available P (mg kg^{-1})	5.7
MPN of native rhizobia (cell g $soil^{-1}$)	5.12 × 10^1

Ezekiel-Adewoyin (2014)

Statistical Analysis

- Proc mixed in SAS 9.4 and means separated by Tukey HSD at a significance level of 0.05

Results and Discussion

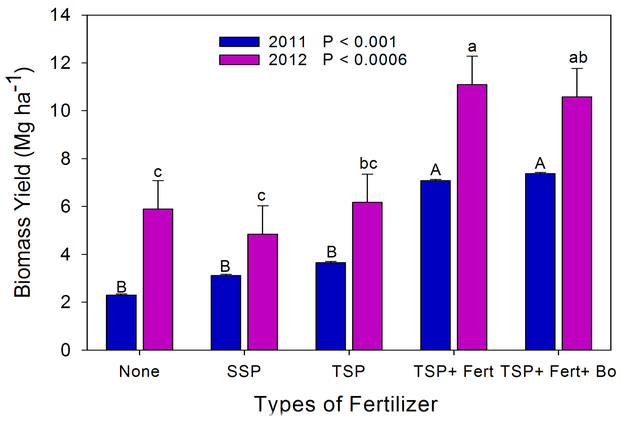

Fig. 1. Biomass yield as affected by fertilizer in 2011 and 2012.

- TSP+Fertisoil and TSP+Fertisoil+Bo significantly increased (P< 0.05) biomass yield in 2011. In 2012, None (no P fertilizer) and SPP treatments generally produced the least biomass yields (Fig. 1).

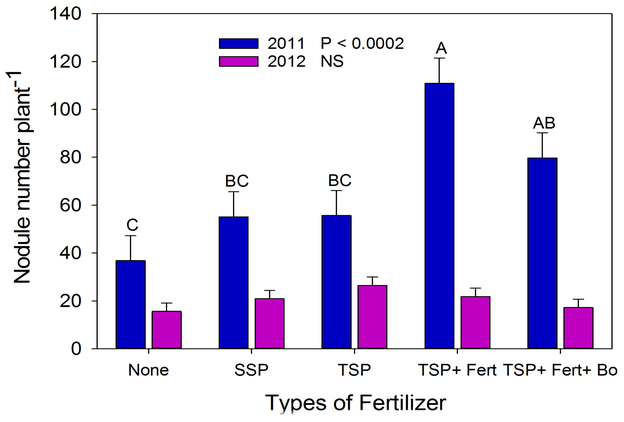

Fig. 2. Nodule number as affected by fertilizer in 2011 and 2012.

- TSP+Fertisoil significantly increased nodule number per plant compared to TSP, SSP and None (no P fertilizer) treatments in 2011 (Fig. 2). There was no significant treatment effect on nodule number in 2012.

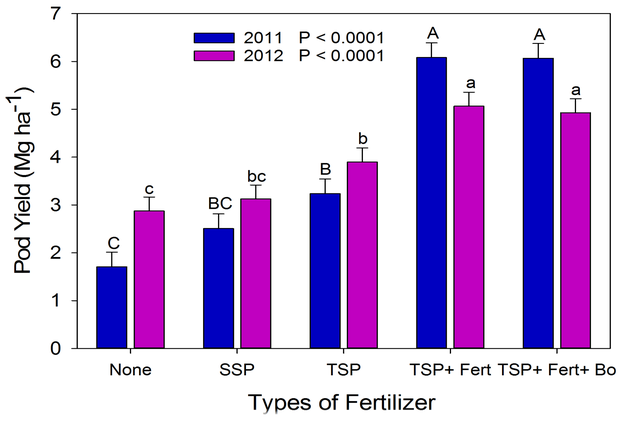

Fig. 3. Pod yield as affected by fertilizer in 2011 and 2012.

- Application of TSP+Fertisoil and TSP+Fertisoil+Bo significantly increased (P< 0.0001) pod yield compared to the other treatments in both years. Also, TSP alone increased pod yield compared to None (no P fertilizer) in both years (Fig. 3).

Results and Discussion (cont.)

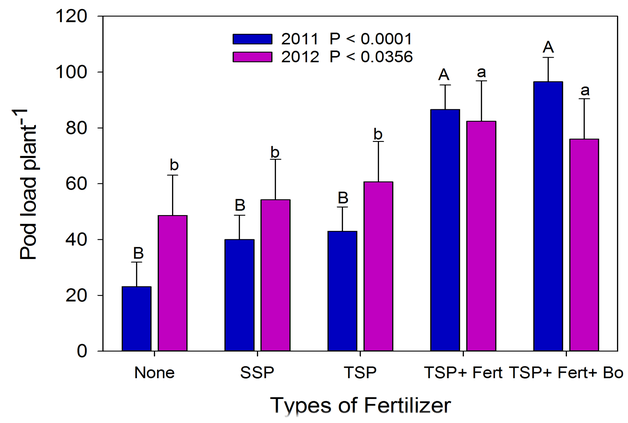

Fig. 4. Pod load as affected by fertilizer in 2011 and 2012.

- Application of TSP+Fertisoil and TSP+Fertisoil+Bo significantly (P<0.05) increased pod load compared to the other treatments in both years (Fig. 4).

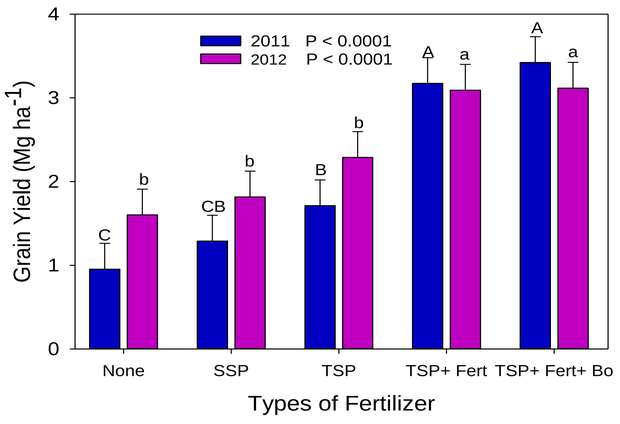

Fig. 5. Grain yield as affected by fertilizer in 2011 and 2012.

- Greater grain yield was produced due to the application of TSP+ Fertisoil and TSP+Fertisoil+Bo compared to the other treatments in both years (Fig.5). Also, TSP alone produced greater grain yield than None (no P fertilizer) in 2011.

Table 2: Effect of legumefix inoculant on nodulation and yield

Inoculant	Nodule number $plant^{-1}$		Nodule weight (mg $plant^{-1}$)		Grain yield (Mg ha^{-1})	
Year	2011	2012	2011	2012	2011	2012
- Ino	83 a	25 b	718 b	133 b	2.2	2.5
+ Ino	52 b	30 a	1708a	197 a	2.0	2.9

- Inoculation with *Bradyrhizobium japonicum* generally increased nodulation in both years (Tab 2). However, this did not increase grain yield.

Conclusion

- A combined application of inorganic and organic fertilizer is needed to increase grain yield and yield components in soybean.
- Inoculation is needed to increase nodulation in soybean.

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