The effects of planting position, timing of nitrogen and phosphorus fertilizer rates on growth and yield of soybean (*Glycine max L*)

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Abstract

The amount of nitrogen fixed symbiotically is rarely adequate for optimal plant growth. Appropriate tillage systems can be adapted to specific soil conditions in order to amplify soybean yield response to added fertilizers. A 36-week field experiment was carried out at Chisumbanje Experiment Station (2048 S; 3214 E, elev. >300 m above sea level, Zimbabwe) on a soybean crop in order to determine the effect of timing nitrogen and phosphorus fertilizer application rates in three seedbed configurations on seedling emergence, nodule weight, plant height, aboveground biomass and yield (biometric characteristics) of soybean. Planting soybean on 0.5 m wide ridge seedbeds enhanced germination. Planting soybean on flat seedbeds reduced seed germination by 62.5% compared with 0.5 m wide ridge seedbeds. Widening ridge seedbeds to 1 m whittled down seed germination by 32.3% compared with 0.5 m wide ridges. High root nodule weight does not necessarily increase grain yield. The 0.5 m wide ridge beds, which had the highest seedling emergence score, recorded the largest yield responses. On flat seedbeds, basal application of P_{120} and N_{30} at planting increased biomass by 2.6 g plant^{1} while the reduction of P fertilizer application rate to 80 kg ha^{-1} and the delay of N_{30} topdressing to 6 weeks after planting improved aboveground vegetative dry weight by 2.9 g plant^{-1}. Cutting the ridge seedbed width from 1 m to 0.5 m increased soybean grain yield by 41.6% when P_{80} was applied as a pre-planting fertilizer and N_{30} as a top dressing at six weeks after planting. The 0.5 m wide ridge seedbeds had 27.3% more soybean grain yield over that in the 1 m wide ridges when P_{120} was applied as a pre-planting fertilizer and N_{30} was applied at planting. Delaying the application of N_{30} to six weeks after planting and downgrading P application rate from 120 to 80 kg ha^{1} reduced soybean yield by 20.3 g plot^{1} in the wide ridges, increased grain yield by 106.9 g and 67.6 g plot^{1} in the narrow ridge and flat seedbed variants respectively.

Key words: Soybean, seedbed configuration, fertilizer.

Introduction

A small minority of microorganisms are exceptional in being able to reduce molecular N_2 to NH_3. The NH_3, in turn, is combined with organic acids to form amino acids and, ultimately, proteins.The symbiotic N_2 fixation in legumes involves an endosymbiotic association with diazotrophic (N_2-fixation) soil bacteria of the family *Rhizobeaceae,* which include *Rhizobium, Bradyrhizobium, Mesorhizobium and Azorhizobium* bacteria. *Rhizobia* bacteria invade the root hairs and cortical cells, ultimately inducing the formation of nodules that serve as the home for the organisms (Santos *et a*l., 2001). Within these nodules, the differentiated bacteria (bacteroids) reduce N_2 with the participation of the enzyme nitrogenase as follows:

$$N_2 + 8e^- + 16ATP ? 2NH_3 + H_{2bnh} + 16ADP + 16Pi$$

The host plant supplies the bacteria with carbohydrates for energy, and the bacteria reciprocate by supplying the host plant with fixed nitrogen compounds, an association that is mutually beneficial (Long, 2001). For the continued success of legumes in agricultural systems, the legume should have effective root rhizosphere associations. Successful inoculate bacteroid strains must be able to rapidly colonise the soil and tolerate environmental stresses, as well as compete with populations of background *Rhizobia* for nodule formation (Brockwell *et al.*, 1995).