Growth and Yield Responses of Two Soybean Cultivars to Inoculation, P and N Fertilization in Northern Mozambique

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INTRODUCTION

Soybean grain yield depends on nitrogen obtained from two major sources: soil mineral N and through symbiotic N_2 fixation when grown in association with effective and compatible *Bradyrhizobium* strains. A well-nodulated soybean is capable of obtaining more than 80% of its N requirement from N_2 fixation. However, many tropical soils, in particular first-time soybean fields may not contain the specific *Bradyrhizobium* to establish effective association. Thus, inoculation is essential to ensure that a large and effective *Bradyrhizobium* population is available in the rhizosphere of the plant to facilitate nodulation and N_2 fixation. However, the symbiotic nitrogen fixation process can be limited by a number of biotic and abiotic factors. It is well documented that successful N_2 fixation depends on the interaction of environment, management, legume cultivar and soil factors. In Mozambique, where soybean is relatively new, inoculation increased soybean yield at several sites. However, grain yield may be constrained in soils deficient in P and also when N at the beginning of the growing season is limited. The objectives of this study were to evaluate the responses of two soybean cultivars to inoculation and the interactive effects of phosphorous and started N application on nodulation and grain yield.

MATERIALS AND METHODS

A field experiment was conducted during the 2012/2013 growing season on clay loam soil at Ruace (15º14' S, 36º43' E) in Northern Mozambique (Fig. 1) using two soybean cultivars: Storm and Zamboane (a promiscuous nodulating cultivar). A split-plot design with four replications arranged in a randomized complete block with zero and 40 kg P/ha as main plots was used. The sub-plots consisted of a factorial combination of the two cultivars, 40 kg N/ha as starter N, a peat based inoculant applied at planting, and a combination of 40 kg N/ha and inoculant. Seeds were planted on 12 Dec 2012 and each plot consisted of five rows measuring 9 m long with 0.50 m row spacing. Data analysis was performed using PROC GLM. Cultivar, inoculant and the fertilizers were considered fixed factors. Significant differences among means were evaluated using LSD at 5% probability.

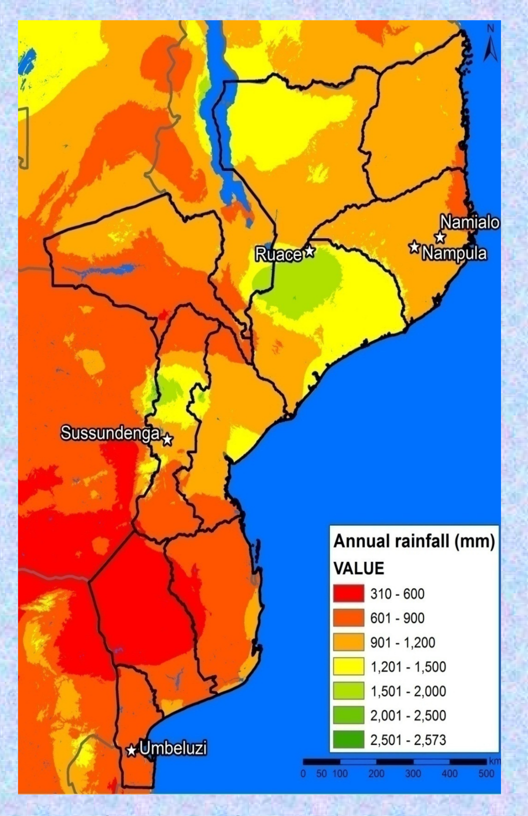

Fig. 1. Map of Mozambique

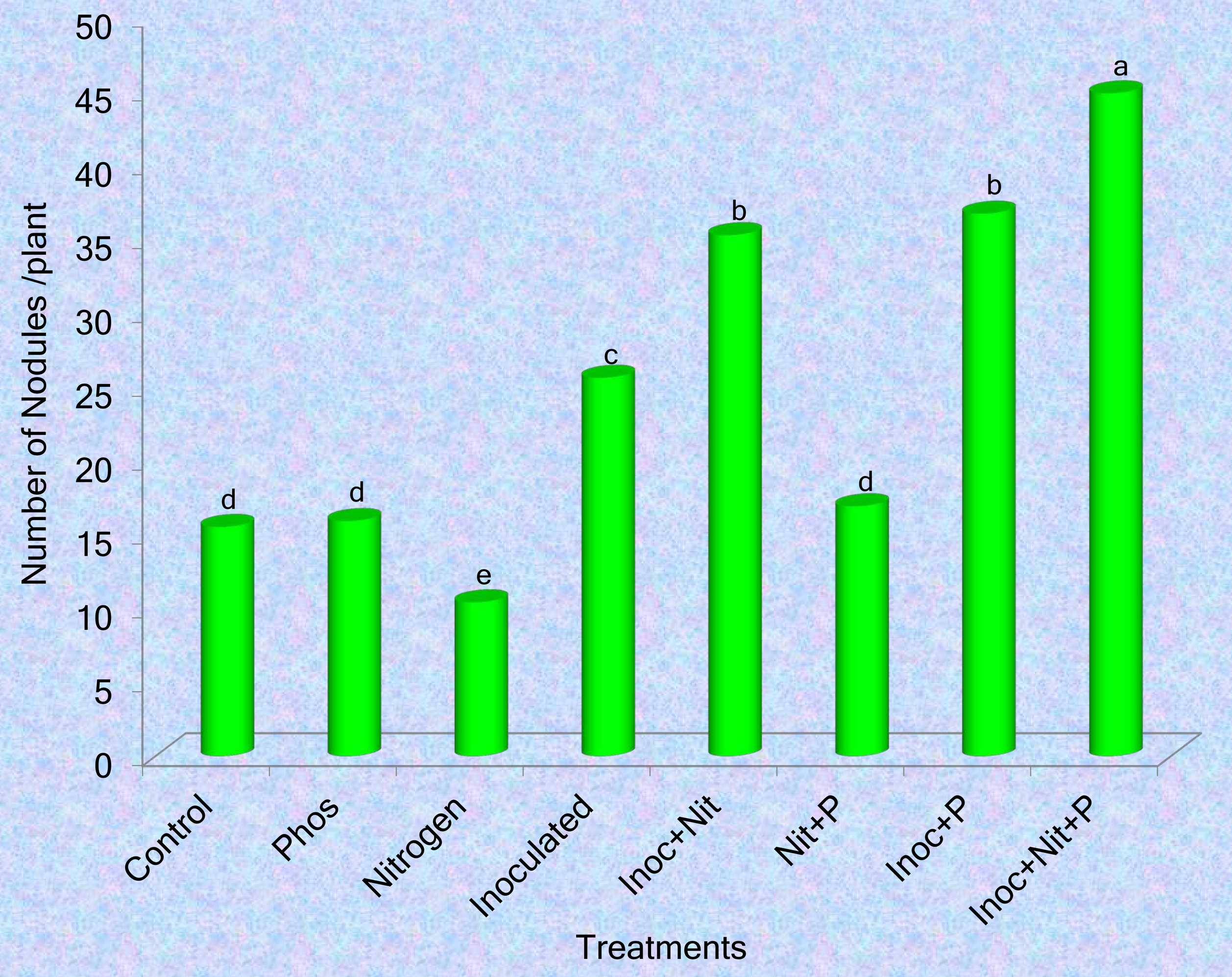

Fig. 2. Number of nodules produced by soybean cultivar Storm in response to inoculation, phosphorous, nitrogen and a combination of the inputs at Ruace. Bars with the same letter are not significantly different at $P = 0.05$

RESULTS

- The cultivars differed in nodulation, yield and yield components and significant cultivar x P, N or inoculant interactions occurred for number of nodules, plant height and number of pods per plant
- Inoculation increased nodulation but P alone had no effect on nodulation in both cultivars (Fig. 2)
- N decreased nodulation in Storm, but it had no effect on nodulation in Zamboane
- Significant interactions between inoculum and the other factors occurred for nodulation, yield and other variables
- Inoculant+N increased nodulation of Storm, whereas a combination of the two factors decreased nodulation in Zamboane compared with inoculation alone
- Inoculant+N+P produced the highest number of nodules in Storm but Inoculant+P produced the highest number of nodules in Zamboane,

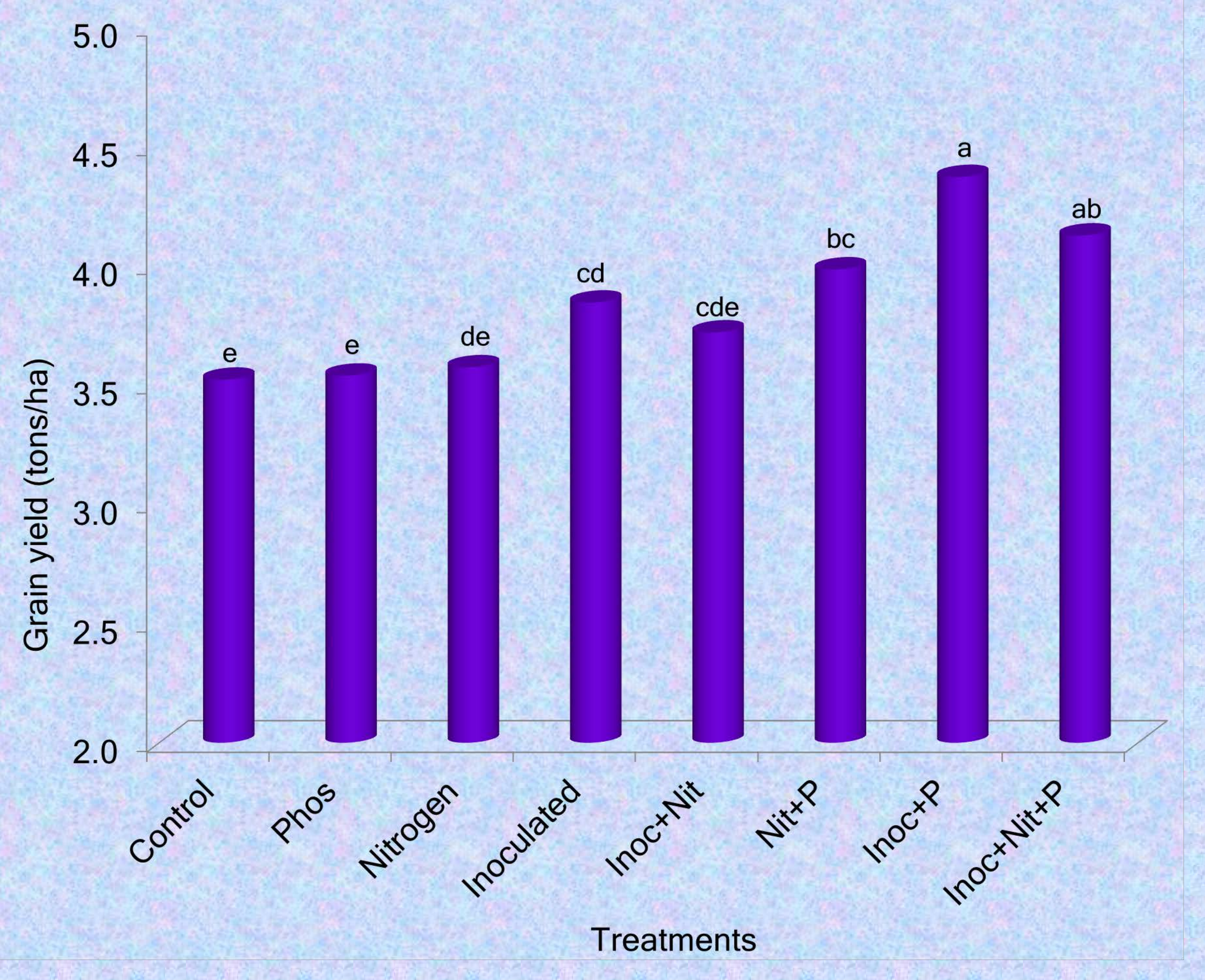

Fig. 3.Yield response of soybean cultivar Storm to inoculation, phosphorous, nitrogen and a combination of the inputs at Ruace. Bars with the same letter are not significantly different at $P = 0.05$

- Grain yields of plants that received inoculation alone were higher than that for either P or N alone (Fig. 3)
- Either P or N alone had no effect on grain yield of Storm but P increased grain yield of Zamboane
- Positive interaction occurred between Inoculant and P for grain yield in both cultivars
- Similarly, grain yield increased when a combination of inoculant, P and N were applied
- Inoculation + P produced the highest yield: Yield increased by 849 kg/ha for Storm and 688kg/ha for Zamboane
- Similar results were obtained in on-farm demonstration trials involving 60 farmers; Mean yield increase over control = 304 kg/ha for P; 421 kg/ha for Inoculant; 559 kg/ha for Inoculant+P

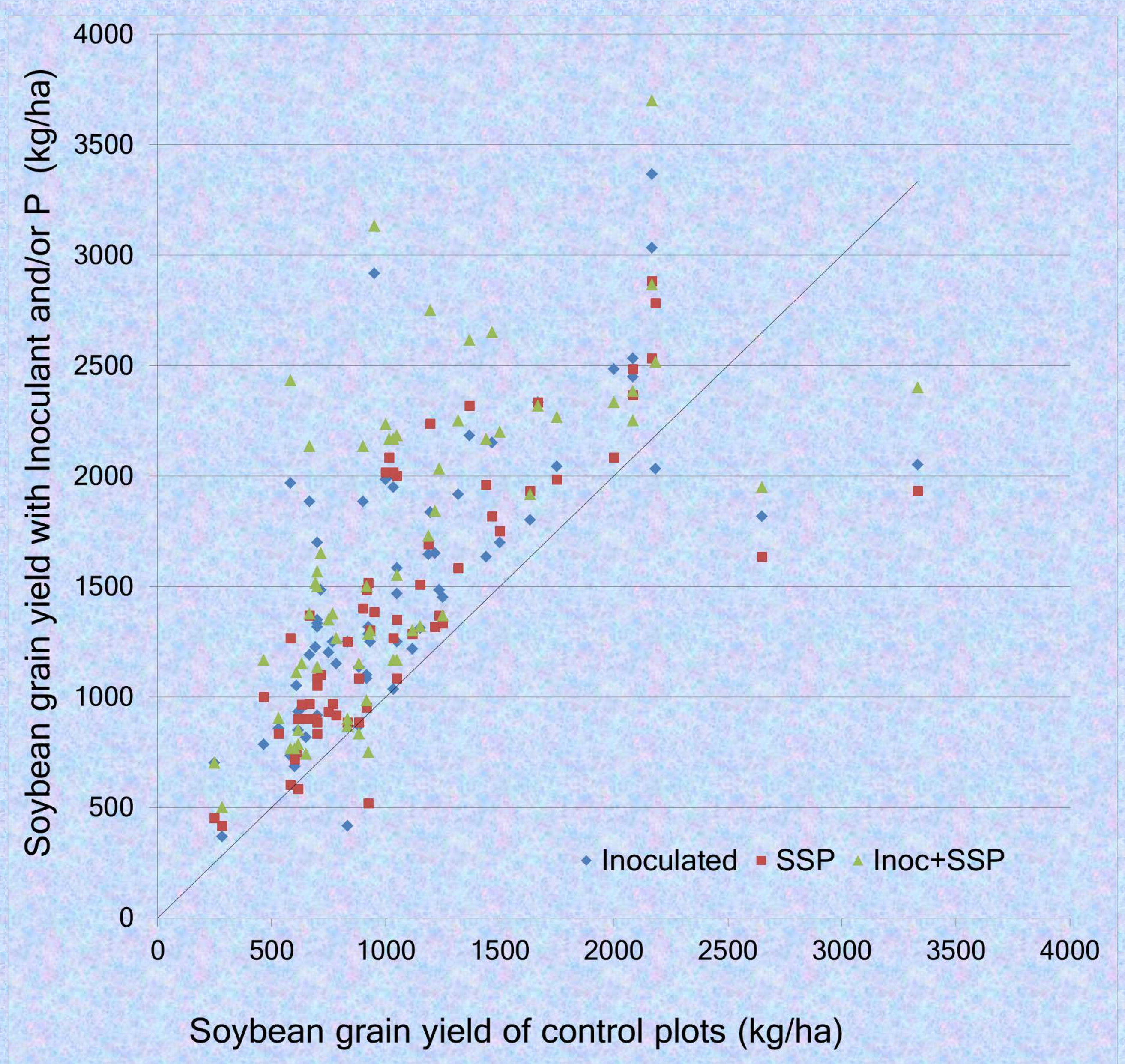

Fig. 4. Yield of soybean grown with no inputs vs. those with inputs. Points above the trend line indicate grain yields are relatively higher than those for the control and vice versa

SUMMARY AND CONCLUSIONS

Inoculation increased nodulation and grain yield of the soybean cultivars and adding P and N further improved nodule formation. Combination of Inoculant and P produced the highest grain yield in both cultivars. Though not significant, addition of N as a third input decreased grain yield. The results suggest that grain yield was constrained by P; hence the combined use of Inoculant and P produced higher yield than when Inoculant or P was applied alone. It is also clear that starter N is not necessary at that location. The cost of the inoculant was \$6 ha^{-1} and is cost effective but the high cost of fertilizers in Mozambique makes it uneconomical to apply P since the yield increase can not pay for the cost of the P applied.

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