Growth and Yield Responses of Cowpea Cultivars to Inoculation and P Fertilization in Different Environments

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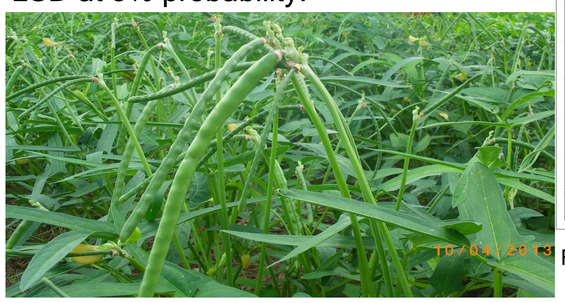
INTRODUCTION

Cowpea [*Vigna Unguiculata* (L.) Walp] is a major grain legume grown in semi-arid regions of Sub-Saharan Africa (SSA). It is a major source of protein and a cheap source of quality protein for both rural and urban dwellers. It is also an essential component of smallholder cropping systems. Under this system, cowpea grain yields are very low averaging 300 kg ha^{-1} due to lack of improved cultivars, poor management practices and limited inputs use. Inoculation with rhizobia is a common practice that can enhance nitrogen fixation in legumes leading to increase yields. However, it is not a common practice in cowpea production because it is assumed that indigenous rhizobia that effectively nodulate cowpea is abundantly present in tropical soils. Therefore, inoculation is not necessary. In this study, we estimated the number of the indigenous rhizobia population and evaluated the effects of inoculant and P on nodulation, N accumulation and yield of two cowpea cultivars in three contrasting agro-ecologies of Mozambique.

MATERIALS AND METHODS

Field experiment was conducted in 2014 and 2015 on clay loam soils in Nampula (15.2739^{o} S, 39.3136^{o} E); and Ruace (15.1408^{o} S, 36.4136^{o} E) in Northern Mozambique; and Sussundenga (19.0885^{o} S, 33.4800^{o} E) in Central Mozambique (Fig. 1) using two cowpea cultivars: IT-18 and IT-1263. A randomized complete block design with four replications was used. Treatments consisted of non-inoculated control, seed inoculation with USDA 3456, application of 40 kg P_2O_5 ha^{-1} as single superphosphate (SSP) and inoculant + 40 kg P_2O_5 ha^{-1} applied together. Seeds were planted in Jan and each plot consisted of seven rows measuring 9 m long with 0.75 m row spacing.

Data analysis was performed using PROC MIXED. Significant differences among means were evaluated using LSD at 5% probability.



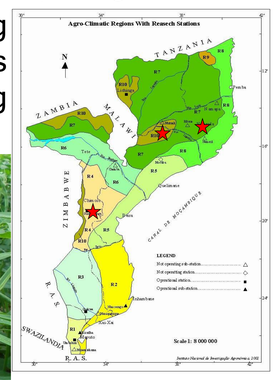


Fig. 1. Map of Mozambique

Table 1: Effects of inoculation and P on nodulation and yield components averaged across two growing seasons and over two cowpea cultivars in Nampula and Ruace, Mozambique

Treatment	No. Nod plant^{-1}	Nod DW plant^{-1} (mg)	Shoot dry Wt. plant^{-1} (g)	No. Pods plant^{-1}	Seeds pod^{-1}	100-Seed wt. (g)
			Nampula			
Control	14.6^{b}	56.1^{b}	22.6^{c}	23.4^{a}	14.0^{b}	14.0^{a}
Inoculant	19.6^{a}	97.4^{a}	32.0^{ab}	25.2^{a}	15.0^{a}	14.1^{a}
P	18.3^{a}	90.7^{a}	32.3^{a}	23.8^{a}	15.0^{a}	14.0^{a}
Inoculant + P	19.4^{a}	101.2^{a}	27.8^{b}	24.0^{a}	15.2^{a}	14.2^{a}
			Ruace			
Control	8.4^{d}	77.9^{d}	37.2^{b}	20.3^{b}	11.6^{a}	14.2^{a}
Inoculant	14.8^{b}	159.8^{b}	48.8^{a}	26.7^{a}	12.0^{a}	14.7^{a}
P	11.7^{c}	124.8^{c}	44.0^{a}	21.2^{b}	11.9^{a}	14.4^{a}
Inoculant + P	18.4^{a}	209.2^{a}	47.9^{a}	23.6^{ab}	12.3^{a}	14.8^{a}

Means within a column followed by the same letter are not significantly different at $P = 0.05$

RESULTS

- The estimated indigenous rhizobia populations by MPN method were 6.89 x 10^{2}, 1.07 x 10^{3} and 5.27 x 10^{2} cells g^{-1} soil for Nampula, Ruace and Sussundenga, respectively
- Location had dominant effect on the variables evaluated than all the other factors
- Inoculant and P had similar effects on the two cowpea cultivars across locations, and treatment x cultivar interactions for most of the variables were not significant
- Inoculation increased nodule number by 34-76% and doubled the dry weight of the nodules (Table 1)
- P improved nodulation and had positive interaction with inoculant
- Inoculant, P and inoculant + P increased shoot dry weight, but differences in number of pods plant^{-1}, seeds pod^{-1} and 100-seed weight were not consistent

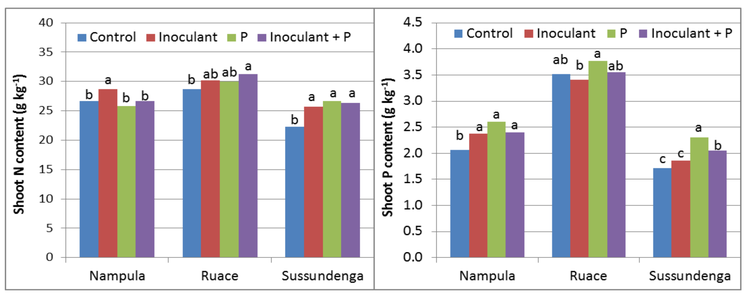


Fig. Effects of inoculation and P fertilization on shoot N and P content averaged across two cropping seasons and over two cowpea cultivars in Nampula, Ruace and Sussundenga, Mozambique. Bars with the same letter at the same location are not significantly different at $P = 0.05$

- Shoot N content of inoculated plants and inoculated + P fertilized plants was relatively higher (Fig. 1)
- Shoot P uptake was higher for plants that received P alone
- Inoculant or P increased yield and positive interaction between the two inputs occurred (Fig. 2)
- Applying inoculant + P increased yield by 56% (557 kg ha^{-1}) in Nampula and 30% (386 kg ha^{-1}) at Ruace compared with the control
- In low P soil (Nampula), yield response to P was higher than the response to inoculant
- Grain N and protein content increased when inoculant or inoculant + P was applied, although inoculation alone was superior
- Negative correlation between grain yield and protein concentration was evident

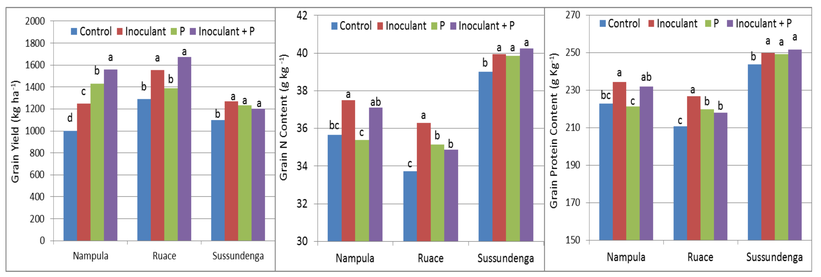


Fig. Effects of inoculation and P fertilization on grain yield, and grain N and protein content averaged across two cropping seasons and over two cowpea cultivars in Nampula, Ruace and Sussundenga, Mozambique. Bars with the same letter at the same location are not significantly different at $P = 0.05$

SUMMARY AND CONCLUSIONS

Cowpea responded to inoculation and P in soils containing indigenous *Bradyrhizobium* spp. The effect of the inoculant strain was higher in soils with adequate available P, whereas significant response to P occurred on low P soil. Applying inoculant + P resulted in positive interactions for most of the yield parameters and was more pronounced for yield on the low P soil suggesting that grain yield was constrained by P. The results demonstrate the potential of improving cowpea grain yield and quality using inoculant and/or P, although the cost-benefit for using P at the current fertilizer price in Mozambique is not attractive.

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