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Phosphorus Fertilizer Rating and Rhizobia Inoculation for Improved Productivity of Cowpea in Northern Uganda

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Abstract

Cowpea (*Vigna unguiculata*) is an important legume crop in the tropics and subtropical regions of the world. It is mainly grown for its leaves and grains, and to a lesser extent as a fodder crop. Cowpea is considered as the most important food grain legume in the dry savannas of tropical Africa. This study compared the yield of local (*Agondire*) and improved (SECOW 2W) cowpea varieties grown on an Oxisol. Inorganic P at levels of 0, 10, 20, and 40 kg·ha^{-1} was tested on each variety with or without rhizobia inoculation. The experiments were set up in a randomized complete block design and replicated thrice during the short and long rains of the 2015/2016 seasons on fifteen fields in Arua district, northern Uganda. *Agondire* responded significantly ($P < 0.05$) better than SECOW 2W when high rates of inorganic phosphorus (40 kg P ha^{-1}) were applied. A significant increase of 26.4% and 28.4% in grain yield of *Agondire* and SECOW 2W, respectively was obtained after inoculation with rhizobia. We concluded that inoculation and P fertilizer application increased the yield of both varieties, but with inoculation, SECOW 2W performs much better at lower P fertilizer rates than *Agondire*. Therefore, we recommend growing of SECOW 2W under inoculation with 20 kg P ha^{-1} and an application of 40 kg P ha^{-1} for *Agondire* local cowpea variety in northern Uganda.

Keywords

Phosphorus Fertilizer, Rhizobia Inoculation, *Agondire*, SECOW 2W, Yield

1. Introduction

Cowpea (*Vigna unguiculata*) is a tropical, annual herbaceous legume that belongs to the family Papilionacea (Fabaceae), order Leguminosae and genus Vigna [1]. It is an important component of agricultural food crops consumed by smallholder farming households. Cowpea plays an important role in achieving food security [2]. It is highly nutritive, having dry matter content of 91% with Iron, Zinc, and Calcium up to 363, 32.2 and 1112.9 mg·kg^{-1} respectively, and globulin proteins [3]. The crop is capable of bridging malnutrition and hunger periods since it matures fast and its leaves and grains are edible.

It is estimated that about 14 million hectares of land are globally under cowpea annually [2]. In Africa, the average production area annually under cowpea is over 12.5 million hectares [4]. In sub-Saharan Africa (SSA), the total area harvested for all food legume crops totaled 20 million hectares by 2006-2008 of which 54% was under cowpea [2]. In Uganda, 11,000 MT from 23,800 ha was harvested in the same period. From this production, 51.5% was consumed at production household level, 20.7% sold while 18.5% was stored for seed [5]. Cowpea is consumed by about 200 million people in Africa making it a very important legume [6].

On-farm yields of cowpea on smallholder farmlands have remained low [6] [7]. For example, between 50 kg·ha^{-1} and 500 kg·ha^{-1} attained on-farm is in marked contrast to over 2000 kg·ha^{-1} obtainable at research stations [2] [7] [8]. The low yields of cowpea are due to low soil fertility with P being the most limiting nutrient [4] [8] [9], which is exacerbated by low adoption of improved cowpea varieties and technologies [4] [10] [11]. Around 10 kg·ha^{-1} of starter N and 13 to 30 kg·ha^{-1} P were reported as a requirement in low fertility soils for some varieties to ably fix atmospheric N and better yields in other parts of Africa, Rhodesia [12]. Implying that there is a need for inorganic P fertilizers to be incorporated for soils with low P quantities that lose more P than it is replenished [8]. Thus, the cultivation of cowpeas will require P for efficient nodulation and thus nitrogen fixation in the soil [13].

West Nile loamy farmland agro-ecological zone also known as Annual Cropping and Cattle West Nile System located in northern Uganda is a key zone for cowpea. This zone is dominated by Oxisols as mentioned in Arua State of Environment Report of 2015 and characterized as old and highly weathered soils which are generally low in fertility [14]. Low fertility soils have also been reported to have insufficient rhizobia cells for improvement of N fixation [15]. Increase in N for plant uptake with rhizobia inoculation could be expected to increase vegetative growth in cowpea [16]. But however, the increase does not

environmental stresses like unreliable rainfall and hot weather.

SECOW 2W attains its maximum yield at 20 kg P ha^{-1} with inoculation and therefore inoculation of the variety influenced yield. On the other hand, *Agondire* yield was less affected by inoculation but more by P fertilizer application attaining its maximum yield at 40 kg P ha^{-1} with or without inoculation. It is concluded that the improved variety requires low rates of P than the local variety when inoculation with rhizobia is applied.

We recommended that farmers adopt the improved variety such as SECOW 2W because it realizes the highest yield at low P rate than the local variety (*Agondire*) with and without inoculation. In further studies, there is need of harnessing the native rhizobia strains to match the current commercial rhizobia strain used in this study.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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