Research Application Summary

Farmer - managed trials for evaluation of rhizatech and legumefix in Bungoma district Kenya

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Abstract

The nitrogen reserve of agricultural soils must be replenished periodically in order to maintain an adequate level for crop production. This replacement of soil nitrogen is generally accomplished by the addition of fertilizers or as products of biological nitrogen fixation (BNF). Symbiotic BNF allows many legumes to meet their nitrogen requirements from the atmosphere rather than the soil but in some cases, the resident population of rhizobium bacteria, the microsymbiont associated with nitrogen-fixing legumes, may not perform as an effective symbiotic partner. Increasing grain, tree and pasture legume production and matching these legumes with the correct microsymbiont are therefore a key component of improving agriculture and ecosystem services in the tropics. Identifying niches for legume BNF within existing farming systems is of paramount importance as the price of inorganic fertilizer continue to increase.

Key words: BNF, Kenya, Legumefix, Rhizatech

Résumé

La réserve de l'azote des sols agricoles doit être renouvelée périodiquement afin de maintenir un niveau adéquat pour la production agricole. Ce remplacement d'azote du sol est généralement accompli par l'ajout d'engrais ou de produits de fixation biologique d'azote (BNF). La symbiotique BNF permet à beaucoup de légumineuses de répondre à leurs besoins en azote de l'atmosphère plutôt que de sol, mais dans certains cas, la population résidente de bactéries rhizobium, le micro-symbiote associés aux légumineuses fixatrices d'azote, pourraient fonctionner comme un partenaire symbiotique efficace. L'augmentation de céréales, d'arbres et production de légumineuses et de pâturages correspondant à ces légumineuses avec les microsymbiotes corrects sont donc un élément clé de l'amélioration de l'agriculture et les services éco-systémiques dans les zones tropicales. L'identification des créneaux pour les légumineuses BNF dans les systèmes

agricoles existants est d'une importance capitale comme les prix des engrais inorganiques continuer à augmenter.

Mots clés: BNF, Kenya, *Legumefix, Rhizatech*

Background

African agriculture stands at a crossroads. Either food security in Africa will remain elusive, isolated successes fuelling a sense of false optimism in an otherwise dismal situation or decisive action can be taken to assist small-scale farmers to grow more and more valuable crops. Excellent progress is being made in crop improvement and seed systems, and many crop diseases, particularly viruses and fungal leaf pathogens, no longer pose a major problem (DeVries and Toennissen, 2001). Poor soil fertility and nutrient depletion continue to represent huge obstacles to securing needed harvests. Improving access to fertilizers is a necessary countermeasure, particularly when farmers develop skills in selecting which fertilizers are required and how to best derive benefits from their application.

LEGUMEFTX is a rhizobial inoculant. Rhizobia are microbial organisms that are able to fix nitrogen from the atmosphere. They form nodules on the roots of leguminous plants and live in symbiosis with their host. They provide nitrogen to the plant, and receive nutrients from the plant in return. Soils naturally contain Rhizobia, especially if they are often cultivated by legumes. Introducing new and more efficient Rhizobia can however greatly improve nodulation and nitrogen fixation. LEGUMEFIX contains such rhizobia. It is a peat-based commercial inoculant that is mixed with the seed lust before planting. Only a small amount of inoculant is required.

RHIZATECH is a mycorrhizal inoculant. Mycorrhizas are fungal organisms that colonize the plant roots and form hyphae. These hyphae function as extensions of the root system that allow the plant to explore a larger soil volume. Mycorrhizas live in symbiosis with their host. They receive sugars from the plant, and in return assist the plant to acquire nutrients from the soil, especially phosphorus. Soils naturally contain Mycorrhiza, but introducing new and more efficient organisms can improve crop growth and yield. RHIZATECH (a commercial product) contains such organisms, mixed with sand, phosphate rock and some organic mailer. It is applied in the planting line, together with the seed. The inoculant should not be placed in the sun, as this will affect the organisms. When applying Mycorrhiza, application of large amounts of phosphorus-containing fertilizers such as DAP and TSP should be avoided, because this will suppress the organisms ability to forage for P. However, Mycorrhiza mainly assist the plant in obtaining phosphorus.

Literature Summary

Nitrogen in maize-based systems of West African savanna is estimated to be 36-80 kg N ha^{-1} per year (Sanginga *et aI.*, 200lb) and it has been obvious since the mid-1990s that fertilizer use is necessary if sustainable agricultural production in smallholder farms is to be raised to levels that can sustain the growing population. In contrast to expensive chemical N fertilizers, the use of nodulated legumes in smallholder farming systems is often a more attractive and practicable alternative. Their ability to fix atmospheric N allows them to grow in N impoverished soils. Maximal rates of BNF recorded in the tropics reach an astonishing 5 kg N ha^{-1} day^{-1}with the green manure *Sesbania rostrata* (Giller, 2001). More than 250 kg N ha^{-1} of fixed N_2 has been measured in soybean in Southern Africa with associated grain yields of 4 t ha^{-1}.

Arbuscular mycorrhizal fungi (AMF) are common roots colonizing fungi forming symbiosis with most plants (Sieverding and Liehner, 1984). These fungi have been reported from diverse natural ecosystems including deserts, sand dunes, tropical forests, salt marshes and in managed systems such as pastures, orchards and field crops (Brundrett, 1991). Soil hyphal networks produced by these symbiotic fungi provide a greater absorptive surface than plant root hairs. In their turn, AMF benefit from carbohydrates provided by host plants as a source of energy. The value of AMF in extending the nutrient absorptive area of crop species has been thoroughly documented (Jacobson *et al.*, 1992). Plant growth stimulation with mycorrhizal colonization is normally attributed to enhanced P uptake (Cooper and Tinker, 1978). Mycorrhiza could be the most important untapped and poorly understood resource for phosphorus acquisition in agriculture (Johnson *et al.*, 1991). While it has become widely accepted that mycorrhizal populations associated with roots of crop plants play a ubiquitous and critical role in phosphorus acquisition, progress in utilizing this resource is incomplete. The fundamental reason underlying this disappointing progress is the lack of methodology suitable for identifying and evaluating mycorrhizal species and strains under field conditions.

Study Description

Soils of Bungoma District have an average pH of 5.54, percent carbon 1.37, percent Nitrogen 0.18 and available P 4.8mg/kg from 57 samples. The trial were instaled during the long rains of 2010. The trial consisted of 4 plots of 4.5 m x 4.5m each. Alleys of 1 m between plots were maintained between plots.

Plots were numbered and coded as follows:

Plot Number	Code	Treatment
P1	C	Control (no product applied)
P2	R	Application of Rhizatech
P3	L	Application of Legumefix
P4	R+L	Application of both Rhizatech and Legumefix

Plant variety and density. Soybean was grown, and variety TGx174O-2E ("SB19) was used. This variety is a medium-maturity type with promiscuous nodulation capacity, but has been shown to respond positively to both products. Soybean was planted at a spacing of 50cm between rows and 7.5cm between plants in a row. Each plot received 125 g of seed, which was more than required. After emergence, thinning was done to the appropriate density.

Management and observations during growth. At about 2-3 weeks after planting, when plants were about 10-15cm tall, the farmer counted the number of plants in each plot. Thinning was then be done, so that - the distance between plants in each row was about 7.5 cm (4 fingers width). After thinning, the number of plants per plot was recorded again.

Farmers managed the plots and weeded timely, as required. During weeding, farmers started by weeding P 1, followed by P 2. Tools were then washed with water and soap to avoid contamination, before weeding P 3 and P4 as per the treatments above.

During crop growth, farmers observed if any pest or disease symptoms appeared. The farmer noted down observations in their field books. If any pesticides (chemical or local) were applied during crop growth, this was also noted in the field book.

At full maturity, the farmers counted the number of plants in each plot. Each plot was harvested separately, and the pods were stored in well labeled paper bags. The pods were weighed fresh immediately after harvest, and the weights were recorded. The farmer dried the pods by placing the bags under the sun for

3 days. Subsequently, opened-up grains were weighed after shelling and grain yields recorded.

Research Application

In most cases, a strong response to Legumefix was observed in plant greenness, vigour and pod load. Effect of Rhizatech was less pronounced when applied solely, likely because plants were N-limited (pale green). When Rhizatech and Legumefix were applied in combination, plant vigour appeared to improve relative to sole Legumefix application

In terms of nodulation, legumefix tended to have few nodules, compared to combination of legumefix and Rhizatech; Rhizatech then comes third and finally control. In terms of weight of nodules, roots, number of pods, fresh weight biomass and fresh weight, in most cases the combination of legumefix and Rhizatech tended to performs better.

Recommendation

Farmers in Bungoma can increase their food security by inoculating their soybean seeds using Rhizatech and Legumefix in combination.

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