Integrated Soil Fertility/Pest and Disease Management approaches to address root-rot problems in common beans

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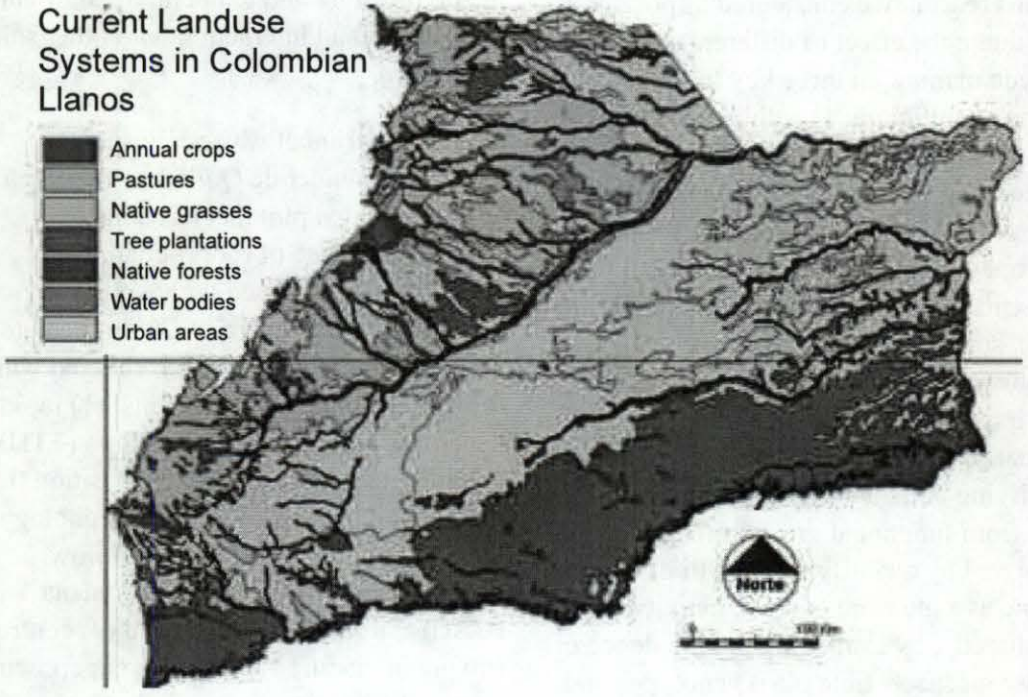
Consensus about societal demands for agricultural sustainability and biodiversity conservation has been reached in the past decade. New approaches to continuing problems, like soil degradation and soil pest and diseases, are then needed in order to achieve agricultural sustainability. Our overall working hypothesis in this study is that combining soil fertility and pest management approaches would provide a unique opportunity to exploit synergies allowing a better control of soil fertility/pest disease limitations to crop productivity than either approach alone.

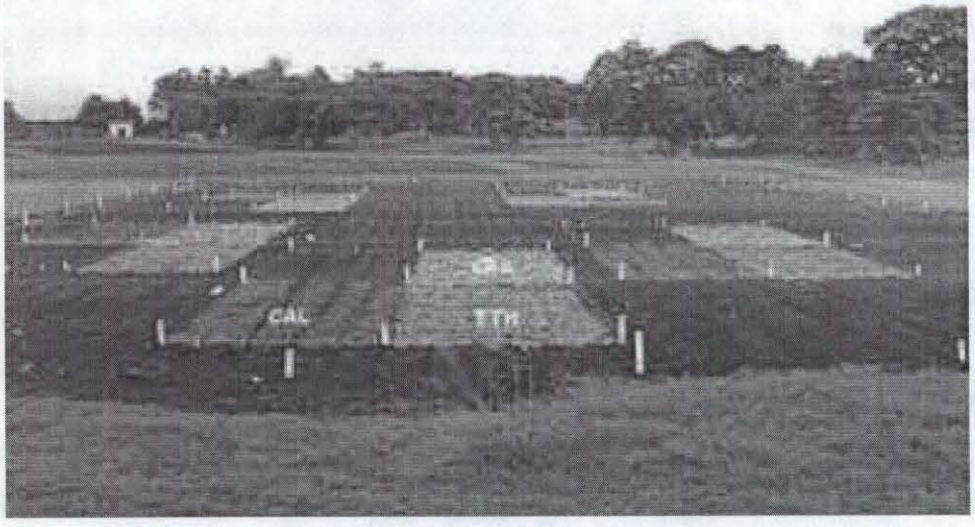
The management of organic matter is crucial to the activities of the soil biota. Use of green manures can have a multi-faceted beneficial effect on crop productivity arising from (i) protection of the soil from erosion; (ii) increased nutrient cycling; (iii) synchronized nutrient release and uptake by the plants; and (iv) increase in soil biological activity and diversity of microorganisms, which in turn can lead to minimized damage and loss from soil borne pathogens, and increased activity of beneficial microorganisms. However, different sources of green manure can have different effects on the balance between populations of



Land use distribution in tropical savannas (Llanos) of Colombia in 2003.

ISFM/IPDM Experiment

Potential of Green manures to control soil borne phytopathogenic fungi



harmful and beneficial organisms because they have different rates of decomposition and nutrient release as well as different impact on soil moisture and temperature that invariably affects relative population sizes. For this reason, we considered important to evaluate the effect of different sources of green manure on three key functional groups of soil biota: 1) pathogens, 2) microregulators and 3) microsymbionts. We are studying the population dynamics of soil pathogenic fungi (Fusarium, Sclerotium, Macrophomina, Rhizoctonia and Pythium), soil nematodes (discriminated by feeding habit), soil microsymbionts (mycorrhiza, rhizobia) during cultivation of common bean in soils infested with pathogenic fungi. Evaluations were carried out by: a) directly identifying and quantifying different soil biota from functional groups mentioned above and by quantifying growth of external hyphae as a measure of AMF activity and b) indirectly, by evaluating the incidence of disease on susceptible plant genotypes and by plant infection test for determining the native rhizobia symbiotic potential. The relative position of these three groups in the soil food web suggests the potential for soil organic matter management to reduce soil pathogenic fungi populations and incidence in bean plants by change induced in soil moisture and temperature, nutrient availability and interaction with other soil organisms.

A joint experiment was established in CIAT's Santander de Quilichao Research Station, using a plot that has a history of high incidence of root rot pathogens. The plots were planted with a root rot susceptible bean variety A 70. Immediately after planting, the plots were covered with three green manures treatments: (1) rapidly decomposing Tithonia diversifolia (TTH); (2) intermediate rate of decomposition (but greater soil cover due to leaf morphology) by Cratylia argentea (CRA); (3) slow decomposing (Calliandra houstoniana (CAL) at a rate of 6 t ha-1; and (4) control (no green manure added). The experiment was replicated five times. Soil samples (0-10 cm) collected during the cropping season

included at least planting and harvesting time. Samples were collected within rows and between rows, to measure the effect of the rhizosphere of bean plants on the soil biota studied.

Use of green manures can have a multi-faceted beneficial effect on crop productivity and are showing the potential to reduce crop losses from soil borne pathogens (root rots) and to improve the activity of native beneficial microorganisms (non-pathogenic nematodes, mycorrhizae and rhizobia). Following 4 cropping seasons, results reveal that application of Calliandra increased bean yield, reduced the incidence of root rots, increased AMF hyphal lengths and reduced nematode abundance. For treatments receiving Cratylia, minor differences were observed for root rot incidence, yield and nematode abundance, but AMF hyphal lengths were increased when compared to control. Although showing greater AMF hyphal lengths and lower disease incidence, bean yields in plots receiving Tithonia were lower than that obtained in control plots. Further studies are in progress to understand the interactions among soil fertility, soil biota (pathogenic and beneficial), and crop yield.