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Research Application Summary

Sustainable crop production using hairy vetch (*Vicia villosa* Roth) to enrich soil fertility and conserve soil moisture for maize cropping in smallholder farming systems in Zimbabwe

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Abstract

Crop production in smallholder farming systems of Zimbabwe is limited by low inherent soil fertility, particularly N and P and available soil moisture. One of the major agricultural challenges in developing countries is the development of technologies that are able to sustain soil fertility and conserve soil and moisture. The use of legumes is one way this could be achieved and therefore there is need to select appropriate and beneficial legumes for smallholder crop production in Southern Africa. Hairy Vetch (*Vicia villosa* Roth) has great potential for improving the crop production of high N demanding crops such as maize (*Zea mays*). This study therefore seeks to investigate the effect of the cover crop, Hairy vetch (*Vicia villosa* Roth) on maize yield, determine its N contribution through biological nitrogen fixation (BNF), its biomass production, characterise its decomposition and nutrients N and P release patterns and its effect on soil and water conservation in smallholder farming systems of in central Zimbabwe. Two agro-ecological zones, Natural Region II (Rainfall 750-1000 mm/year) and in Natural Region III (Rainfall 450-650mm/year) were selected for this study. Preliminary results have shown that sunnhemp has the greatest biomass production followed by cowpea with hairy vetch having the lowest yield. Soil and foliar samples are being analysed and soil and nutrient loss being measured using rainfall simulation.

Key words: Biomass production, hairy vetch, intercrops, rainfall simulation, soil conservation, soil fertility

Résumé

La production agricole dans les systèmes des petites exploitations agricoles du Zimbabwe est limitée par la faible fertilité des sols inhérente, en particulier à N et P et l'humidité disponible dans le sol. Un des grands défis agricoles dans les

pays en voie de développement est le développement de technologies qui sont en mesure de maintenir la fertilité des sols et de conserver les sols et l'humidité. L'utilisation de légumineuses est une façon d'atteindre cet objectif et, par conséquent il est nécessaire de sélectionner des légumineuses appropriées et bénéfiques pour la production agricole des petits exploitants en Afrique Australe. La vesce velue (*Vicia villosa* Roth) a un grand potentiel pour améliorer la production des cultures avec plus d'azote N exigeant des cultures comme le maïs (*Zea mays*). Cette étude vise donc à étudier l'effet de la culture de couverture, la vesce velue (*Vicia villosa* Roth) sur le rendement du maïs, de déterminer sa contribution en azote N par la fixation biologique de l'azote (BNF), sa production de biomasse, de caractériser sa décomposition et les modèles de libération des nutriments N et P et ses effets sur la conservation des sols et de l'eau dans les systèmes des petites exploitations agricoles dans la région centrale du Zimbabwe. Deux zones agro-écologiques, la Région naturelles II (pluviométrie 750-1000 mm / an) et dans la région naturelle III (pluviométrie 450-650mm/ an) ont été sélectionnées pour cette étude. Les résultats préliminaires ont montré que la crotalaire a la plus grande production de biomasse suivie par le haricot noir le niébé avec la vesce velue ayant le rendement le plus faible. Les échantillons de sol et des feuilles sont en cours d'analyse et la perte des sols et de nutriments mesurée à l'aide de la simulation de pluie.

Mots clés: Production de biomasse, vesce velue, intercalaires, simulation de pluie, conservation des sols, fertilité des sols

Background

In Zimbabwe most smallholder farmers are found in areas where soils are inherently infertile and rainfall low and erratic. Households living in smallholder areas depend on agriculture for their livelihood and the main crop grown is maize. Soils are generally sandy with low clay content and water holding capacity and are mainly derived from granitic and gneissic rocks and Kalahari sands (Anderson *et al.*,1993). They have low inherent soil fertility, particularly N and P, which is compounded by nutrient/fertility depletion as a result of continuous cropping without adequately replenishing nutrients and as well as through runoff and erosion. Leguminous plants can significantly enhance soil fertility by adding N directly to the soil. Some can be intercropped with grain crops such as maize thus reducing labour costs and solving the need for separate pieces of land for legume production (Palm *et al*., 1997). Hairy vetch is one such legume

plants that needs to be evaluated in terms of its ability to enrich soil fertility and improve soil physical properties.

Literature Summary

One of the major agricultural challenges in developing countries is the development of technologies that are able to sustain soil fertility and conserve soil and moisture. Hairy Vetch (*Vicia villosa* Roth) has great potential for improving the crop production of high N demanding crops such as maize (*Zea mays*). The plant has approximately 4.5 % N which is considerably higher than other cover crops such as red clover (3 %), alfalfa (3.5%) and mucuna (3.8 %) (Iragavarapu *et al*., 1995). Hairy vetch's characteristics are ideal for rapid turnover of nutrients. Several studies have shown that Hairy vetch contributes significant amounts of N to soil and to a crop inter-cropped with the legume (Hargrove, 1982; Smith *et al.*, 1987; McCraken *et al.*, 1989; Power *et al*., 1991; Ranells and Wagner, 1996, 1997). Some studies have also shown that Hairy vetch is drought tolerant (Duke, 1991) and is able to grow well in sandy and sandy loam soils (McLeod, 1982). There is limited information on performance of Hairy vetch under Southern African conditions where climate change impacts are likely to affect many smallholder farmers.

Study Description

Field experiments are being conducted in Wedza (31°30', 18°46') and Chiota (31°05', 18°11') communal farming areas, and on-station at University of Zimbabwe (UZ) farm and at Grasslands Research Station in Marondera. The soils at all sites are granite-derived sands to loamy sands except at the UZ farm where soils are red clays derived from dolerite.

Three experiments were established in each farmer's field selected in this study. The objective of the first experiment was to determine the dry matter production potential of hairy vetch and comparing it with cowpea and sunhemp. The experiment was a completely randomised blocked design with 6 treatments replicated (Blocks) 3 times.

The objective of the second experiment was determine the residual N contribution of hairy vetch to a succeeding maize crop in comparison to the residual N benefits of cowpea and sunhemp. The third experiment determined the effect of intercropping maize with hairy vetch, cowpea and sunhemp on maize yield. The effect of the three legumes on soil physical properties was also measured in experiment 1. Soil and nutrient loss was also measured using a rainfall simulator on plots in the same experiment.

The rate of decomposition and N and P mineralization of the legume residues will also be determined in a constant temperature room using two sandy soils from Wedza and Chiota communal areas. The experiment will run for 72 days.

Research Application

Biomass production of the various legumes was measured at 45, 60 and 75 days after planting (DAP) and maize stover and grain yield at the end of the season. For the 3 legumes planted, biomass production was greatest at 75 DAP. Sunnhemp had the greatest biomass yield at all the study sites followed by cowpea then hairy vetch (Fig. 1). Figure 1 shows the legumes in the field in Wedza. Soil samples are in the process of being analysed so as to assess the soil fertility benefits of the legumes. Rainfall simulation has been conducted at sites in Chiota and will be carried out at the other sites. This research project will increase our understanding of the benefits of the cover crop, Hairy vetch compared to cowpea and sunhemp, in smallholder maize farming systems in Zimbabwe and Southern Africa.

Figure 1. Hairy vetch, cowpea and sunhemp at 45 days after planting at a site in Wedza.

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