EFFECT OF BIOCHAR AND PHOSPHORUS FERTILIZER APPLICATION ON SELECTED SOIL PROPERTIES AND AGRONOMIC PERFORMANCE OF CHICKPEA *(Cicer arietinum L)*

BY

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Dissertation for Master of Science (MSc) degree in Agriculture (Soil Science)

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2015

ABSTRACT

Low soil fertility due to a decline in soil organic carbon is a major constraint affecting crop production in the tropical and subtropical regions of South Africa. Therefore, soil management practices such as biochar application which will maintain and sustain soil organic carbon and retain moisture and nutrients in the long term in such regions are imperative. This study aimed at evaluating the effect of biochar and phosphorus fertilizer application on selected soil properties and agronomic performance of chickpea grown in two different soil types.

Two field experiments, one in summer (2013/2014) and the other in winter (2014) season, were conducted at University of Venda's Experimental Farm in Thohoyandou, Limpopo Province (site A) and at the Agricultural Research Council- Institute for Tropical and Subtropical Crops (ARC-ITSC) in Nelspruit, Mpumalanga Province (site B). Treatments consisted of a factorial combination of four biochar levels (0, 5, 10 and 20 t ha^{-1}) and two phosphorus (P) fertilizer levels (0 and 90 kg ha^{-1}) arranged in a randomized complete block design and replicated three times. Selected soil physical (soil bulk density, porosity and aggregate stability) and chemical properties (soil pH, total C, total N, SOC, available P, Na, K, Mg, and CEC) were determined before and after harvest at both sites. Dry matter accumulation was determined at 50% flowering and at harvest maturity; grain yield and yield components were determined at harvest maturity at both sites. Crop water use was measured at 7 day interval using a neutron probe, and water use efficiency (WUE) was determined as ratio of total crop biomass/grain to cumulative water use at site A. The proportion of intercepted radiation (IR) was determined at a 7 interval; a ceptometer was used to measure the photosynthetically active radiation (PAR) above and below the canopy. All data for the summer and winter sowing was subjected to ANOVA using GLM procedure of Minitab, and data for soil chemical properties for the winter sowing was subjected to ANOVA using the RCBD model of SAS software. The difference between the treatments means were compared using the LSD test at ($P \leq 0.05$).

The effect of biochar and phosphorus fertilizer application on aggregate stability, bulk density and porosity was significant at site B (loamy sand soil) in both seasons. Biochar application increased total C, total N and C:N ratio at site A (clay soil) in the summer sowing. In contrast, biochar and P fertilizer application increased total C, SOC, C:N ratio, K, Mg, CEC in the summer sowing and Ca, K, available P in the winter sowing of a loamy sand soil. Biochar and P fertilizer application had no effect on dry matter accumulation, grain yield and harvest index of chickpea in both soils. Similarly, the effect of biochar and P fertilizer on water use and water use

efficiency was not significant in the summer and winter sowing on a clay soil. Intercepted radiation increased with biochar and P fertilizer application on a clay soil in the summer and winter sowing. The positive effect of biochar application with and without phosphorus fertilizer to improve soil properties on a loamy sand soil was observed at 10 and 20 t ha^{-1}, but was insufficient to increase growth and yield of chickpea in this study. It is evident from the results of this study that biochar effect may be soil specific as the effect was greater on low nutrient loamy sand soil than heavy clay soil. The results suggest that wood biochar used in the current study has the potential to improve carbon sequestration due to the increase in total C. Since this study was conducted over two seasons and biochar effect tends to be long term, further research is needed on biochar application rate and phosphorus fertilizer application on soil properties and yield of chickpea over a wide range of soils using biochar types from different feedstocks over a long-term period.

Keywords: biochar, soil degradation, organic carbon, soil properties, crop yield, water use efficiency