EFFECT OF PLANT DENSITY, PHOSPHORUS, AND RHIZOBIUM ON NODULATION, GROWTH, YIELD, AND SECONDARY METABOLITES IN SELECTED BEAN CULTIVARS IN IMENTI SOUTH, MERU COUNTY

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DECLARATION AND RECOMMENDATION

This thesis is my original work and has not been presented for the award of a diploma or conferment of a degree in any other university or institution.

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Recommendation

This thesis has been examined, passed and submitted with our approval as University Supervisors.

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DEDICATION

I dedicate this thesis to my beloved family especially my loving wife Lucy Keeru and our dear son Dan Murimi who have been a pillar of my strength throughout this education journey. Their prayers and encouragement even when things got tough gave me the zeal to continue.

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ABSTRACT

Common bean (*Phaseolus vulgaris* L.) is an important source of protein for more than 500 million people globally. Its production is low due to various biotic and abiotic factors. Many farmers grow bean varieties developed for different ecologies in their farms. This practice affects bean growth, yield, type and concentration of secondary metabolites. This study aimed at assessing the plant density, phosphorus and rhizobium effect on growth, nodulation, yield and secondary metabolite profiles of common bean varieties grown in medium potential agro ecological zone of Imenti South. A baseline survey was done to determine the factors affecting production and varietal selection of common beans. Field experiments were conducted at Kaguru Agricultural Training Centre for two seasons in a 3 x 2 x 2 x 2 factorial arranged in a randomized complete block design with three replications. Factors tested included plant densities (111,111, 222,222 and 166,666 plants/ha), bean varieties (KAT B1 and Red Haricot), rhizobium inoculum (0 g and 100 g/ha) and rock phosphate fertilizer rates (0 kg P/ha and 30 kg P/ha). Collected data was subjected to ANOVA using SAS version 9.4 and significant means separated using least significance difference at $\alpha = 0.05$. Baseline results showed that farmers with college education used proper fertilizer application methods, with 22.37 % of them producing higher yield 1.4-1.9 tonnes/ha. Several (16.74 %) with secondary education planted Red Haricot variety. Majority (88.16 %) farmers applied DAP fertilizer, while none used rock phosphate. About 18.42 % of middle-aged farmers did not use rhizobium during planting. Females (36.84%) planted beans for domestic use, and males (26.32%) for commercial purposes. Currently, the spacing adopted for Red Haricot, Rose Coco and Mwitemania varieties is 30 x 15 cm, while for KAT B1 is 45 x 20 cm. Rose coco variety was the most planted (14.47 %), while Red Haricot and Mwitemania were least (11.84 %) attacked by insect pests. Red Haricot was the most and Rose coco the least infested by weeds. Farmers (5.26 %) growing Rose coco, KAT B1 and Mwitemania attributed low yields to soil health. Integration of rhizobium and rock phosphate in Red Haricot recorded high significant ($p < 0.05$) number of nodules (5.79 and 13.00), the longest taproot length (5.20 cm and 5.57 cm) was in treatment R1V2D2P1. It recorded an average and satisfactory (4.79 and 6.45) number of nodules distributed on the upper roots and an average number of nodules (2.79 and 4.15) on the lower roots that were effective. The highest taproot lengths (4.81 cm and 5.27 cm) and (5.20 cm and 5.57 cm) was also recorded in treatments R1V1D3P1 and R1V2D2P1, in season 1 and 2, respectively. Red Haricot had the highest number of grains per pod (60.00 and 77.00) in season 1 and 2, respectively. Red Haricot significantly ($p < 0.05$) produced the highest number of pods (20.45 and 24.29) in treatment R1V2D2P1 at 14 DAFP, and R1V2D2P1 had the highest above ground biomass (3.70 tonnes/ha and 4.33 tonnes/ha) in season 1 and 2, respectively. Treatment R1V2D2P1 significantly ($p < 0.05$) gave the highest grain yield (2.66 and 3.03 tonnes/ha) and R0V2D1P0 the lowest grain yield (0.80 and 0.98 tonnes/ha) in season 1 and 2, respectively. In bean leaves, Quercetin metabolite concentration (16.90 mg/kg) was highest in R0V1D1P0 due to increased nutrient stress and least (0.04 mg/kg) in R1V2D2P1 probably due to adequate nutrients. Myricetin metabolite concentration (16.54 mg/kg) on the leaves was highest in R0V1D1P0. Treatments R1V1D2P1, R1V1D1P1, R1V2D3P1, R1V2D1P1, R1V1D3P1 and R1V2D2P1 did not record any myricetin concentration. Incorporation of rhizobium inoculant and rock phosphate under plant density 166,666

plants/ha and 222,222 plants/ha in KAT B1 and Red Haricot common bean varieties respectively, increased common bean production in medium potential agro ecological zones of Imenti South. The study, therefore, recommends growing of KAT B1 variety at a planting density of 166,666 plants/ha and Red Haricot at 222,222 plants/ha in medium potential agro ecological zones of Imenti South for enhanced plant growth and yield.