STUDIES ON FERTILIZATION, PLANT DENSITY, TRAINING, REPLACEMENT METHODS OF ESTABLISHED COFFEE AND INTERCROPPING FOOD CROPS WITH *Coffea arabica* L. cv. 'RUIRU 11'

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STUDIES ON FERTILIZATION, PLANT DENSITY, TRAINING, REPLACEMENT METHODS OF ESTABLISHED COFFEE AND INTERCROPPING FOOD CROPS WITH Coffea arabica L. cv. 'RUIRU' 11

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GENERAL ABSTRACT

Field studies were undertaken on nitrogen fertilization with or without phosphorus and/or potassium requirements of Coffea arabica L. cv. 'Ruiru 11' at establishment and cropping phases during the first production cycle. Fertilizer treatments were evaluated over tree densities of 2400, 3200 and 4000 trees/ha. Tree growth parameters such as tree height, stem diameter, primary branch growth and leaf expansion were not significantly increased with an increase of plant density. Similar observations were recorded on yield components which included the number of branches per tree and node production per primary branch. Yields of coffee beans increased by 43% from a plant density of 2400 to 3200 trees/ha and by 12% from a plant density of 3200 to 4000 trees/ha. Increase in yield of coffee beans with an increase of plant density were positively and linearly correlated (r=0.99).

Application of 27 kg K_2O/ha was noted to depress

yields of clean coffee unless it was applied in combination with N and P. The rather poor tree growth and yield response to fertilizers at the establishment period was evidenced by the statistically similar adequate leaf nutrient concentrations for coffee growth among the studied fertilizer treatments.

However, coffee leaf N was noted to be increased by increased N application. The proportions of large grade 'A'-sized coffee beans and plant water status were not significantly influenced by fertilizer and plant density treatments during the first two years of cv. 'Ruiru' 11 establishment.

Application of N alone or in combination with PK or P at 100 kg P_2O_5 and 80 kg K_2O/ha enhanced tree growth characteristics such as tree height, stem diameter, growth in length of primary branches and leaf expansion at production phase. Production of yield components were similarly influenced by N applications. Positive correlations between yields of clean coffee and rates of N application alone or with PK combinations were observed. These correlations were stronger when combinations of N and P or N, P and K were applied. Application of 160 kg-N/ha was superior to the other studied fertilizer treatments on the improvement of yields of clean coffee.

Plant densities studied did not influence significantly the tree growth characteristics at production phase. Yields of clean coffee significantly

increased with plant densities and this relationship was strongly positively correlated (r=0.99) as at establishment period. Yields increased by 27%, 13% and 44% from 2400 to 3200 trees/ha, 3200 to 4000 trees/ha and 2400 to 4000 trees/ha, respectively. A tree density of around 3200 trees/ha was ideal.

Proportions of coffee bean sizes, raw and liquor qualities were not influenced by fertilizer and plant density treatments. However, a decrease in yield of large coffee beans with increased rate of N application was observed. This decrease was reversed by an application of a combined N and P fertilizers.

The results of leaf nutrient analysis showed a high demand of nutrients such as N, P, and K during the coffee fruit development and ripening stages. Leaf N increased with an increase of the rates of N application. Similarly, leaf P was enhanced by addition of P fertilizer but this was observed to be depressed when P fertilizer was applied in combination with N fertilizer. The plant water status was not significantly affected by fertilizer applications and plant densities. Radius of coffee tree canopy measured after four years of field establishment indicated that there was no intercroppable gap between coffee rows with annual crops at that stage of growth of cv. 'Ruiru 11' where coffee trees were planted at 2m inter-rows.

Training of coffee trees with one or two stems per tree at plant densities of 1600, 2400, 3200, 4000 and

4800 trees/ha was studied. Trees trained to have two stems per tree tended to be taller than those trained with single stems. Irrespective of the training method, trees at lower plant densities had slightly thicker stems. Total number of primary branches were significantly higher on trees trained with two stems. However, the bearing primaries and productive wood were higher on trees trained with single stem system during the first year of production and increased in the subsequent production years on trees with two stems. Trees with two stems significantly depressed yields of clean coffee in the first production year to a magnitude of 245-842% irrespective of the plant density studied and despite the advantage of higher number of primary branches.

Yields of clean coffee increased significantly with tree density irrespective of the tree training method but the increase was at a decreasing rate after 3200 trees/ha. Proportions of large coffee beans, grade 'A', were not significantly influenced differently by the treatments. It was concluded that it is possible to raise two stems per tree during the first production cycle of cv. 'Ruiru 11'. However, single stems would be preferred and a high plant density of between 3000-3500 trees/ha would be ideal during the first coffee production cycle of cv. 'Ruiru 11'.

Studies on intercropping potatoes (Solanum tuberosum L. cv. 'Anett'), tomatoes (Lycopersicon esculentum, cv.

'Money maker'), maize (Zea mays cv. '511' and 'Katumani') and dry beans (Phaseolus vulgaris L. cv. 'Mwezi moja') with cv. 'Ruiru 11' were carried out for a period of two and a half years during field establishment phase. Coffee trees were planted at a spacing of 2 x 1.5m (3,333 trees/ha). Maize intercrop depressed the coffee tree growth characteristics such as tree height, stem diameter and growth of primary branches. This resulted in a significant reduction of initial yields of clean coffee by 59-100%. All other intercrops insignificantly depressed the yields of clean coffee. Potatoes planted at alternate coffee inter-rows and potatoes alternated with beans seasonally had the lowest influence on initial coffee yield depression of 8-25%. Potato, tomato and dry bean intercrops did not have any significant influence on coffee bean sizes, raw, roast and liquor quality.

The soil residue moisture content and coffee leaf water potentials were not influenced significantly by the intercrop systems. Similarly, the soil nutrient concentrations and reactions as well as the coffee leaf nutrient contents were not significantly influenced by the intercrops. Yields of food crops intercropped with cv. 'Ruiru 11' were not depressed by coffee trees at the establishment period of two and a half years.

Studies on replacement methods of established traditional coffee trees with cv. 'Ruiru 11' showed that addition of cv. 'Ruiru 11' to cv. 'French Mission' at hedgerow or staggered system giving a total population of

2664 trees/ha (2.74m x 1.37m) insignificantly enhanced cv. 'Ruiru 11' tree height. Irrespective of the replacement method, cv. 'Ruiru 11' seedlings trained with two stems per plant resulted in significantly higher number of primaries per tree. However, the bearing primaries/tree declined in the first year of production resulting into low or no yields. The highest number of bearing primaries on cv. 'Ruiru 11' were observed where cv. 'French Mission' was either completely or partially replaced with cv. 'Ruiru 11'. These two replacement methods resulted with the highest mean yields of clean coffee over the production cycle. Hedgerow system gave statistically similar yields to the partial replacement method of cv. 'French Mission' with cv. 'Ruiru 11'.