Nitrogen Use by Yam as Affected by Mineral Fertilizer Application


ABSTRACT

Soil fertility decline and high N demand during plant growth are cited as main causes of low yield in yam (*Dioscorea* spp.). As information regarding fertilizer N use in yam is lacking, a field experiment was undertaken in 2006 and repeated in 2007 in central Côte d’Ivoire using 15N ([15NH₄]NO₃) labeled fertilizers to monitor N uptake and fertilizer use efficiency in *D. alata*. The 15N-labeled fertilizer was added in two splits (at 90 and 130 d after planting) for a target tuber yield of 40 Mg fresh tuber ha⁻¹. The application of mineral fertilizers increased total biomass production and tuber yield as well as N uptake from native soil organic matter. The recovery of 15N-labeled fertilizer applied at 90 and 130 d after planting was not significantly different but the year affected 15N recovery by the plant. The maximum 15N recoveries calculated from the sum of the 15N recovery measured at both application dates were 46 and 23% in 2006 and 2007, respectively. Leaf dry matter and leaf N uptake were higher in 2006 than in 2007, but tuber dry matter was not different between years at the final harvest. Up to 170 kg N ha⁻¹ was returned to the soil through the fallen shoots, indicating an important recycling of N for soil fertility replenishment. Thus, crop succession or intercropping are encouraged in a yam cropping system. Our results also show that the application of mineral fertilizers had a strong “priming effect” on the native soil N in both years.

Yam is a highly demanding crop for N and K (Degras, 1993). To optimize yam fertilizer use efficiency in Africa, information on a variety of topics including: (i) understanding the relationship between climatic conditions and yam yields; (ii) nutrient uptake and distribution to different plant organs; (iii) soil critical values for optimum production; (iv) the release of nutrients from organic fertilizers; and (v) overall nutrient budgets are required. Unfortunately, this body of information is only scarcely available for yam.

In Africa, fresh tuber yields in farmers’ fields often are <10 Mg ha⁻¹ (Ettien and Tschannen, 2003). If new cultivars were adopted by producers, yields could reach 20 to 50 Mg ha⁻¹ (Ettien and Tschannen, 2003; Diby et al., 2009). To reduce the risk of soil nutrient mining by these high-yielding cultivars, fertilizer recommendations need to be developed and tested. When harvested, yams remove 3 to 5 kg N, 0.3 to 0.5 kg P, and 3 to 6 kg K kg⁻¹ of tuber fresh matter (Sobulo, 1972a, 1972b; Le Buanec, 1973; Obigbesan and Agboola, 1978; Ferguson et al., 1980; Budelman, 1989; Rodriguez et al., 1989; Degras, 1993; Diby, 2005). The amount of nutrients returned to the soil from senescent organs remains unknown, however. While the concentration of nutrients has been measured in other plant organs, e.g., by Sobulo (1972a, 1972b), Obigbesan and Agboola (1978), Aduayi and Okpon (1980), Irizarry and Rivera (1985), O’Sullivan and Jenner (2006), O’Sullivan et al. (2008), and Law-Ogbomo and Remison (2009), these data have rarely been used to quantify the total nutrient uptake by yams at different stages of crop growth (Sobulo, 1972a), making it difficult to assess what the maximum nutrient need would be and when it would be reached during the growing season. This, in turn, would be important for the timing of fertilizer addition. Finally, only limited attempts have been made to quantify the rate of release of soil nutrients to yam during plant growth (O’Sullivan et al., 2008).

The yield potential and response to fertilizers of yam are influenced by the plant germplasm and local climatic and soil conditions (Ettien and Tschannen, 2003; Diby et al., 2011; Marcos et al., 2011). For example, for *D. rotundata* in Nigeria, <50 kg N ha⁻¹ produced a yield ranging from 17 to 24 Mg fresh tubers ha⁻¹ (Kayode, 1985; Law-Ogbomo and Remison, 2008, 2009), while in Côte d’Ivoire, yields of 13 to 15 Mg ha⁻¹ were produced when 120 kg N, 28 kg P, and 103 kg K ha⁻¹ were applied (Ettien et al., 2009). For *D. alata*, the mineral fertilizer rates for maximum tuber yields varied from 75, 12, and 250 kg ha⁻¹ of N, P, and K fertilizer in Puerto Rico, where the tuber yield reached 18.8 Mg ha⁻¹, to 240, 11, and 269 kg ha⁻¹ of N, P, and K in Côte d’Ivoire, where the yield varied from 34 Mg ha⁻¹ when the yam was planted in a less fertile savannah site to 50 Mg ha⁻¹ when the crop was planted.

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Abbreviations: DAP, days after planting; Ndff, nitrogen derived from fertilizer.