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# Isotopic Tracer Study of Hydraulic Transfer Between Native Woody Shrubs and Associated Annual Crops Under Dry Conditions in the Sahel

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Erratic precipitation at the beginning and end of the rainy season combined with short drought periods during the cropping season pose a major challenge for rain-fed agriculture and food security in the Sahel. Research has shown that intercropping annual crops with native evergreen woody shrubs in Senegal can greatly increase crop productivity. Hydraulic redistribution (HR), or the diurnal rewetting of dry soil by the pathway of the root system that extends into wetter soil has been found in many plants and climates worldwide. The HR pathway could be a factor in Senegal where water provided by shrubs aids crop growth during dry periods but this has not been confirmed. Therefore, the objective was to determine the ability of shrubs to provide water to millet plants using the deuterium tracer. Penisetum glaucum (Pearl Millet) was grown in association with the native woody shrub Guiera senegalensis under drip irrigation until 68 days after sowing, followed by a with holding of water during late flowering and early grain-filling stage. Within 10 days the soils in the stressed plots became extremely dry with water potentials ranging from -0.5 Mpa to -3.0 Mpa at 20cm depth. Twenty days after the initiation of water stress, vials of isotopically enriched deuterium tracer was sealed around cut roots of three separate shrubs at a depth of 1.0 m followed by sampling of aboveground tissue from injection shrubs and closely growing crop plants over a period of five days. Using cryogenic vacuum distillation, plant water samples were extracted from plant tissue. With lab work completed on two replications, a highly enriched deuterium signal was observed in the tissue water of the shrub beginning twelve hours after the injection. In the same replication thirty-six hours after the beginning of injection, a highly enriched pulse of deuterium in the crop growing directly adjacent to the injection shrub was observed. In a concurrent injection to a nearby shrub under much drier conditions, slight pulses of enrichment were found in the shrub and crop, though with much lower magnitudes. Although this was a simulated drought experiment, we were able to recreate conditions similar to those experienced at this site under rain-fed conditions, where the presence of drought is a constant threat at the beginning and the end of the season. These findings support the hypothesis that there is transfer of hydraulically lifted water from native woody shrubs to annual food crops in the region.