Enhancing legume-cereal intercropping yield through "Biofertilization" and "Bioirrigation"

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Abstract: Legume-cereal intercropping is often used in traditional dry land agriculture, but little is known about the processes by which nutrient and water resources are shared between the crops. Here, we tested whether finger millet, a shallow-rooted cereal, can profit from a deep-rooted neighboring pigeon pea (capable of "bioirrigation", a mechanism by which a deep-rooted plant redistributes water to a neighboring plant) in the presence of "biofertilization" with arbuscular mycorrhizal fungi (AMF) and plant growth-promoting rhizobacteria (PGPR), when exposed to drought conditions. We conducted a greenhouse experiment using compartmented microcosms. Pigeon pea was grown in a deep compartment with access to a moist substrate layer at the bottom, whereas finger millet was grown in a neighboring shallow compartment, separated by 25-µm nylon mesh, without direct root-access to the moist substrate layer. In the presence of a common mycorrhizal network (CMN), with or without PGPR, drought conditions had little negative effect on the biomass production of the finger millet plant whereas in absence of biofertilization, finger millet biomass production was less than half compared to well-watered conditions. Isotope tracing (^{15}N and ^{33}P was employed to investigate nitrogen and phosphorus transfer in the context of biofertilization and the different water conditions. Our results show that "biofertilization" with AMF alleviates the negative effects of drought on the finger millet plant and indicate that the pigeon pea plant provides a "bioirrigation" effect in this simulated intercropping system.

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