Impacts of crop irrigation on rangeland soil biodiversity and insect pollinators at Isinya, Kenya

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Abstract:

Anthropogenic perturbations have varying short and long terms effects on structure and function of an ecosystem. How and the extent to which irrigated tillage and crop rotation affect agricultural beneficial belowground microorganisms as well as above ground structure in cultivated tropical rangelands are not adequately understood. This knowledge is key to efficient ecosystem management through land reclamation or restoration, in addition to providing understanding for affordable and environmentally benign means for soil fertility replenishment. The study explored how the introduction of irrigated legumebased rotational cropping system impacts on soil assemblages of rhizobia, insect species richness and abundance, as well as soil seed bank density and composition in a managed rangeland. The study involved three independent but related experiments comprising field activities and laboratory procedures carried out between January and December 2011. The fieldwork was carried out at three agro-pastoral farms and their adjacent natural grasslands located within the range unit of Isinya District, Kajiado County. The location is about 70 km south of the Kenya capital, Nairobi. Soil samples were systematically taken from experimental blocks to assess rhizobia assemblage and seed bank composition. The Most Probable Number plant infection method (MPN) was used to compare rhizobia assemblages between the natural range and cultivated plots under different crop rotation regimes. Seed bank assessment was carried out using the seedling germination method. Sweep nets and water traps were used to sample insets population during the dry and wet seasons. Multiple diversity indices were calculated to understand the effects of cover type on insect visitation. Rhizobia population was found to vary between disturbed and undisturbed range sites, and the degree of differences significantly depended on cover crops and rotation regimes. This suggested that in soils containing significant amounts of rhizobia, the necessity of inoculating legumes seeds with the bacteria innoculum prior to planting diminishes with repeated precropping of compatible grain legumes. Secondly, with respect to the insect assessment, higher taxonomic diversity of pollinators was found in the French bean plots compared to the natural grasslands. The dominant pollinators were of the Apidae family (bees). However, majority of the pollinators found in the unmanaged range were absent in the cultivated areas including the French bean plot. Many other arthropods found in the adjacent grassland were absent in the cultivated plots. This showed that although monocrops of nectar rich legumes provided habitat resources for some pollinators, the cultivation of the range was detrimental to many others insects that dot not derive direct benefit from agricultural crops. The study also found that tillage was both a sink and a pool of seed bank. Tillage was detrimental to natural seeds because it entailed soil turning, which brought deep buried propaules closer to the surface where condition was favorable for their germination, only for germinants to be destroyed and wasted as weed. At the same time it caused seeds of agriculture associated plants to be buried in the soil thereby changing the seed bank composition over time. The most resilient natural seeds included those of Crotalaria sp and Trifolium sp, which belong to the pea family known for their affinity for pollinators and ability to colonize rhizobia. Tillage is likely to engineer structural composition of abandoned agricultural fields within East African rangelands.