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Austria abstract-Sustainable Operation of Selenium Phytomangement with the Production of New Bio-based Products in Central California

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A plant management remediation strategy for selenium (Se) was developed by researchers introducing alternative crops, e.g., Brassica and Opuntia species, under a variety of arid and high salinity conditions in California. These genera can manage Se from soils irrigated with poor quality water via plant accumulation and volatilization because of selenium's chemical similarity to sulfur (S). Higher non-Se-accumulating plants tend to take up and metabolize Se via S transporters and pathways. Obtaining products with economic value from plants used in the management of Se in the soil would certainly be an additional benefit and help sustain its long-term and practical use. In this regard, Banuelos has developed new phyto-products from the plant species used in the phytomanagement of Se. These include; biofuel, Se-enriched food products and animal feeds, biofumigants, and organic Se fertilizer.

Multi-year field studies were conducted from 2006-2010 with mustard (Brassica juncea), broccoli (Brassica oleracea), cactus (Opuntia-indica–fica) grown in the westside of central California with an Oxalis silty clay loam (fine montmorillonitric, thermic Pachic haploxeral with a well-developed salinity profile). Soil electrical conductivity ranged from 6-10 ds/m, soluble B from 5-8 mg/L and total Se from 1-2 mg/kg. Volatilization measurements for volatile Se were collected when electricity was available. Brassica seed was harvested, and eventually processed for oil with a 'horizontal press' and 'extruder and biodiesel (BD) 20 was produced. Residual seed meals were available for use as animal feed, Se fertilizer and biofumigants. Other food products as Se-enriched broccoli and prickly-pear fruit were available after harvest of the respective edible plant parts. All samples were processed and analyzed for Se and other trace elements by the ICP-MS (Agilent 7500cx, Santa Clara, CA, USA).

All tested plant species were able to tolerate the high levels of salinity, B, and Se in the soil. Extractable soil Se concentrations were lowered most significantly between 0-30 cm with mustard and broccoli plantings compared to cactus. Rates of Se volatilization for all plant species ranged from 25 to 105 μg m-2 day. Mustard seed yielded about 600 L oil
ha-1 of 100% biodiesel (BD) after transesterification. BD 20 fuels (80% diesel and 20% mustard oil; typically used) were then produced and available to operate diesel-powered engines. The residual mustard seed meal with Se concentrations of 2.8 mg kg-1 is currently being tested as a biofumigant in strawberry and carrot production, as well as used as an organic source of Se in dairy feed trials and for creating Se-biofortified food products. Phytomanagement of Se with plant-induced and associated microbiological processes will require time to effectively remove soluble Se from the soil. Chances for widespread acceptance and usage of phytomanagement could exacerbate if there are marketable healthy products produced from such alternative crops as mustard, broccoli, and cactus.