

Adaptation to climate change: A case study of using wastewater as a resource for crop production: Risks and opportunities

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Pakistan is extremely vulnerable to the adverse impact of climate change among the developing countries. The most serious concerns identified by Task Force of Climate Change (2010) includes threats to its water supply, besides threats to food and energy security, vulnerability of coastal area, increased risks of extreme events (Flood, drought) land degradation due to salinity, water logging and adverse impact on forest, biodiversity and human health. There are very limited choices to address the climate change issues. In Pakistan we need adaptation by changing production technologies and using water efficiently by minimizing water losses. A series of experiments were carried using wastewater generated from the small industries admix with municipal and household wastewater (WW) by growing wheat, carrot, tomato and alfalfa. Tomato was grown in soil and irrigated with either tubewell water (TW) or wastewater (WW) with or without basal dose of NP and K fertilizers. Significantly taller plant with higher fresh and dry biomass yield was produced in WW irrigated plots with or without fertilizers. With exception of Cd, there were significant variation in the plant uptake of metals when irrigated with different supply of irrigation water in both leaves and fruit. Leaves accumulated higher concentration of all the metals (above the permissible limits for Fe, Cr and Ni) in plots receiving effluents. The fruit concentration was lower than the permissible limits in all the treatments for all the metals. On the same laid out plots, carrot was grown with the same treatments combinations. It was concluded that fruit (roots) accumulated higher conc. of Cd, Cr, Ni and to some extent Zn, while conc. of Cu, Fe and Mn (essential plant nutrients) were higher in leaves. By comparing the two water supplies, it was found that WW irrigated plants accumulated higher conc. of metals compared to TW irrigated plants. The addition of fertilizers reduced the metals uptake by plants; however, the reduction was not significant. All the metals were accumulated in conc. above the permissible limits set by WHO. It was concluded that carrots should not be grown with WW or soil receiving wastewater. Similarly, another field experiment, wheat was grown and irrigated with WW and TW as control. The WW irrigated plots were amended with farm yard manure (FYM), poultry manure (PM) both at the rate of 20 tons/ha, DAP and SSP at the rate of 150 kg/ha each and humic acid (HA) at the rate of 2.5 kg/ha. The results showed that higher yield was harvested from plots supplied with humic acid (HA) followed by poultry manure. Higher concentrations of all the metal under study were noted in leaves when irrigated with WW and TW irrigated plants resulted minimum values. The effect of amendments on the plant uptake of metal was variable. Addition of HA reduced the uptake of Cd, Cr and Mn whereas DAP was effective in reducing the uptake of Pb and Zn. The grain analysis showed that none of the samples accumulated metals beyond permissible limits whereas the non essential metals (Pb, Cr, Ni and Cd) were below detection limits. Alfalfa was also grown in the field irrigated with WW or TW without amendments and fertilizers. It was found that shoot dry weight increased when irrigated with WW that was attributed to the high nutritive value of WW. The shoot dry weight increased by a factor of about 2 to 3 times from first cut to third cut in both

the treatment plots and the magnitude of increase was higher in WW irrigated plots. The heavy metal uptake by the crop was much higher in wastewater irrigated plots compared to tubewell water. The order of metal uptake was $Fe > Mn > Zn > Cu > Pb > Ni > Cr > Cd$. Shoot metal analysis showed no metal toxicity because the conc. was less than phototoxic level and all the metals were within the permissible limits (FAO 1985). It was concluded from these results that it is unlikely that developing countries like Pakistan will be able to treat all wastewater currently used by farmers up to WHO/FAO/USEPA standards. However, enforcement of crop restrictions like avoiding fruits and vegetable eaten in uncooked form such as carrot and growing crops like cereals and other vegetables eaten in cooked form can be grown with respect to heavy metal concerns. Means and ways to reduce health and environmental risks while at the same time safeguarding positive impacts of using wastewater can be achieved by using amendments such as HA, DAP or FYM to reduce the heavy metal uptake of metals.