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Detecting crop yield reduction due to irrigation-induced soil salinization in South-West Russia

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The South-European part of the Russian Federation has experienced serious land degradation in the form of soil salinization since the 1960s. This land degradation was caused by intensive, large-scale irrigation on reclaimed land in combination with the salt-rich nature of the substrate. Alkaline soil salinity is believed to be an important factor decreasing crop yield in this area. A large research effort has been directed to the effects of soil salinity on crops, there is a need for simple, easily determinable indicators of crop health and soil salinity in irrigated systems, that can help to detect crop water stress in an early stage. The objectives of this research were to study the effects of soil salinity and vegetation water stress on the performance of alfalfa crop yield and physiological crop properties, and to study the possibility to measure soil salinity and alkalinity and the crop water stress index at plot level using a thermal gun and a regular digital camera. The study area was located in Saratov District, in the South-West part of Russia.

Variables on the surface energy balance, crop properties, soil properties and visible reflectance were measured on plots with alfalfa cultures in two fields with and without signs of alkaline soil salinity, and with and without irrigation in July 2009. The research showed no clear adverse effects of soil salinity and soil alkalinity on crop yield and physiological crop properties. Soil salinity, as reflected by the electric conductivity, positively affected the root biomass of alfalfa in the range of 0.15 to 1.52 dS/m . This was a result of EC levels being below the documented threshold to negatively affect Alfalfa, as would be the case in truly saline soils. The soil pH also showed a positive correlation with root biomass within the range of pH 6.2 and 8.5 . From the literature these pH values are generally believed to be too high to exhibit a positive relationship with root biomass. No relationship was found between EC and pH on the one hand , and soil moisture content on the other. However, soil moisture content in the topsoil appeared to have a major influence on the crop water stress index, which on its turn affected the leaf area index, the fresh biomass and the mean plant height. The crop leaf color as detected by a regular digital camera appeared to be correlated with pH and EC properties of the soil. The visible light band ratios red/green and blue/green correlated well with the crop water stress index. More research is necessary to prove if this relation is applicable in different environments, and for different crops. A confirmation of these findings would offer scope to increase the spatial support of this technique using satellite images.