Effects of crop residue management practices on soil moisture conservation and validation of cropwat model for predicting water use requirements for tomato crop in Kabete, Kenya

Karuku, George Njomo
Date: 2011

Abstract:

The frequent drought due to climatic change poses a major challenge to food security and incomes to the rural farming communities. Therefore, there is need to develop technologies that can increase crop yields with the low available water through improved water use efficiencies that are sustainable without posing land and environmental degradation. Dependence on rainfed agriculture in Kenya leads to very low yields especially in years when rains are insufficient to support normal growing period for most crops. Among vegetable crops, tomatoes are the most important horticultural crops in Kenya. Tomatoes are generally sensitive to environmental extremes, and thus high temperatures and limited soil moisture are major causes of low yields in the country. The response of tomato to environmental stresses depends on development stage and severity of the stress. Tomatoes are mainly grown under irrigation by small scale farmers for domestic consumption and for cash. The objectives of this study were; to determine the soil hydraulic properties in a Nitisol; to evaluate the effect of different cover crop residue management practices on soil moisture content under a tomato crop (Lycopersicon esculentum); and validate the use ofCROPWAT model to predict water use in irrigated tomato crop. Internal drainage procedure was applied to characterize the hydraulic properties of the soil whereby partitioning of the water balance components and the soil water retention curve allowed for the establishment of the soil water content at field capacity and at permanent wilting point. Trials were then established to evaluate the effect of different management practices of legume cover crops namely, Velvet bean (Mucuna pruriens), purple vetch (Vicia benghalensis) and Tanzanian sunnhemp (Crotalaria ochroleuca) on soil moisture conservation, water use efficiency and performance of tomato in the field and the control consisted of non fertilized and fertilized plots. The CROPW AT model was applied to predict water use in irrigated tomato (Lycopersicon esculentum) crop. Total available water capacity between field capacity and permanent wilting point for the Nitisol profile at the Kabete, University of Nairobi Farm was 79.2 mm mol. The bulk density (Ph) was 1.05 Mg m' while the particle density (Ps) was found to be 2.71 Mg m'. The infiltration rate was 134 mm hr' indicating a rapid infiltration rate. The saturated hydraulic conductivity (Ksat) in the vertical direction was higher than horizontal and ranged from 8.3 em hr-I in 0 - 15 cm to 0.6 em hr -1 in the 115 - 143 cm depths. The plots that were treated with purple vetch (Vida benghalensis) conserved 449 at transplanting and 340 rnm water at the vegetative stages of crop development compared with 371 and 307 mm water for nonfertilized and 375 and 308 mm water for fertilized plots, respectively. Incorporation of above and below ground biomass increased soil water storage significantly (p :s: 0.05) compared to the other residue management practices while surface mulched plots stored more water than where the

roots only were left. Below and above ground biomass incorporated plots also had the highest cumulative soil water storage of 322.2 compared to 316.8 mm for surface mulch and 313.4 mm water for roots. Tomatoes grown in plots mulched with vetch residue had significantly higher yields (p :s: 0.05) of 7.4 compared to 5.8 for mucuria, 5.7 for Tanzanian sunnhemp, 4.2 for fertilized and 4.1 kg ha' for non-fertilized plots. Similarly, these plots had water use efficiencies of 34.7 followed by those that received mucuna residue at 26.1 kg mm' 1 ha', The CROPWAT model predicted increased irrigation requirement for tomato crops of 13.1, 28.2 and 36.5 mm water, in the 1st, 2nd and 3rd decades of the vegetative crop development stage. Water depletion and yield reduction were highest at this stage. The ETc requirements by tomato crop were predicted at 458.1 mm for the short rainy season while ETa was 243.5 mm for the short rainy season giving a yield response factor of 0.47. The model suggested an additional 227.7 mm of irrigation water for optimal tomato yields and this showed that the model could effectively be used for predicting irrigation requirements for tomatoes.