EVALUATION OF AN IOT–BASED SMART SOIL WARMING APPARATUS FOR SIMULATING VARYING DEGREES OF SOIL TEMPERATURE

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The performance of an Internet of Things (IoT) based smart soil warming apparatus was evaluated under different soil wetness and atmospheric temperatures to simulate future soil warming scenarios. The soil warming apparatus consisted of two identical pots, one is fitted with a heater and thermocouples at three depths (2 cm, 12 cm, and 22 cm). Using the second pot, ambient soil surface temperature (T_{ss}) and air temperature (T_{air}) were recorded. Both pots were filled using reddish-brown earth soil. Data were collected when soil is air-dried and moisture-saturated as well as after raising T_{ss} by 2°C and 3°C using the heater under two thermal environments: in a glasshouse and in a shade. The apparatus did not successfully elevate the T_{ss} of dry soil by 2°C and 3°C when it was set to achieve T_{ss}+2°C and T_{ss}+3°C, neither in shade nor in glasshouse conditions. The apparatus successfully increased T_{ss} by 1.6°C and 2.49°C, when it was set to achieve T_{ss}+2°C and T_{ss}+3°C in wet soil placed in a shade. The T_{ss} decreased with increasing soil depth. The heat transmittivity increased to deep layers of soil in wet soil placed in a shade. The T_{ss} was 3.73°C warmer than T_{air} with wet soil placed inside the glasshouse. The difference between T_{ss} and T_{air} at night was higher than the difference during the daytime under all conditions. When diurnal mean T_{air} increased by 3°C, T_{ss} did not increase by the same magnitude under shade. The study concludes that the apparatus can be successfully used for soil warming experiments with wet soils kept in a shade. Furthermore, it infers that soils in shaded places may be more resilient to increasing T_{air} despite excessive warming that may occur at night. However, the effect of direct solar radiation on T_{ss} needs further investigation.

Keywords: Air temperature, Heat transmittivity, Soil heater