International scientific and professionnal conference

Organic agriculture and climate change - April ,17th-18th 2008

Enita Clermont, Lempdes, France

Colloque international scientifique et professionnel

Agriculture biologique et changement climatique

Contribution de l'agriculture biologique et de nos choix alimentaires à l'effet de serre

17 et 18 avril 2008

Enita Clermont, Lempdes, France

Effects of Organic Mulch on Soil Temperature: Simulation Study

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Mulching is a common practice in organic farming to keep soils warmer when temperatures begin to drop. This will reduce the risk of freezing and therefore better seed germination. Temperature of mulched soils depends on thickness and physical properties of organic mulch. In this study variation of temperature in bare and mulched soil is compared by means of simulation model.
Variation of the soil temperature around a constant average, T_{av}, at time t and depth x, $T_{x,t}$ is (Koorevaar *et al.* 1993):

$$T_{x,t} = T_{av} + T_{amp} * exp(-x/d) * sin(\omega t - x/d) \quad (1)$$

where T_{amp} is the amplitude of sinusoidal wave, ω is the angular frequency of temperature wave, and d is the attenuation depth, ω and d can be expressed by Equations 2 and 3 (Leffelaar, 1993):

$$\omega = 2\pi / tc \quad (2)$$

$$d = (2\lambda / \omega * C_h)^{1/2} \quad (3)$$

where tc is the time required for the wave to make a complete cycle, λ and C_h are conductance and the volumetric heat capacity, respectively. Soil was divided into layers of 2 cm depth and the model was run for bare soil and soil with 4-cm organic mulch at top. Soil temperature for layers was simulated for T_{av} = 0 °C with T_{amp} = 4.5 °C, model parameters were set as λ (soil) = 0.42, λ (organic mulch) = 0.25 J/(m s °C) and C_h (soil) = 1.05*10^6, C_h (organic mulch) = 2.5*10^6 J/m3 °C) (Leffelaar, 1993).
Based on simulation results with an organic mulch layer of 4 cm no freezing occurs at a soil depth of 8-10 cm. However, in the bare soil no freezing would occur at a soil depth of 16-18 cm (Fig. 1). Large variation of temperature at soil surface will decrease with depth which is evident from amplitude of the wave both in bare and mulched soils. However, mulched soil will have less variation in day/night temperature at lower depth compare to bare soil (Fig. 1).
Using simulation models it would be also possible to find out which mulch thickness is needed to prevent frost at shallower depths and what are the consequences of global warming on temperature of organically managed soils.

Key words: Soil temperature, Organic mulch, Simulation.

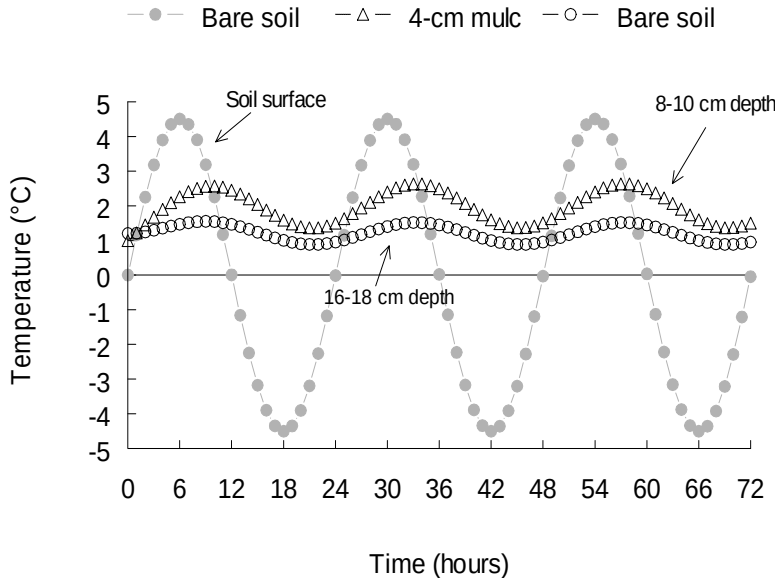

Fig 1. Simulated temperature variation for bare and mulched soil during 72 hours (T_{av} = 0 °C)

References

Koorevaar, P.G., Menelik, G. and Dirksen, C. 1983. Elements od Soil Physics. Developments in Soil Sciences, 13. Elsevier, Amsterdam, 228 pp.
Leffelaar, P.A., 1993 (ed.). On System Analysis and Simulation of Ecological Processes. Kluwer Academic Publishers, 206 pp.