Seedling emergence at four temperatures from drying-out seed-zones underlain by wet soil

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Abstract

Water absorption by and seedling emergence of barley (Hordeum vulgare) seeds was studied in a two layer drying-out system. Seeds were placed 3 cm below surface in sandy loam (Typic Ustochrept) soil having 4 or 7 g.100 g⁻¹ water underlain by wet (10 g.100 g⁻¹) layer 2, 4 or 6 cm below seed. The study was carried out at 18°C, 23°C, 28°C and 33°C with and without a thin liquid-flow barrier placed on top of the wet layer.

Water absorption by seed and coefficient of rate of emergence showed parabolic relation with temperature and strong soil-water × temperature interactions. Liquid-flow barrier considerably reduced the seed water absorption, percent emergence and coefficient of rate of emergence showing thereby that liquid flow was the principal mode of upward water transport from the wet soil to the seed. Influence of both the wet soil and the liquid-flow barrier was detectable up to about 8 cm; shorter the distance greater the effect. It is concluded that in a drying out seed-zone, in addition to wetness of the soil surrounding the seed the wetness of the soil several cm below the seed is also crucial for seedling emergence. Also indicated that the optimum temperatures in drying out seed-zones are different from those in the absence of evaporation.

Introduction

In dryland agriculture, if planting cannot be done shortly after rain, disturbance of surface soil by tillage to kill weeds and conserve water, produces a two-layered system in which a layer of loose dry soil overlies an undisturbed wet soil (Hillel and Hadas, 1972; Gill and Prihar, 1983). In such cases, if seeds cannot be planted deep enough to be in the wet soil, the latter's effects on seeds placed some distance above it are not known. The relative importance of liquid and vapour flow from wet layer to the seed is also unknown.

Effects of temperature and seed-zone water on seed water absorption and seedling emergence have generally been studied in systems sealed against evaporation (Chaudhary et al., 1971; Dewez, 1964; Fayami, 1957; Lindstrom et al., 1976; McGinnies, 1960; Romo and Haferkamp 1987; Sharma, 1976; Tadmor et al., 1969; Wanjura and Buxton, 1972; Webb et al., 1987; Woods and MacDonald, 1971). However, in a drying out seed-zone the ambient temperature not only affects seed's biological activity but also seed-zone drying and hence soil-water availability to the seed.

We studied, at four temperatures, the effects of water flow from wet soil situated at variable distances below the seed on the seed water absorption and seedling emergence of barley. To know the relative contribution of liquid and vapour flow of water under such conditions, the investigations were conducted with and without a barrier to prevent liquid flow from wet soil.

Materials and methods

Using a completely randomised design, effects of the three initial soil water contents of 10.0, 7.0 and
4.0 g water/100 g soil, respectively, termed as wet (W), moist (M) and dry (D), in the combinations shown in Fig. 1, on water absorption and seedling emergence of barley (*Hordeum vulgare*) seeds were studied at constant temperatures of 18, 23, 28 and 33°C. The sandy loam (75% sand, 11% silt and 14% clay) soil collected from the 0–15 cm layer of a Typic Ustochrept retained 23.7, 18.4, 13.6, 7.6, 6.7, 6.1 and 5.8 g water/100 g soil, respectively, at the 0.05, 0.15, 0.20, 1.5, 2.0, 4.0 and 7.0 bar suction. Thus the matric potentials in W, M and D corresponded to approximately −0.6, −2.0 and −15.0 bar, respectively. Cylindrical plastic containers (15 cm high and 10 cm dia.), without any drainage holes, were used to hold the soil columns. There were two replications.

**Preparation of soil columns and planting**

Soil passing through 2-mm sieve was moistened to the three initial soil water contents and incubated at the specified temperature for 24 hours. After incubation, the depths of the soil layers below the seed, as shown in Fig. 1, were packed to bulk density of 1.5 g cm⁻³. Fifteen seeds per container were placed at this plane and covered with 3 cm of soil of bulk density 1.2 g cm⁻³. All the treatments having wet (W) soil underlying the moist (M) or dry (D) soil were studied without and with a liquid flow barrier (3 mm layer of hydrophobic aggregates) on top of the wet soil. When the liquid-flow barrier was present, the thickness of the M or D layer below the seed was 3 mm less than the thickness shown in the Fig. 1. Six columns were prepared for each treatment.

The hydrophobic aggregates used to form liquid-flow barrier were prepared by soaking soil passed through a 0.5-mm sieve with a saturated solution of polyvinyl alcohol in water. It was incubated for four days and air dried. The 0.25 to 2.0 mm dia aggregates, used to form the liquid flow barrier were separated out by sieving. This kind of barrier

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*Fig. 1.* Layering of the wet (W), moist (M) and dry (D) soil and position of seed in various treatments. Treatments with wet (W) soil below the moist (M) or dry (D) soil were studied with and without the barrier at depths indicated by crosses.