The Effect of High Soil Temperatures on the Seedling Emergence of Perennial Grasses

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Environmental conditions following seeding determine in large measure the success or failure of stand establishment on grazing lands. The effects on stand of type and preparation of seedbed, method and depth of planting, and availability of soil moisture have been studied rather extensively. Temperature of the seedbed has received attention in numerous germination and emergence experiments employing constant temperatures, usually below 100°F. These studies, however, do not consider the effect on emergence of the relatively high soil temperature which frequently prevails for short periods of time following seedings in late spring, summer, or early fall. Investigation of several stand failures in California indicated that unusually high temperatures in the soil immediately surrounding the seed may have contributed in large measure to these particular failures.

The temperature of the surface inch of soil, which constitutes the seedbed of many small-seeded grasses, periodically reaches levels considerably higher than air temperature. Bouyoucos (2), Hide (4), and Smith (6) have studied soil temperature in relation to air temperature and report that soil temperatures at 1/2- to 1/2-inch depth may reach maxima of 30° to 40°F above air temperature. Smith (6) in extensive studies at Davis, Calif., reported temperatures of 110° to 130°F in bare soil at 1/2-inch depth at seasons of the year when grasses are frequently seeded. Baker (1) has assembled maximum surface soil temperature data obtained by various investigators and cites values ranging from 122° to 160°F. A study of the effect of brief exposures of the seedbed to temperatures in excess of 100°F would therefore appear desirable.

Moore (5) obtained increased seedling emergence in the field in straw mulched plots compared to bare plots. The mulching reduced the temperature of the surface inch 6° to 14°F when bare soil reached temperatures approaching 100°F. He proposed the moderation of seedbed temperature as one benefit of the mulch. Sprague (7) studied seedling emergence of eight pasture species under several conditions of controlled environment. He found that the species varied widely in their ability to emerge at different temperatures. At the highest temperature level employed (100°F for 4 hours daily), he noted reduced emergence compared to that at lower temperatures in all species except Sudan grass. In the present investigation the effect of soil temperature on seedling emergence has been studied at 100°F, except for the duration of the heat exposure.

Soil temperature was measured during the heat exposures by mercury thermometers in 1/2-inch pots at 1/2-inch depth. The authors are aware of the inaccuracies of the test chamber used for the determination of both the amount and the rapidity of seedling emergence. Counts of emerged seedlings were made daily for 15 days after planting to emergence for the control and for each treatment, except for the duration of the heat exposure.

Air temperature, the change in the chamber temperatures with time, and the soil to air temperature difference were obtained at 4-hour intervals. Relative humidities were so adjusted to 92% F. After removal of the pots from the chamber, the soil temperature was recorded for 20 days after planting rather than for a set period following treatment in all stages of the pre-emergence period. The difference (usually a reduction) between the total emergence of treated and control samples is expressed as a percentage of the control. The difference is obtained by subtracting the control from the treated, which necessitated repetition of numerous tests to determine the behavior of the species.

The chamber temperature was raised to 100°F at selected times. Each heat exposure was applied on different days, and air temperature was raised to 100°F at 111 times. Twenty-four hours before and again after a heat exposure the soil temperature at 1/2-inch depth was raised to 100°F for 4 hours daily. The warm air benches permitted gradual cooling. The chamber was so designed to indicate the relative effect of the heat exposures at all times except for the duration of the heat exposure, and the exposures were watered twice daily.

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