Summer Flooding of Alfalfa

disease induced by excessive flooding of fields during high temperatures is major factor in annual depletion of stands

D. C. Erwin, W. F. Lehman, B. W. Kennedy, and G. F. Worker, Jr.

Alfalfa stands in the Imperial and Palo Verde valleys of southern California often need to be replanted each year.

Three diseases contribute to stand depletion in the inland desert valleys and are of major and approximately equal importance. Phytophthora root rot occurs mainly in the fall, winter, and spring. Rhizoctonia root canker and scald—called summer flooding injury—occur only during the hot summer months. Phytophthora root rot and flooding injury are augmented by excessive flood irrigation and field observations indicate that the severity of Rhizoctonia root canker is increased by the same environmental condition.

Summer flooding injury has been reproduced experimentally in the field by flooding land for 36–60 hours in the summer when high maximum temperatures of 110°–117°F prevailed. Records obtained at the Imperial Valley Field Station showed that the maximum temperature of standing water in alfalfa fields did not exceed that of the air and was usually 4°–8°F lower. Maximum soil temperatures—2″ depth—were considerably below air temperatures.

Controlled tests in the greenhouse showed that alfalfa growing in well drained soil may withstand high soil temperatures with little root damage but may be killed in flooded soil at high temperatures. Thus it appears that excessive flooding—not the scalding temperature of the water—is the primary condition leading to plant death. However, high soil and water temperatures do hasten plant death due to excessive flooding.

Symptoms of flooding injury to roots of alfalfa plants consist in a yellow to brown discoloration of the woody tissues —xylem—which occurs about 7–10 days following the flooding. Without careful observation of symptoms the discoloration of woody tissues might be confused with that caused by bacterial wilt or dwarf especially if seen on plants which have recovered from flooding injury. Often roots of plants completely disintegrate—become soft and mushy and give off a putrid odor—following flooding. A black discoloration on the surface of the roots is not uncommon. Tops of plants become yellow and wilted followed by rapid death of a high percentage of plants in a flooded area.

In tests conducted for three years at the Imperial Valley Field Station, well drained plots were flooded for 12 to 24 hours during times when maximum air temperatures were 110°–117°F. In these cases, only a small amount of plant loss occurred. Again in the fourth year, plots flooded for either 12 or 24 hours during periods of similar temperatures were only slightly damaged. However, when plots were flooded for 36 or 60 hour periods, symptoms typical of summer flooding injury occurred within 10 days.

Mowing alfalfa immediately before flooding increased the susceptibility of plants to flooding injury, compared to flooding plants after several days' regrowth. Repeated tests on the effect of mowing time showed that 88% of the plants remained alive in plots not mowed prior to a 36-hour flooding period. However, on plots mowed five days before flooding, 44%, and on plots mowed one day before flooding only 26% were living 10 days after flooding. Few plants survived the 60-hour flooding treatment. However, it is significant that 25%of the plants survived on the non-mowed plots compared to none on either of the mowed plots.

In controlled greenhouse tests at Riverside, potted alfalfa plants, growing in a Holtville silty clay soil from Imperial Valley, were flooded in a water bath held at 104°F for eight hours. These tests, also, showed that newly clipped plants were much more susceptible to flooding injury than nonclipped. The cause of this reaction is not yet well understood, but may be a key to control of summer flooding injury.

Summer flooding injury appears to be due, at least partly, to replacement of air in the soil by water. High temperatures may hasten plant death by increas-

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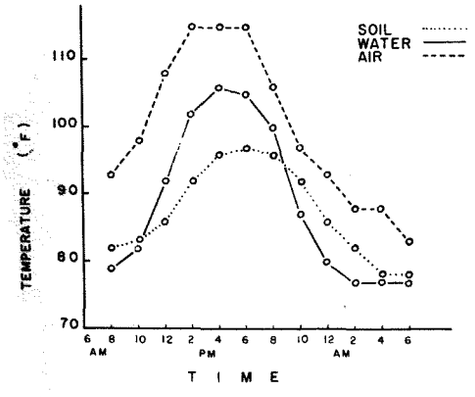
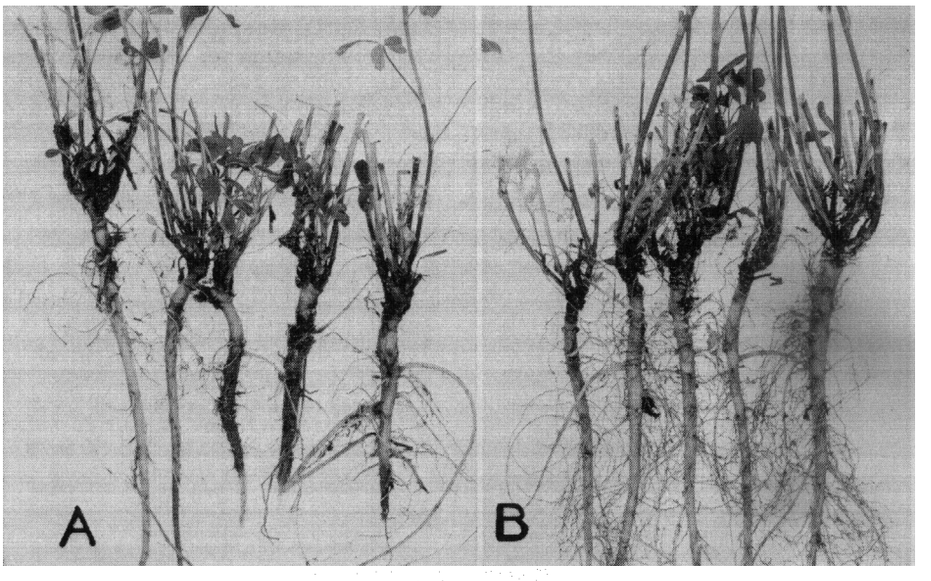
Comparative temperatures of soil—2″ depth—standing water, and air occurring in an alfalfa field at the Imperial Valley Field Station, El Centro, July 4, 1957.



Alfalfa plants in a greenhouse test were taken from soil maintained at 104°F. Those on left—A—were flooded 24 hours. Those on the right—B—were not.



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FLOODING

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ing the demand for oxygen by plant roots and soil microorganisms.

Greenhouse studies further showed that flooding injury was less severe in sterilized soil than in unsterilized. Because extensive attempts failed to isolate a single microorganism capable of inducing the symptoms of flooding injury, the function of soil microorganisms probably is complex. When bare-rooted plants were placed in an aerated mixture of soil and water at 104°F for eight hours, no root damage occurred after transplanting to soil but when roots of plants were placed in a nonaerated soil-water mixture, all died after transplanting. The primary cause of summer flooding injury may be the lack of aeration in the saturated soil with increased soil temperature acting to hasten and intensify the damage.

It is unusual to flood a field for 36 hours—the period needed in the fourth year of field tests to develop summer flooding injury—but many fields with an irrigation run of a half mile or more may drain slowly enough to remain saturated for 36 hours.

The severity of summer flooding injury of alfalfa is influenced by water and soil temperatures; the length of time the soil remains saturated; and the predisposition of plants by recent mowing.

These studies indicate that stand depletion of alfalfa is influenced by excessive summer flood irrigation and have stimulated research on the effect of regulating irrigation of alfalfa by soil moisture measurement.

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