EFFECTS OF HIGH SURFACE-SOIL TEMPERATURE ON CEREALS AND FLAX[1]

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Abstract

The effects of high surface-soil temperatures on cereals and flax are reviewed. On cereals, the effects may be of the leaf-banding type, the basal heat-canker type or a lodging and breaking-over type following inadequate crown-root development. On flax, there is early seedling blight and killing, and a breaking-over of older plants resulting from a constriction at ground level, Measurements with thermocouples showed that on clear days when the air temperature was 96°F (35.5°C), surface-soil temperatures on bare areas between the rows in wheat fields and on summer fallow ranged from 134° to 139°F (56.5 to 59.5°C).

Heat damage of various kinds to cereal and flax crops is of common occurrence on the Canadian Prairies. The particular type of damage usually depends on the stage of plant development and is also closely associated with other environmental conditions, such as drought. Most enquiries about these troubles are received from growers early in the season. This suggests that the growers do not expect heavy damage from heat so early in the year and are inclined to attribute the troubles to other causes. The injury is, in fact, not caused by the direct action of the sun's rays on the young plant tissue, but by the heating of the dry soil surface by strong insolation on the afternoons of hot, calm days. Similar injury by freezing on near-freezing temperatures was reported earlier (1).

Injury to cereal seedlings is of the leaf-banding type (Fig. 1). This condition is also illustrated in an earlier paper by the author (Vanterpool, 1949); slightly older plants may show the heat canker or basal constriction type of injury (Fig. 2); and plants well past the crown-rooting stage may show a lodging or breaking of the sub-crown internode caused by the failure of the crown roots to develop in the hot, dry, surface soil (Fig. 3). These latter conditions were also illustrated earlier (Vanterpool, 1959). Injuries to flax caused by high surface-soil temperatures may be of two kinds, namely: an early heat-canker or seedling blight (Fig. 4); or a lodging or breaking-over of older plants in which the damaged zone shows as a constriction at ground level (Fig. 5).

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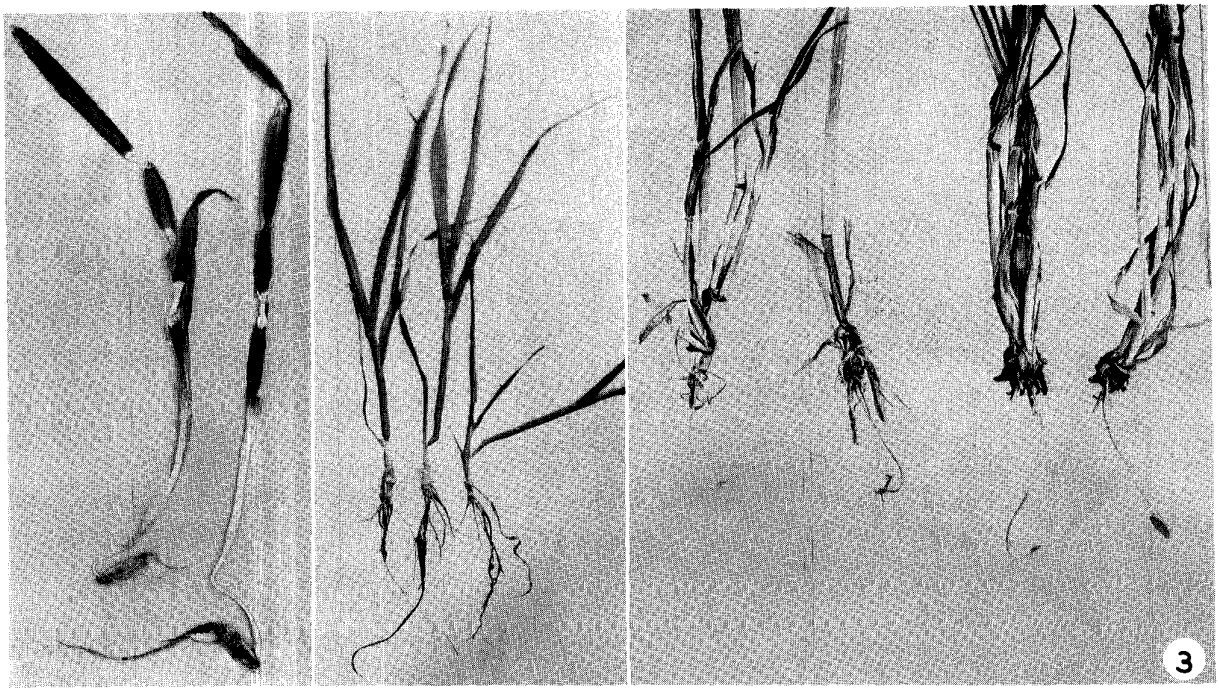

Figure 1. Leaf banding of oats caused by high surface-soil temperature.

Figure 2. Heat canker and basal contribution on oats.

Figure 3. Failure of crown roots of oat plants to develop.

Damage of the heat-canker and leaf-banding types on flax and cereals in 1961 was the most serious and widespread ever encountered in Saskatchewan. Exceptionally favorable to this trouble was the dry, hot, clear weather with sub-normal wind velocities that began during the last week in May and continued for virtually the rest of the summer. The only appreciable break was on June 12 and 13 when 0.64 inches of rain fell. The period from June 3 to 7 (Table 1) was most favorable for heat damage to young crops. No dew deposits were recorded and immediately afterward numerous reports of general leaf banding of cereals were received from Radville and Estevan in southern Saskatchewan to as far north as Debden. Heat canker on seedling flax was also general and about two weeks later the breaking-over type of injury was very damaging in central Saskatchewan with the most reports coming from Kindersley and the area stretching eastward through Rosetown and Saskatoon to Meacham.

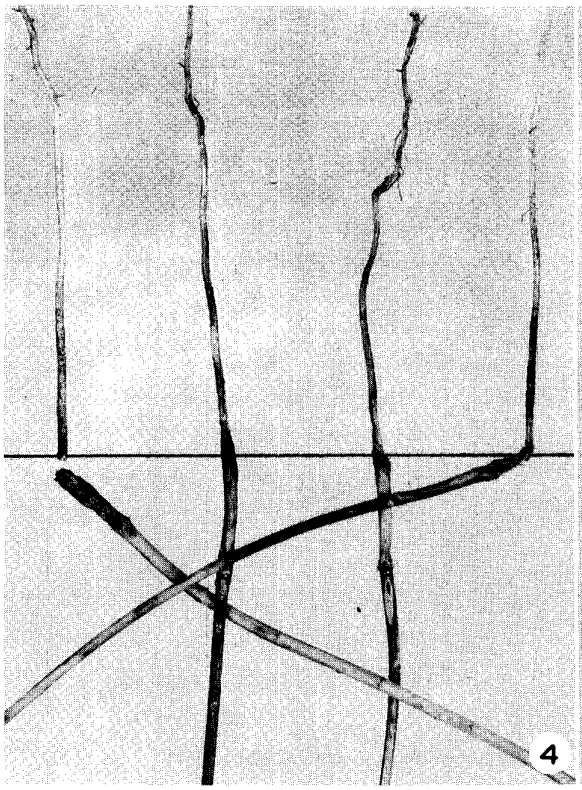

Figure 4. Heat canker seedling blight of flax.

Figure 5. Heat canker – late type on flax.

Table 1. Some meteorological records at Saskatoon University of Saskatchewan, June 3 to 7, 1961

Date June	Afternoon air temp. °F.	Minimum night temp. °F.	Total hours sunshine	Wind velocity
3	92	57	15.7	10.1
4	95	57	13.2	6.2
5	94	60	14.5	10.7
6	96	65	15.8	10.1
7	95	63	12.3	8.5

The surface-soil temperature records reported earlier (1) were taken with laboratory thermometers and lack the precision obtained with thermocouples. In the studies reported here, special instruments with delicate thermocopule measuring points were loaned by the Agricultural Engineering

Department, University of Saskatchewan and the Building Research Department, National Research Council. On June 6, when the air temperature was 96°F, soil-surface temperature readings were taken between 1.30 and 2.30 p. m. in areas between rows in wheat fields and on bare summer fallow receiving direct insolation. The highest surface-soil temperatures recorded ranged from 134" to 139°F; some 10 to 15°F higher than the minimum required for injury to plant tissue. Soil color and degree of compaction are factors responsible for some of the temperature variations.

As pointed out in an earlier paper (1), leaf-banding of cereals with consequent "flagging" of damaged leaves in the wind delays growth only slightly and does not cause appreciable thinning of the crop unless the internal growing points happen to be emerging through the soil-surface on hot afternoons. Seedlings with injured growing points are likely to be killed. Stands of flax, on the other hand, are frequently liable to severe thinning. Many young seedlings may be killed and on many others a constriction may form at ground level. These partially damaged young plants are later broken over by strong winds, further reducing the stands. In 1961, many flax fields near Rosetown had 15 to 20 per cent of this late type of heat canker. They were so thinned that they were unable to adequately compete with weeds and, in some instances, were plowed under.

The effects of high surface-soil temperature referred to here can be alleviated by sowing early and at slightly higher rates than normal, Soil packing to encourage even germination, shading provided by surface trash, and seeding in a north-south direction are also beneficial.

Literature Cited

1. VANTERPOOL, T.C. 1949. Chlorotic banding of cereal seedlings. Sci. Agr. 29: 334-339.
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