CHAPTER XIV. GROUND MEASUREMENT OF SURFACE TEMPERATURE

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Four surface types typical of that found on the Little Washita River watershed were identified at site 1 prior to the April experimental campaign: alfalfa, bare soil (pre-emergent corn field), winter wheat, and rangeland. These subsites were subsequently labeled as sites 11, 12, 13, and 14, respectively. A 5 m x 5 m subsurface soil temperature sampling grid was established at sites 11, 12, and 13. The spacing of the thermistors in the sampling grid was designed to represent 2 or more pixels of thermal and NS001 data acquired by the NASA aircraft (depending upon aircraft altitude). At each grid node a thermistor was placed approximately 5 mm below the soil surface so that soil temperature could be measured. In place of a sampling grid at site 14 (a flux station site) the thermistors were placed just inside the fence surrounding the flux site but not on the downwind side (fetch side) of the flux instrumentation. Four readings from a handheld infrared thermometer (IRT) were taken simultaneous around each thermistor location when the subsurface soil temperatures measurements were made. Dates and times of subsurface and IRT measurements are found in Table XIV-1. On April 6,7, and 11 the NASA C-130 collected remotely sensed data along north-south transects flown directly over the subsites at varying altitudes.

Sites 11 and 13 were instrumented with thermistors which allowed the measurement of air temperature profiles within and just above the plant canopies. During the April experimental period the alfalfa and winter wheat measured approximately 30 cm and 35 cm tall, respectively, and the plant canopies were nearly fully closed. Leaf area indices of these sites are found in Chapter V of this report. At the alfalfa site air temperature profile thermistors were located at 18, 39 and 95 cm above ground level; at the winter wheat site air temperature thermistors were located at 18, 46, and 90 cm above ground level.

Figures XIV-1 through XIV-6 are graphs of the subsurface and IRT temperature data collected at the subsites at 5 times during the day on April 7, 1994. The sites with actively growing, green vegetation (alfalfa and winter wheat sites) show small differences and little variability between and among the subsurface and IRT temperature measurements for most times of the day (Figs. XIV-1, -2, -5, -6, and Table XIV-2). The bare soil and rangeland sites exhibit the most difference between the subsurface and IRT measurements but also display considerable variability among the subsurface temperature measurements. The rangeland site also displays considerable variability in the IRT measurements. Variability of the subsurface soil temperatures at the bare soil site can be explained by the location of the thermistors which may be in the furrow, on the ridge top, on the shaded side or unshaded side of the row. The IRT measurements were made at four points around a given thermistor and averaged, and since the bare soil site was fairly homogeneous the IRT data show little variability. As stated above, the rangeland site exhibited variability in both the subsurface and IRT temperature measurements. This variability is explained, in part, by the heterogeneous nature of this site. Vegetation within and around the immediate area of the flux station is made up of bunch grasses

separated by areas of short vegetation producing a "clumpy" landscape. Thus, one thermistor may be located underneath or nearby a rather tall clump of grass while one located 3 to 4 m away would be in an open area underneath vegetation not more than 2 or 3 cm high. Most of the bunch grasses are warm season plants and were in a dormant phase during the measurement period. The cool season range grasses were beginning to green up, but were rather short and made up the "inter-bunch grass" area.

Figure XIV-7 is a plot of the IRT surface temperature data acquired over the four surface types on April 7. The alfalfa and winter wheat sites possess comparable surface temperatures throughout the day. As expected, the bare soil site has warmer temperatures than all other surfaces over the measurement period. The rangeland site begins the day with a canopy temperature much the same as that for the alfalfa and winter wheat sites. However, as the day progresses the rangeland site warms to temperatures several degrees higher than the other vegetated surfaces, but lower than that of the bare soil site.

The air temperature profile data collected at sites 11 and 13 are somewhat incomplete due to the constraint of a limited number of thermistors available for use. For example, only one thermistor was located within each canopy (18 cm above ground level), while the other two in the profile were 9 to 11 cm and 60 to 65 cm above the canopies (Figs. XIV-8 and -9). Nevertheless, the uppermost data in the profiles depict lapse conditions over the crop surfaces, which is typical during the day time. A temperature maximum will often occur near the upper portions of a plant canopy because this is the region of maximum leaf area and where most of the solar radiation is absorbed. Thus, below this area of the canopy temperature profiles will generally depict temperature inversions because the soil surface is normally cooler than the plant canopy above it. This feature is largely missed in these data due to limited number of measurements within the plant canopies.

Table XIV-1. Date and times of subsurface and IRT temperature measurements.

Site 11		Site 12	
Date (mmdd)	Time (CDST)	Date (mmdd)	Time (CDST)
4-6	1029	4-6	1040
	1110		1122
	1136		1150
	1224		1240
	1304		1316
4-7	0904	4-7	0916
	1004		1015
	1105		1115
	1456		1515
	1620		1634
4-11	1153	4-11	1210
4-12	1107	4-12	1055

Site 13		Site 14	
Date (mmdd)	Time (CDST)	Date (mmdd)	Time (CDST)
4-6	1033	4-6	1057
	1120		1134
	1151		1209
	1229		1241
	1258	4-7	0907
4-7	0925		0943
	1052		1107
	1151		1134
	1521		1459
	1554		1612
4-11	1237	4-11	1252
4-12	1212	4-12	1232

Table XIV-2. Mean and standard deviation of the subsurface and handheld IRT surface temperature measurements for data collected on April 7, 1994.

Time (CDST)	Subsurface Temperature (C)		IRT Temperature (C)	
	Mean	Std. Dev.	Mean	Std. Dev.
Site 11				
0904	8.9	0.6	9.1	0.4
1004	11.7	1.1	12.4	0.6
1105	14.8	1.6	14.8	0.8
1456	20.3	2.5	19.9	0.9
1620	19.7	2.8	19.7	1.0
Site 12				
0916	10.4	0.9	12.3	0.5
1015	14.7	1.2	17.9	0.9
1115	18.5	1.7	21.9	1.0
1515	26.6	2.1	30.2	1.3
1634	24.7	1.8	26.8	1.0
Site 13				
0925	9.5	1.1	9.6	0.4
1052	13.4	1.7	13.6	0.8
1151	16.6	1.8	16.7	1.3
1521	20.8	1.5	19.2	1.4
1554	21.1	1.4	20.2	1.3
Site 14				
0907	9.2	1.0	9.5	1.2
0943	10.8	1.5	12.5	1.5
1107	15.0	2.5	20.2	2.1
1134	16.8	3.0	22.1	2.8
1459	22.6	4.7	26.3	3.1
1612	21.6	4.8	24.4	2.9

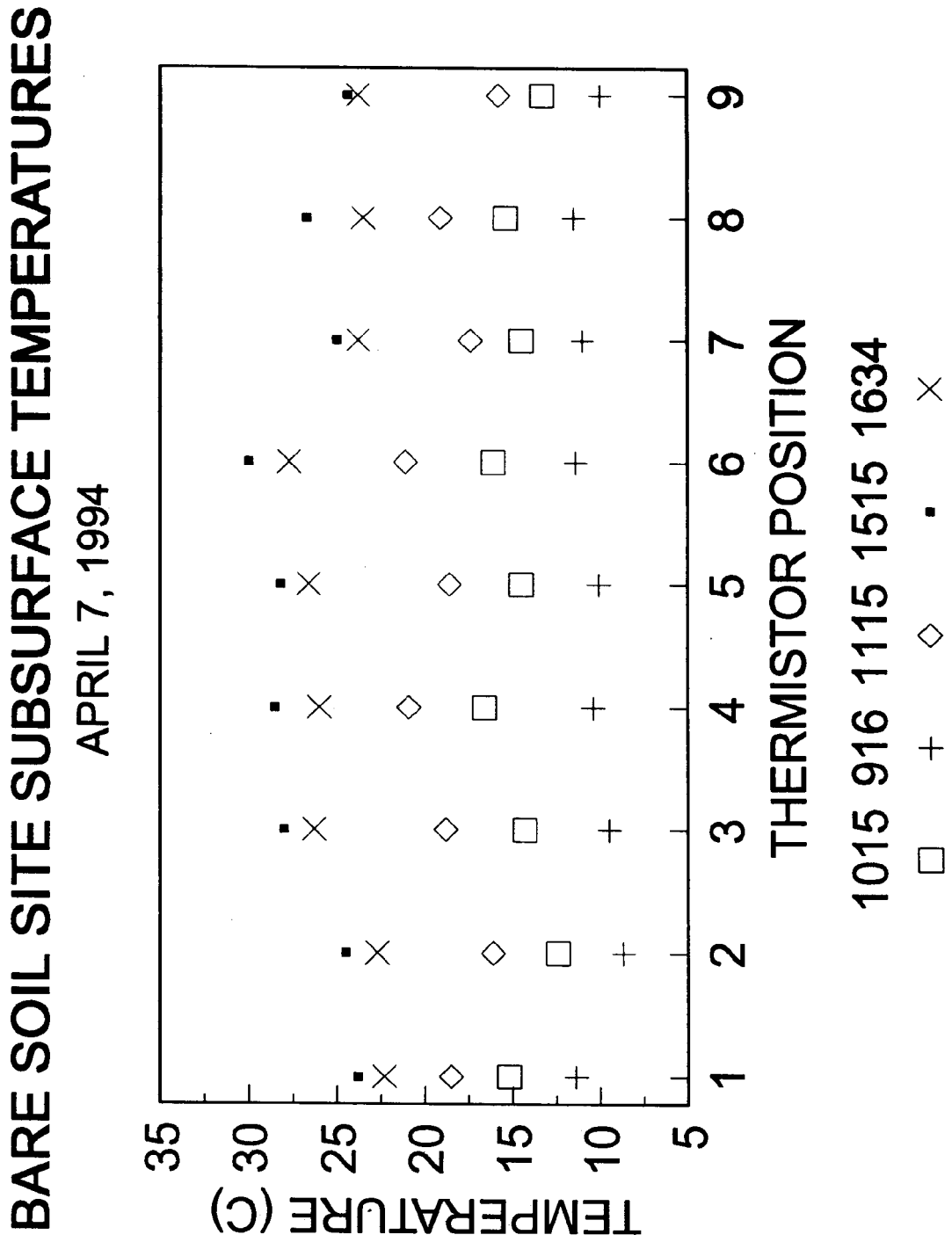

Figure XIV-1. Bare soil site subsurface temperatures.

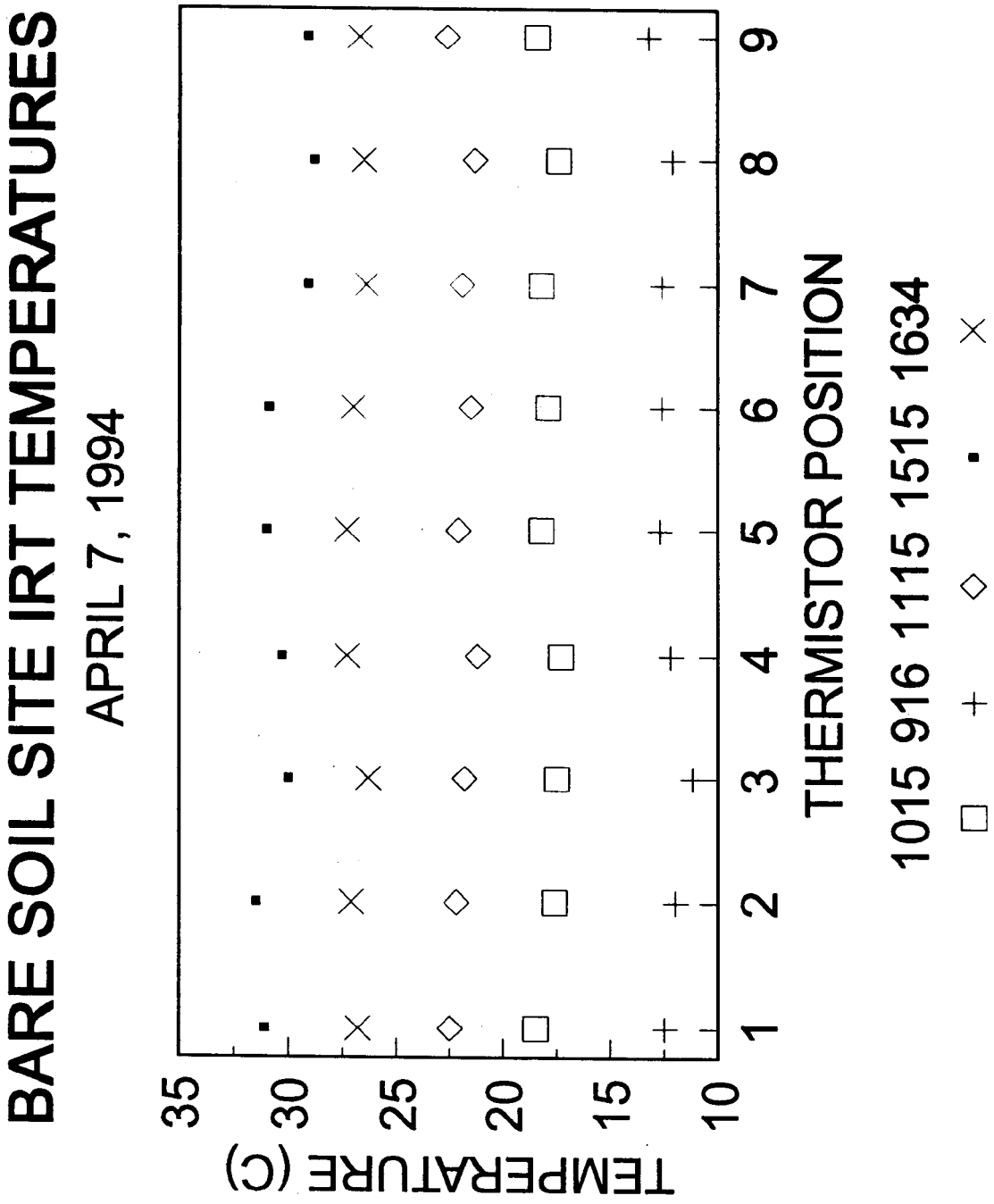

Figure XIV-2. Bare soil site IRT temperatures

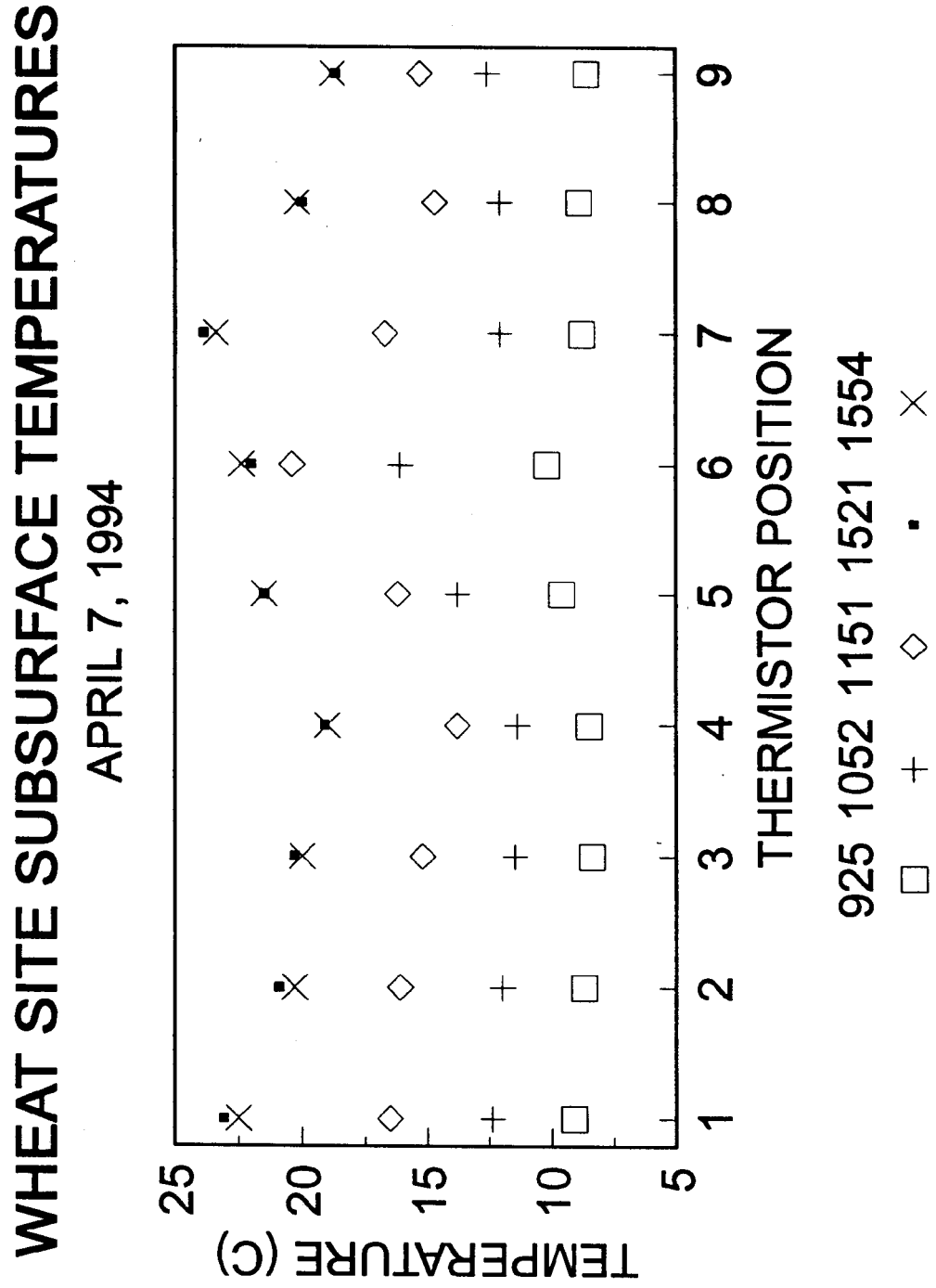

Figure XIV-3. Wheat site subsurface temperatures

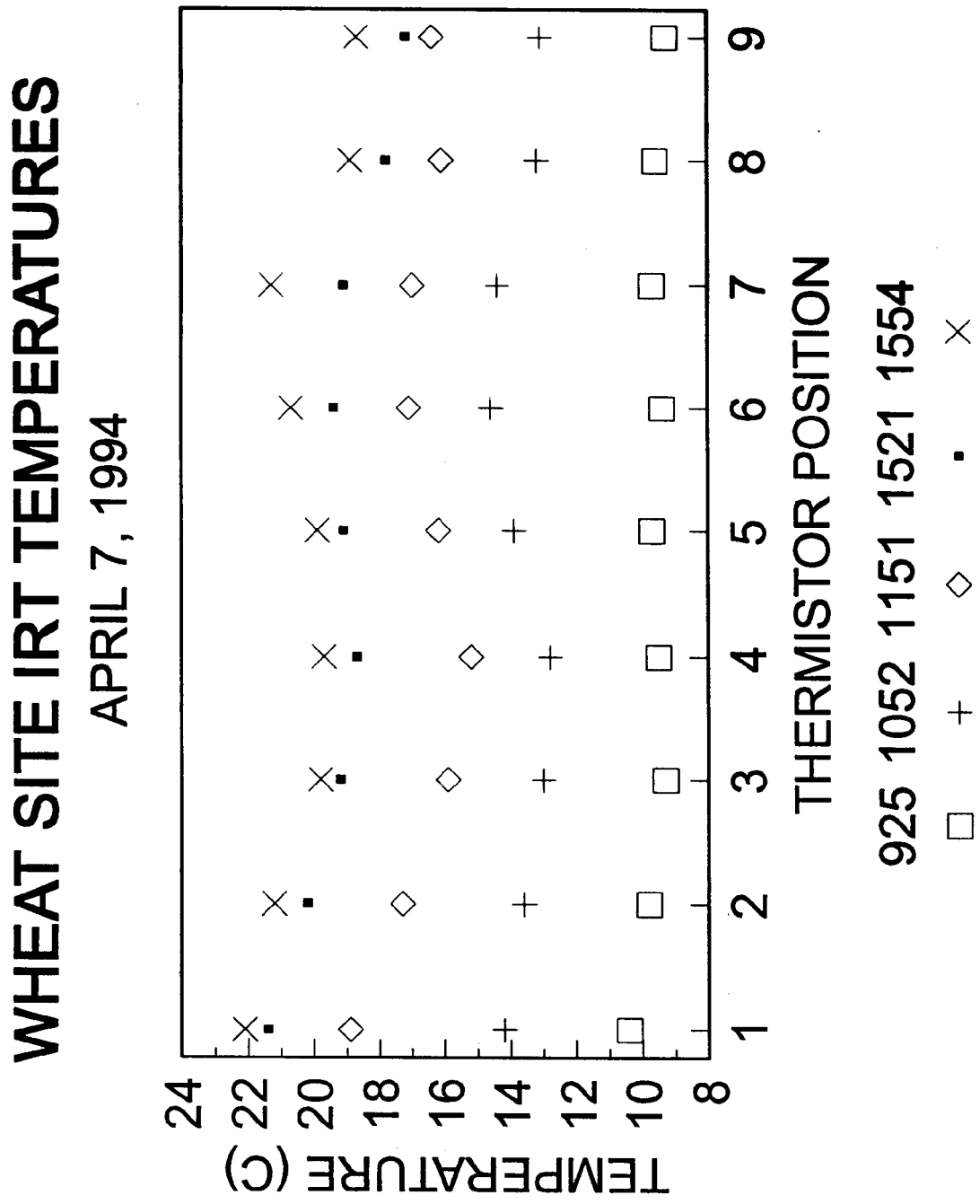

Figure XIV-4. Wheat site IRT temperatures

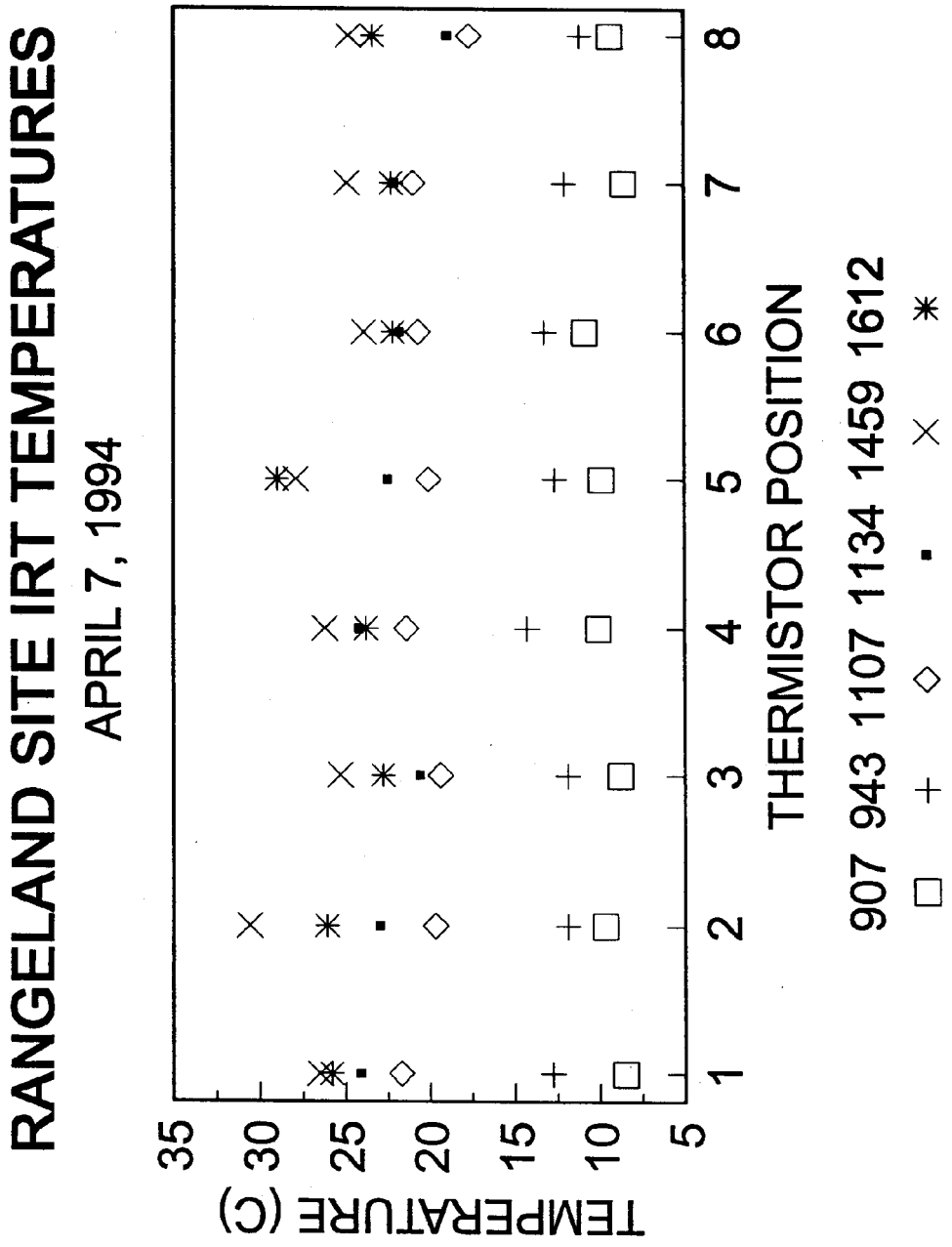

Figure XIV-5. Rangeland site subsurface temperatures

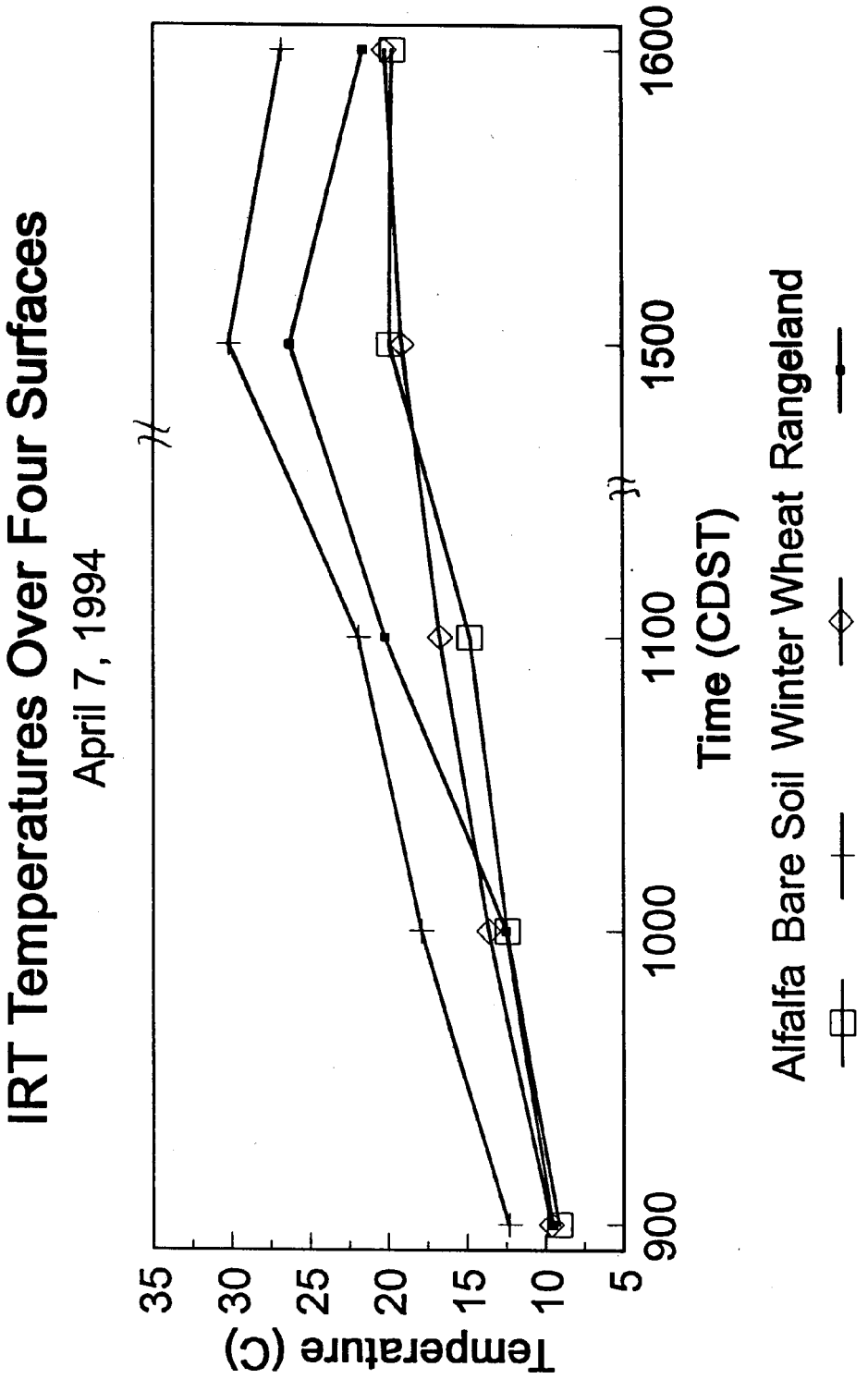

Figure XIV-6. Rangeland site IRT temperatures.

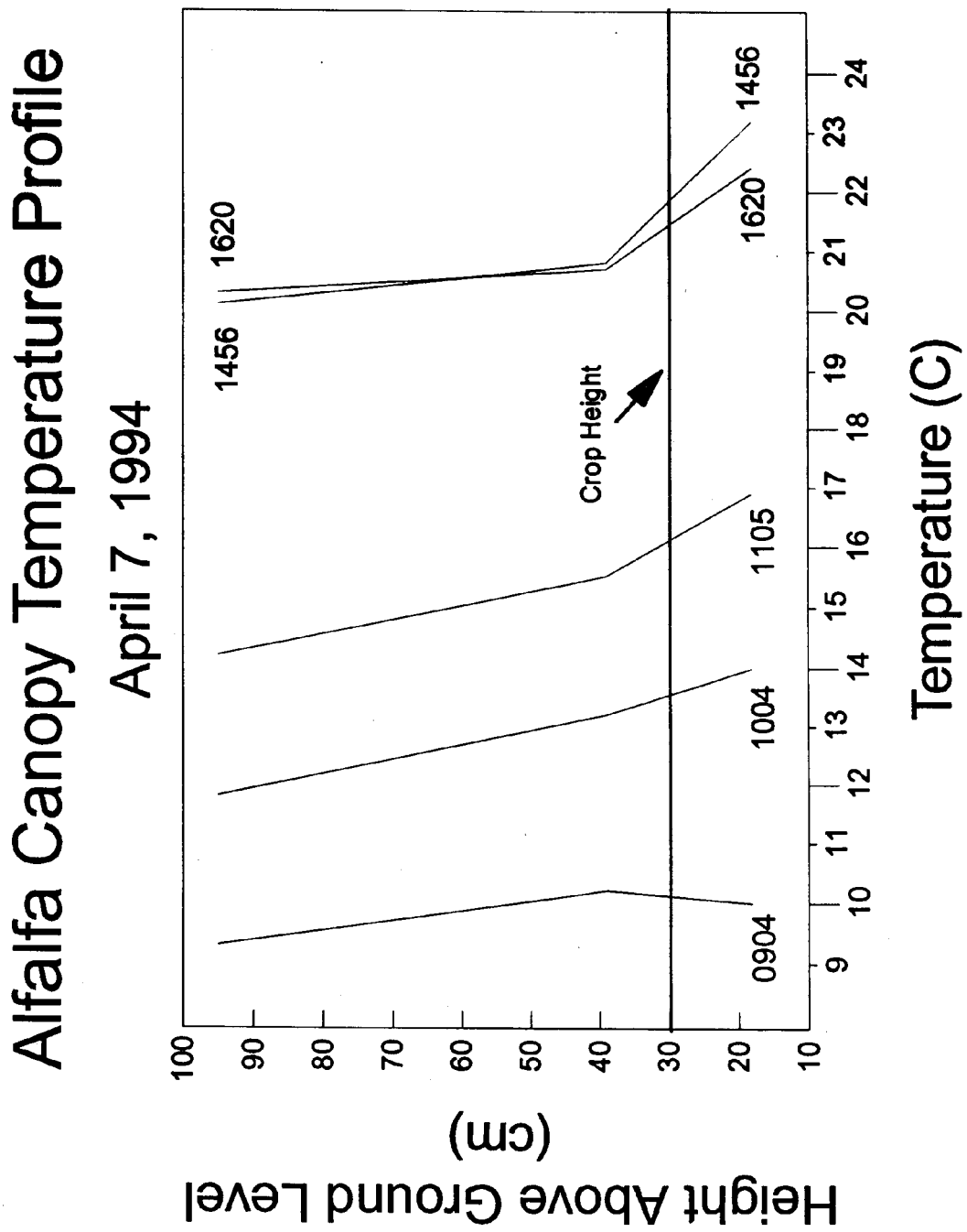

Figure XIV-7. IRT temperatures over four surfaces.

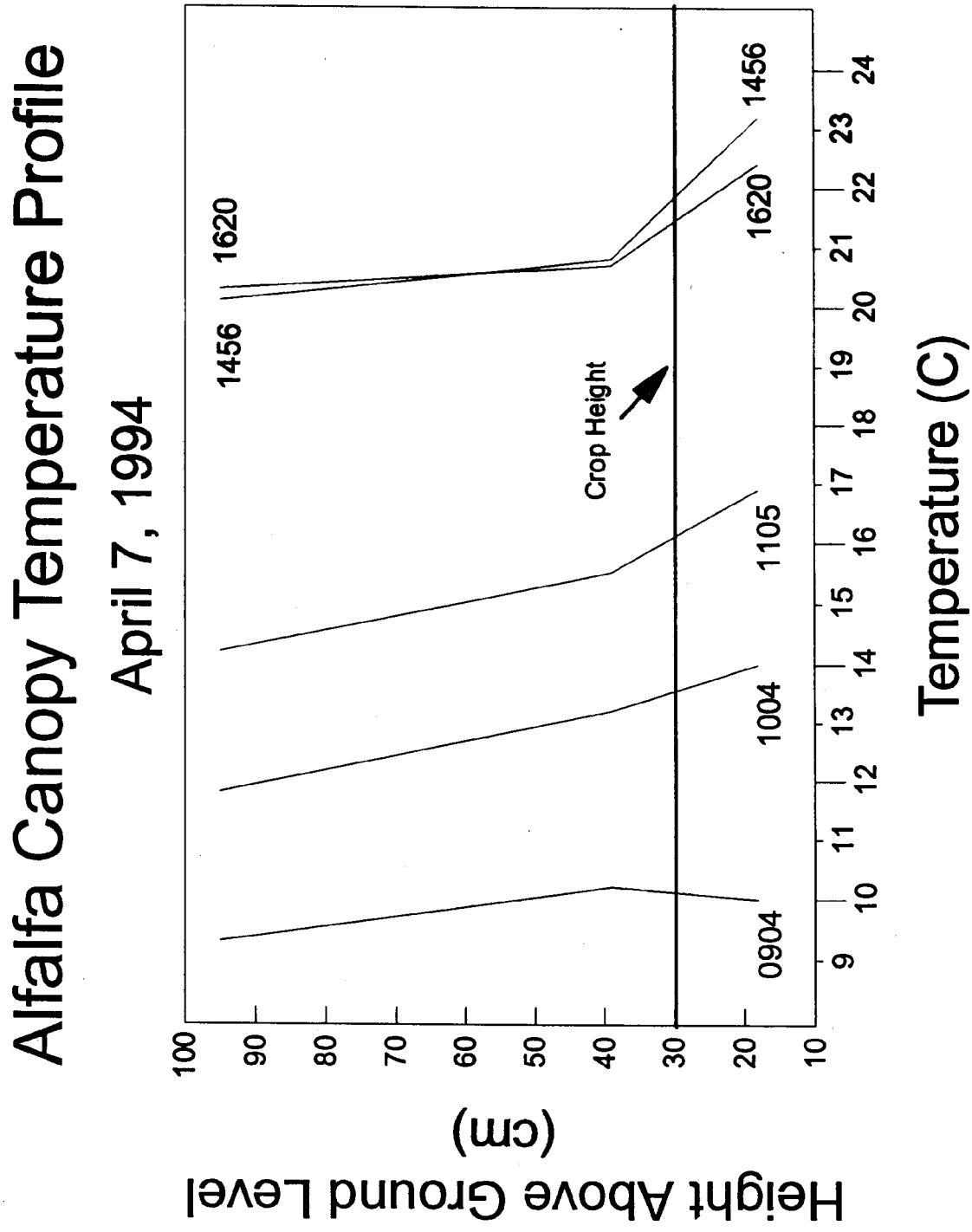

Figure XIV-8. Alfalfa canopy temperature profile.

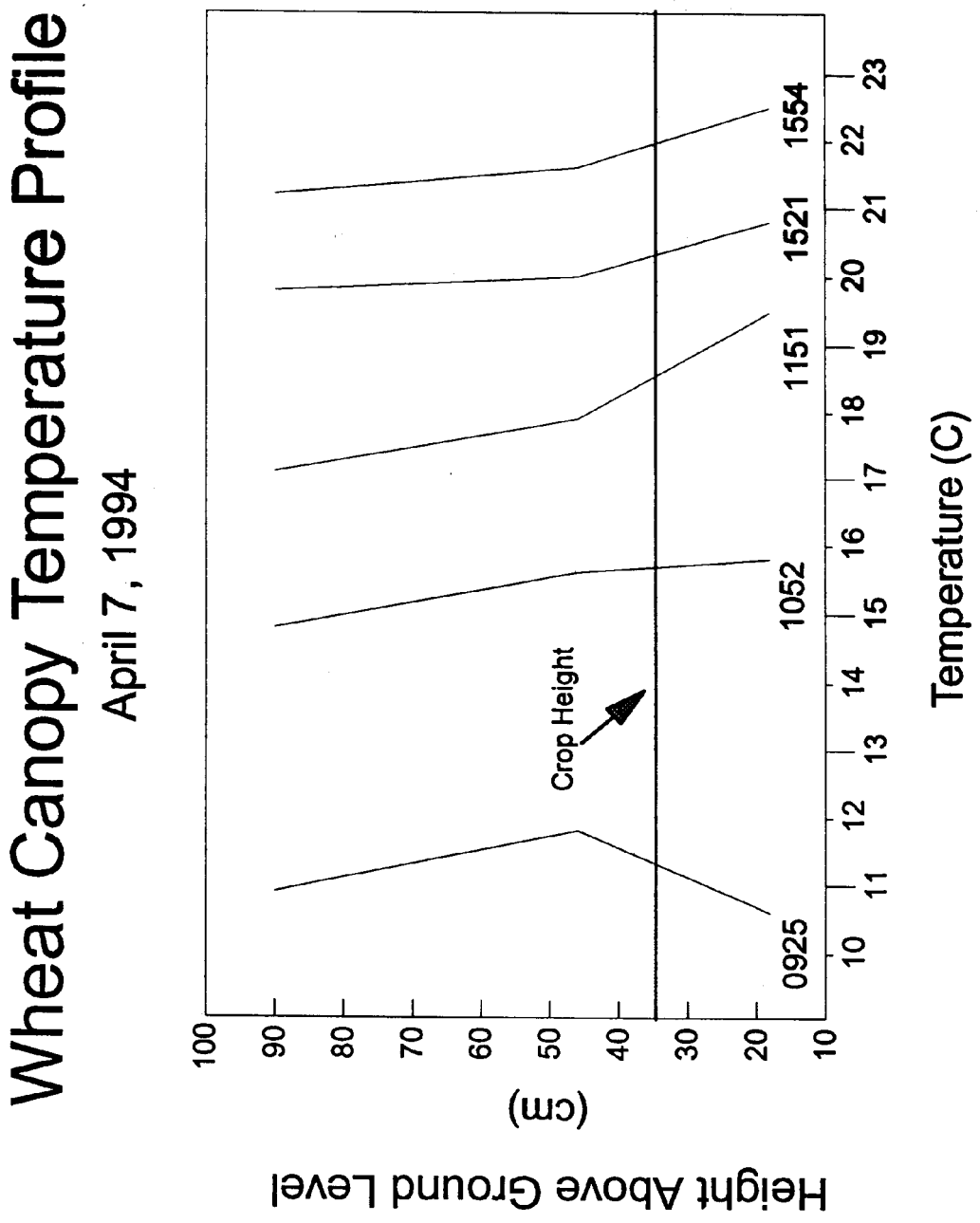

Figure XIV-9. Wheat canopy temperature profile.