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SOME FEATURES OF THE MICROCLIMATE OF A LUXURIANT TURNIP RAPE FIELD ON A CLEAR DAY

PART II

by

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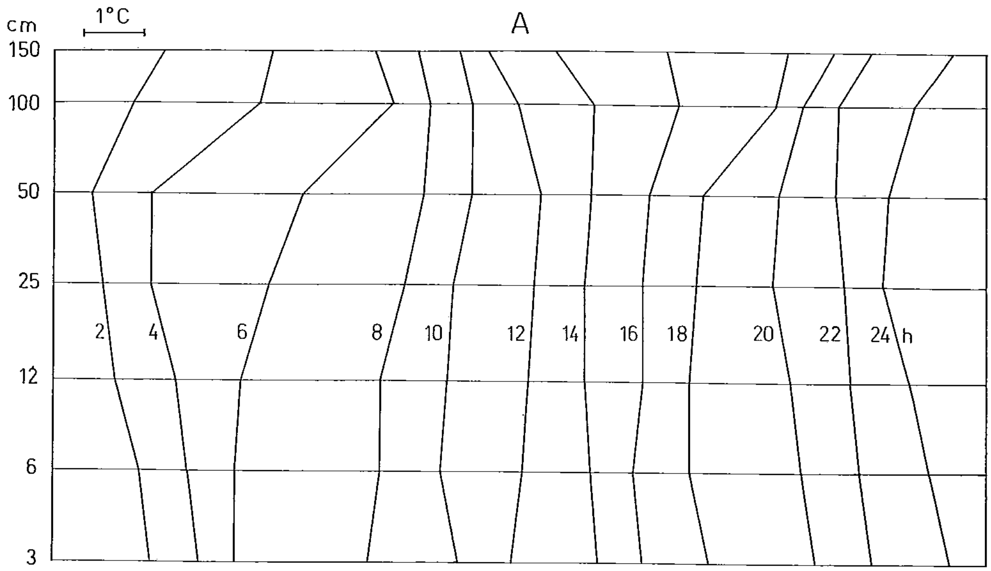
Abstract

This paper is a sequel to a contribution published under the same name in *Geophysica* 8:2. Vertical profiles of temperature, humidity and wind speed are given within and over a dense crop of turnip rape, as well as over a sand surface. Some conclusions are drawn on the basis of the results.

4. *Vertical profiles of temperature, relative humidity and wind speed*

In Figs. 5 and 6 are drawn the mean vertical profiles of temperature and relative humidity from 3 cm to 150 cm above the ground covered by a dense crop of turnip rape as well as above a sand surface. These profiles are given every two hours, whereas the mean vertical profiles of wind speed are drawn in Fig. 7 at four-hour intervals.

Within dense vegetation, the leaves themselves form the meteorological surface, reducing the incoming radiation by absorption and acting as a source of outgoing radiation during the night. The density of the vegetation and the actual height of the meteorological surface above the ground, of course, are primarily functions of the species of plant and of the size of the plant, as well as of certain meteorological factors. As a rule, the height of the functional surface or the zero-plane displacement is somewhat less than the mean top height of the plants. To get the



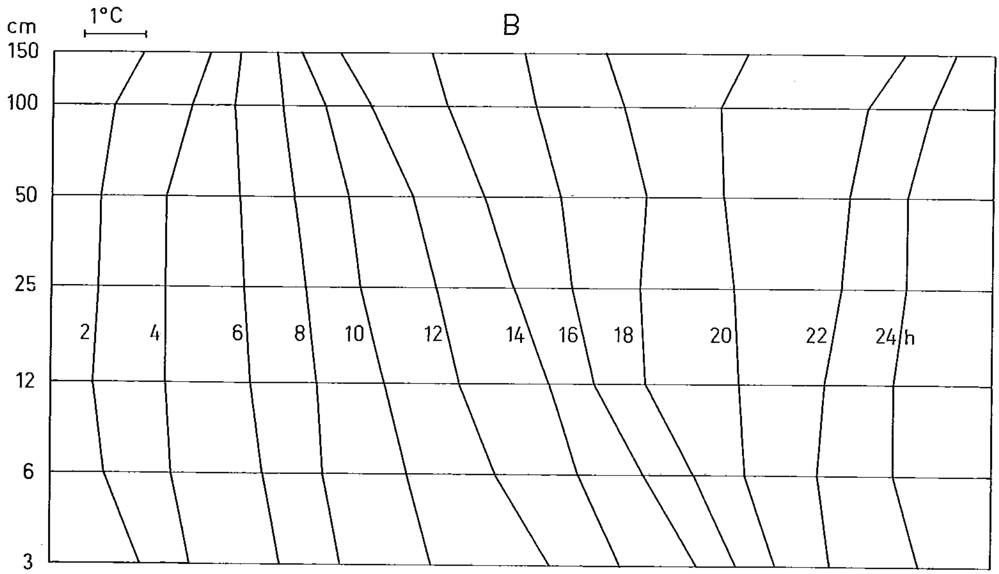


Fig. 5. Vertical profiles of temperature within and above the crop of turnip rape (*A*) and above the sand surface (*B*) every two hours.

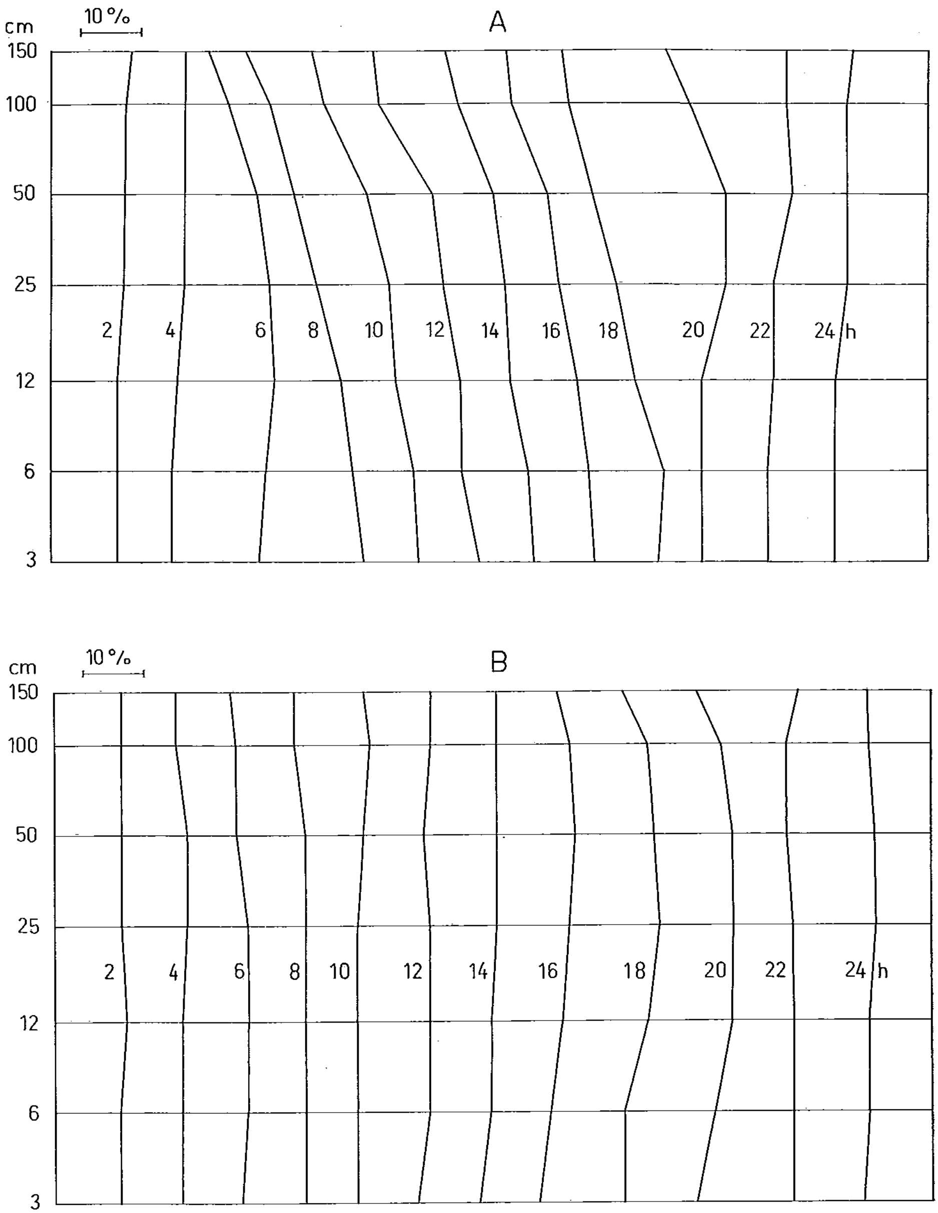


Fig. 6. Vertical profiles of relative humidity within and above the crop of turnip rape (*A*) and above the sand surface (*B*) every two hours.

accurate height of the zero-plane displacement is not, in general, possible, because of the inhomogeneity of the vegetation, but statistical mean values can be derived from a large number of observations made within and above a certain type of vegetation.

As said before, the mean height of the turnip rape during the measurements was about 85 cm. Since the vegetation was very dense, leafy and homogeneous, it was to be expected that the height of the zero-plane displacement would be only slightly less than the mean height of the plants. This can also be verified from the vertical temperature profiles in Fig. 5 A but it would be necessary to make more observations at different heights between 25 cm and 100 cm to obtain the height of such a new zero level more accurately. The vertical temperature profiles over the sand surface are as would be expected when it is borne in mind that the height of the nightly minimum temperature is slightly (roughly 10 cm) above the ground, owing to the formation of dew.

In Fig. 6 A we see that the relative humidity within the turnip rape field decreased sharply with height during the daytime. In the night dew formation first started at the level of minimum temperature (on the top leaves) or roughly at the 50 cm level. Vertical profiles of temperature and relative humidity in Figs. 5 A and 6 A are thus »reflections» at 20 o'clock. Dew formation increased later on in the night and the air was almost saturated up to the highest measuring height. As the simultaneous wind speed was very low, about 5 cm sec^{-1} within the turnip rape, the function of the thermistor psychrometer was rather doubtful among the wet leaves until sunrise. Since the relative humidity, when checked by means of an Assmann psychrometer, was at least 96 per cent at the top height and 98—99 at the lowest measuring levels, a value of 98 per cent at the 3 cm level and 97 per cent at the 150 cm level was assumed during the dew situation. The error thus arising does not exceed 2 per cent. The vertical humidity profiles over the sand surface are quite parallel and each of them has a rather steady value, with the exception of the curves at 18 and 20 o'clock.

The estimation of the vertical distribution of the wind speed is certainly somewhat unreliable, considering the short period of observation and the sensitivity of the anemometer to wind fluctuations. The vertical wind profiles in Fig. 7 are thus not very representative but rather descriptive. In particular, the height of the zero-plane displacement remains doubtful. It seems, however, that the maximum wind speed within the crop of turnip rape is at most 20 per cent of the value in free air at the

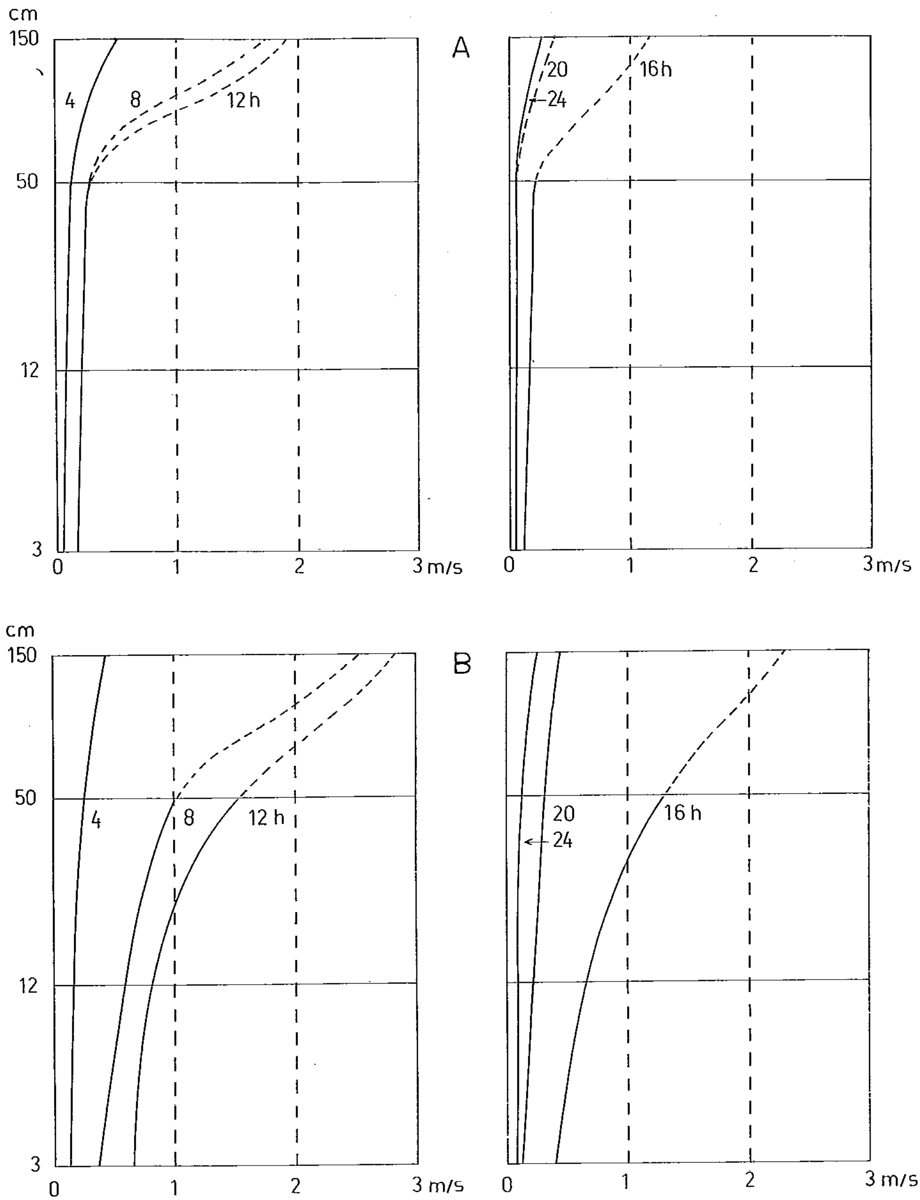


Fig. 7. Vertical profiles of the wind speed within and above the crop of turnip rape (*A*) and above the sand surface (*B*) every four hours.

same height. The wind speed during the night was very low indeed over the whole measuring area. It may be mentioned that a cup anemometer installed at a height of 2 metres above the sand surface for comparison as a rule stood still from sunset to sunrise on a clear night.

This calmness of clear nights, both in summer and in winter, is a very typical inland situation in Finland. In Fig. 8, for comparison, we have drawn curves of diurnal mean wind speeds at a height of 2 metres above the ground observed by FRANSSILA [4] at Pälkäne, Finland, in 1934 and by a research group of MIT [5] at O'Neill, Nebraska, in 1953. Both curves are means of 7 days and mainly recorded in August. We can see the enormous difference in wind speed during the nights. Instead of 4 ms^{-1} at O'Neill, only 0.4 ms^{-1} at Pälkäne was observed as a mean (when preparing FRANSSILA's observations we have estimated instead of 0 (*i.e.* < 0.5 ms^{-1}) a value of 0.3 ms^{-1}). A comparison between Figs. 4 and 8 B reveals that the mean wind speeds are of the same order both in the daytime and at night, but the curve 8 B is more regular, as a result of the longer period of observation.

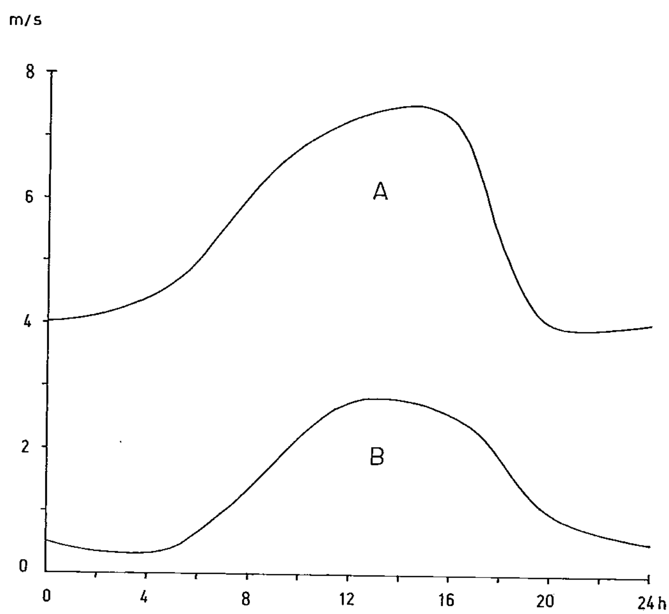


Fig. 8. Mean diurnal variation of wind speed at a height of 2 m above the ground at O'Neill, Nebraska, USA (*A*) and at Pälkäne, Finland (*B*) after [5] and [4].

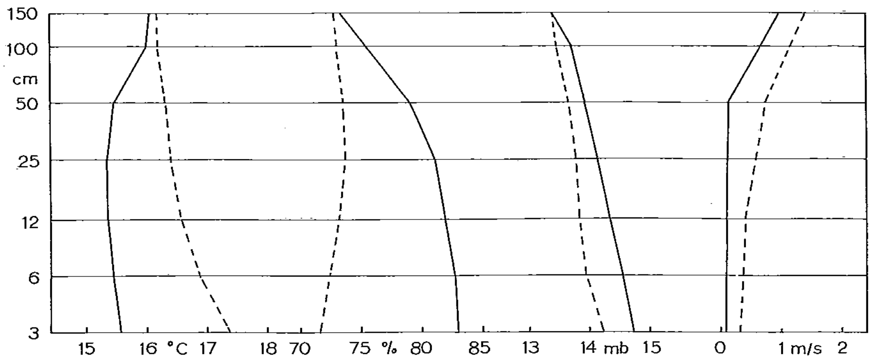


Fig. 9. Diurnal means of the vertical profiles of temperature, relative humidity, vapour pressure and wind speed within and above the crop of turnip rape (solid lines) and above the sand surface (dotted lines).

We would like to point out that in the light of Figs. 4 and 8, we cannot readily adopt in Finland the results of frost research work made in wind conditions such as Fig. 8 A. Frost defence based on heating or mixing the lowest air layers is primarily dependent on wind conditions.

Diurnal mean conditions of the vertical profiles are given in Fig. 9 and Table 1. Their most important features are presented on the next page.

Table 1. Comparison between the diurnal mean values of temperature, relative humidity, vapour pressure and wind speed within and above the crop of turnip rape and over the sand surface.

Height cm	Temperature °C			Relative humidity per cent			Vapour pressure mb			Wind speed cm/s		
	Turnip rape	Sand	Difference	Turnip rape	Sand	Difference	Turnip rape	Sand	Difference	Turnip rape	Sand	Difference
Surface	15.56	24.01	−8.45	—	—	—	—	—	—	—	—	—
3	15.62	17.43	−1.81	82.9	71.5	11.4	14.72	14.23	0.49	9	32	−23
6	15.48	16.91	−1.43	82.7	72.3	10.4	14.54	13.93	0.61	—	—	—
12	15.40	16.60	−1.20	81.8	73.1	8.7	14.31	13.81	0.50	11	41	−30
25	15.36	16.44	−1.08	81.0	73.6	7.4	14.13	13.76	0.37	—	—	—
50	15.50	16.34	−0.84	79.0	73.4	5.6	13.91	13.64	0.27	13	75	−62
100	16.02	16.20	−0.18	75.2	72.9	2.3	13.69	13.42	0.27	—	—	—
150	16.06	16.20	−0.14	73.2	72.6	0.6	13.36	13.36	0.00	97	141	−44

5. *Conclusions*

1. The diurnal mean temperature of the sand surface was 8.5°C higher than the surface temperature within the crop of turnip rape.

2. The vertical temperature profile, as a diurnal mean, was almost isothermic within the turnip rape, whereas the diurnal mean temperature decreased sharply with height over the sand surface.

3. The vertical profiles of the diurnal mean value of relative humidity were the reverse of the vertical temperature profiles, *i.e.* almost steady over the sand surface and sharply decreasing with height within and above the crop of turnip rape.

4. Vertical profiles of the mean vapour pressure are quite parallel over both surfaces and the vapour pressure decreases with height as a diurnal mean.

5. The mean wind speed within the plants was of the order of 10 cms^{-1} as a diurnal mean. The wind prevailing during the night was very light and the mean wind speed between sunset and sunrise did not exceed 0.5 ms^{-1} even at a height of 1.5 m above the sand surface.

6. The differences given in Figs. 2—7 and 9 and in Table 1 are more likely to be too small than too great, because the distance between the two measuring sites was small. In addition, there was plenty of dew and some fog during the night and climatic differences between the two measuring sites were thus considerably smoothed.

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