

Frost

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Will I get a frost tonight is probably the most common question we get at this time of year. Growers are on their guard at this time of year but we should probably be on guard for longer. Table 1 shows the chance of getting a ground frost at various places around New Zealand. It was prepared by NIWA and covers a period of 30 years. The table shows we should be on our guard in November too, particularly in the key apple, grape and kiwifruit areas.

MEAN NUMBER OF DAYS OF GROUND FROST													
Data are mean monthly values of the number of days with ground frosts for the 1971-2000 period for locations having at least 5 complete years of data													
Station details are available in separate table													
Location	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
KAITIA	0	0	0	0	0	0	0	0	0	0	0	0	1
WHANGAREI	0	0	0	0	1	3	4	2	1	0	0	0	11
AUCKLAND	0	0	0	0	1	3	4	2	1	0	0	0	10
TAURANGA	0	0	0	1	5	9	12	9	4	2	1	0	42
ROTORUA	0	0	0	2	8	12	14	11	7	3	1	0	57
TAUPO	1	1	1	3	8	12	16	14	9	7	3	1	69
HAMILTON	0	0	1	3	8	11	14	11	7	3	1	0	63
NEW PLYMOUTH	0	0	0	0	1	4	4	3	1	0	0	0	15
MASTERTON	0	0	1	2	8	11	13	12	8	5	2	1	60
GISBORNE	0	0	0	0	3	8	9	8	3	1	0	0	33
NAPIER	0	0	0	0	3	7	7	7	3	1	0	0	29
PALMERSTON NORTH	0	0	0	1	4	8	10	8	4	2	1	0	38
WELLINGTON	0	0	0	0	1	2	3	3	1	0	0	0	10
WANGANUI	0	0	0	0	0	1	3	2	0	0	0	0	7
WESTPORT	0	0	0	0	2	6	8	6	2	0	0	0	26
HOKITIKA	0	0	0	2	5	12	15	12	5	2	1	0	54
MILFORD SOUND	0	0	0	1	7	14	16	13	5	2	1	0	56
NELSON	0	0	1	4	12	18	21	17	10	4	1	0	88
BLENHIM	0	0	0	1	6	15	16	13	6	2	0	0	60
KAIKOURA	0	0	0	0	2	6	8	6	4	1	0	0	27
MT COOK	1	1	3	9	19	22	24	23	14	8	3	1	140
CHRISTCHURCH	0	0	0	2	9	16	16	15	9	3	1	0	70
LAKE TEKAPO	1	1	5	11	21	25	27	25	16	9	5	3	149
TIMARU	0	0	2	5	12	21	23	19	12	5	3	0	100
DUNEDIN	0	0	0	2	6	13	16	12	7	3	1	0	58
QUEENSTOWN	0	0	1	5	13	21	24	21	14	7	3	0	107
ALEXANDRA	1	2	3	10	19	26	27	26	19	12	6	2	148
INVERCARGILL	1	2	3	6	9	16	18	16	11	6	4	2	94

Table 1

I can hear you asking already ‘Why ground frost? My crop is above the ground’. Well, the ground temperature more closely estimates the temperature of your crop because it is radiating heat like the ground. The windscreen of your car may show ice even though the air temperature is above zero. This is exactly the same principal. The standard air temperature taken at 1.3 m will be slightly higher than your crop temperature on a frosty night.

Will you have a frost tonight depends on many things. Factors include site aspect, altitude, how close you are to a large body of water and shelterbelt orientation. What this all comes down to is that you need to know your site very well and interpret any frost forecasts based on this. Table 2 shows this quite well. A huge variation of 4.8 degrees in temperature is shown around the district. While the regional frost forecast may be reporting a risk, the risk needs to be adjusted to your property. We have compared the temperature in one place in Hawkes Bay with another and it is very predictable and stable, so it should be easy to adjust.

Location	Minimum Temperature
Bayview	3.3
Twyford	0.2
Pakowhai Road	1.6
Lawn Road	0.6
Havelock Noth	-0.6
Te Aute	-1.5
Roys Hill	0.4
Puketapu	-0.2

Table 2: Minimum Temperature around Hawkes Bay on September 7th 2008-10-18

Bob McDavitt of the MetService has said “If the dew point is below zero even before sunset, then that is a pretty good indicator that a frosty night is coming”. The only problem here is how do you get the dew point? Table 3 has a table you can use. The formula for dew point is quite big and a table will be of much more use.

Temperature	Humidity																		
	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
25	-8.7	-3.4	0.5	3.6	6.2	8.5	10.4	12.2	13.8	15.3	16.7	18.0	19.1	20.3	21.3	22.3	23.2	24.1	25.0
24	-8.5	-4.2	-0.4	2.7	5.3	7.6	9.6	11.3	12.9	14.4	15.7	17.0	18.2	19.3	20.3	21.3	22.2	23.1	24.0
23	-10.3	-5.0	-1.2	1.9	4.5	6.7	8.7	10.4	12.0	13.5	14.8	16.1	17.2	18.3	19.4	20.3	21.3	22.2	23.0
22	-11.9	-6.6	-2.8	1.1	3.8	5.9	7.8	9.5	11.1	12.5	13.9	15.1	16.3	17.4	18.4	19.4	20.3	21.2	22.0
21	-11.6	-6.3	-2.5	0.2	2.8	4.9	6.9	8.6	10.2	11.6	12.9	14.2	15.3	16.4	17.4	18.4	19.3	20.2	21.0
20	-12.4	-7.1	-3.3	-0.6	1.9	4.1	6.0	7.7	9.3	10.7	12.0	13.2	14.4	15.4	16.4	17.4	18.3	19.2	20.0
19	-13.3	-8.0	-4.2	-1.5	1.0	3.2	5.1	6.8	8.3	9.7	11.1	12.3	13.4	14.5	15.5	16.5	17.3	18.2	19.0
18	-14.1	-8.8	-5.0	-2.3	0.2	2.3	4.2	5.9	7.4	8.8	10.1	11.3	12.4	13.5	14.5	15.5	16.3	17.2	18.0
17	-14.8	-9.6	-5.8	-3.1	-0.4	1.8	3.7	5.4	6.9	8.3	9.6	10.8	11.9	12.9	13.9	14.8	15.6	16.5	17.3
16	-15.6	-10.4	-6.6	-3.9	-1.2	0.9	2.8	4.5	6.0	7.3	8.6	9.8	10.9	11.9	12.8	13.7	14.5	15.3	16.1
15	-16.4	-11.2	-7.4	-4.7	-2.0	0.3	2.2	3.9	5.4	6.7	8.0	9.2	10.3	11.3	12.2	13.1	13.9	14.7	15.5
14	-17.1	-12.0	-8.2	-5.5	-2.8	-0.1	1.6	3.3	4.8	6.1	7.4	8.6	9.7	10.7	11.6	12.5	13.3	14.1	14.9
13	-17.9	-12.8	-9.0	-6.3	-3.6	-0.9	1.1	2.8	4.3	5.6	6.9	8.1	9.2	10.2	11.1	12.0	12.8	13.6	14.4
12	-18.7	-13.6	-10.0	-7.3	-4.6	-1.9	0.4	2.1	3.6	4.9	6.2	7.4	8.5	9.5	10.4	11.3	12.1	12.9	13.7
11	-19.4	-14.4	-11.1	-8.4	-5.7	-3.0	-0.3	1.4	2.9	4.2	5.5	6.7	7.8	8.8	9.7	10.6	11.4	12.2	13.0
10	-20.2	-15.2	-11.9	-9.2	-6.5	-3.8	-1.1	0.1	1.6	2.9	4.2	5.4	6.5	7.5	8.4	9.3	10.1	10.9	11.7
9	-21.0	-16.0	-12.8	-10.0	-7.3	-4.6	-1.9	-0.2	0.9	2.2	3.5	4.7	5.8	6.8	7.7	8.6	9.4	10.2	11.0
8	-21.8	-16.8	-13.6	-10.8	-8.1	-5.4	-2.7	-0.8	-0.5	1.2	2.5	3.7	4.8	5.8	6.7	7.6	8.4	9.2	10.0
7	-22.5	-17.5	-14.4	-11.7	-9.0	-6.3	-3.6	-1.7	-1.4	-0.2	1.1	2.3	3.4	4.4	5.3	6.2	7.0	7.8	8.6
6	-23.3	-18.3	-15.2	-12.5	-9.8	-7.1	-4.4	-2.5	-2.2	-1.0	-0.1	0.9	1.9	2.8	3.7	4.6	5.4	6.2	7.0
5	-24.1	-19.1	-16.0	-13.4	-10.7	-8.0	-5.3	-3.4	-3.1	-1.9	-1.0	0.0	0.9	1.8	2.7	3.5	4.3	5.1	5.9
4	-24.9	-20.0	-16.9	-14.2	-11.5	-8.8	-6.1	-4.2	-3.9	-2.7	-1.8	-0.8	0.1	1.0	1.9	2.7	3.5	4.3	5.1
3	-25.6	-21.1	-17.9	-15.1	-12.4	-9.7	-7.0	-5.1	-4.8	-3.6	-2.7	-1.7	-0.7	0.1	1.0	1.8	2.6	3.4	4.2
2	-26.4	-21.8	-18.6	-16.0	-13.7	-11.0	-8.3	-6.4	-6.1	-4.9	-3.9	-2.9	-2.0	-1.1	-0.3	0.5	1.3	2.1	2.9
1	-27.2	-22.7	-19.4	-16.8	-14.6	-12.7	-10.1	-8.2	-7.9	-6.7	-5.7	-4.7	-3.7	-2.8	-1.9	-1.0	-0.3	0.3	1.1
0	-28.0	-23.5	-20.3	-17.7	-15.5	-13.6	-11.0	-9.2	-8.9	-7.7	-6.7	-5.7	-4.7	-3.7	-2.8	-1.9	-1.0	-0.7	0.0

Table 3: Dew point chart

Bob McDavitt has this to say about the chart “Measure your dew point. This is the temperature at which water vapour starts condensing (dew forms). The dew point that is measured around 3pm can be taken as a useful first-estimate of the “overnight low”, for those nights with no air-mass change. The air temperature can be expected to cool to this value (or lower) on a clear calm long night. There are not many devices around that can directly measure dew point. One way is to measure the “wet bulb” temperature and then use tables. An easier way is to measure RELATIVE HUMIDITY RH (with a hygrometer- these are cheap and plentiful) and then use table 3. Hygrometers are usually least accurate when the RH is around 50% but give good readings when RH is above 80% or below 30%. Remember to keep the RH probe outside, and if you wish to measure the air temperature at the same time then use a thermometer that is properly housed in a Stevenson screen.”

Bear in mind that this is only an indication of the overnight low. The final overnight low can get lower than this. Once the dew point is reached there may be some further cooling on a calm clear night longer than 12 hours and then the air temperature and dew point may fall in tandem.

The next method is to build a calculation you can use on your property. Ray Smith of the MetService did this some years ago for Canterbury. What he came up with is:

Canterbury on clear calm spring nights:

$$T_g = 0.3 \times (T + T_d/2) - c$$

Where T_g is the forecast ground frost for tomorrow morning in °C

T is the 3pm air temperature in °C

T_d is the 3pm dew point in °C

And c is usually 8 degrees (but in Canterbury in winter it is closer to 9 degrees).

provided that:

1. the cloud amount is $<1/4$ of low or medium clouds and $<3/4$ high clouds
2. the wind speed is < 5 kt from E or NE (wind off the sea) or < 7 kt from any other direction.

I have briefly tried this formula in other regions and it seems to work quite well but it may need more research. Perhaps it is something you could try. As always we are happy to help. Just send us an email.

Users of HortPlus Metwatch Online currently have a national frost forecast updated every day and will soon have the dew point calculated for them. We have been following the forecasts and they are very accurate provided they are adjusted to the local microclimate, as described above.

HortPlus also sells a range of calibrated, high precision temperature loggers as shown in Figures 1 and 2. These loggers are ideal for exploring your property and doing a microclimate calibration. They are also very cheap compared with other loggers. Call Lesley on 06 876 4922 if you would like more information.

So what is the take home message about frosts?

1. Frosts occur later than you think. Don't let your guard down.
2. Pay attention to ground frost. It estimates your crop temperature more closely.
3. Use the dew point table as a first estimate of the night-time low.
4. Know your block and how it relates to the regional frost forecast.
5. Develop a block specific estimate of the night-time low.



Figure 1



Figure 2