How to apply weather station data to turfgrass management…..

Mark Hunt

Weather Analytics

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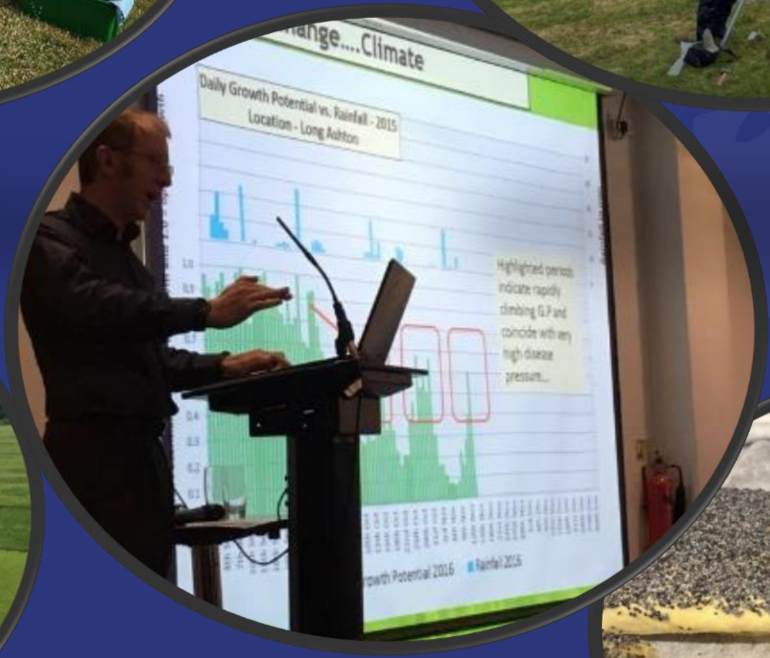
A bit about me..

headland
AMENITY PRODUCTS



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Talk Content

- **Data and its usage in modern day greenkeeping – a perspective.**
- **Davis weather stations – what primary climatic parameters they measure as standard and what they can also measure through supplementary sensors.**
- **Derived agronomic parameters & the use of software packages.**
- **Worked examples using both primary climatic and derived agronomic parameters.**
- **Summary**

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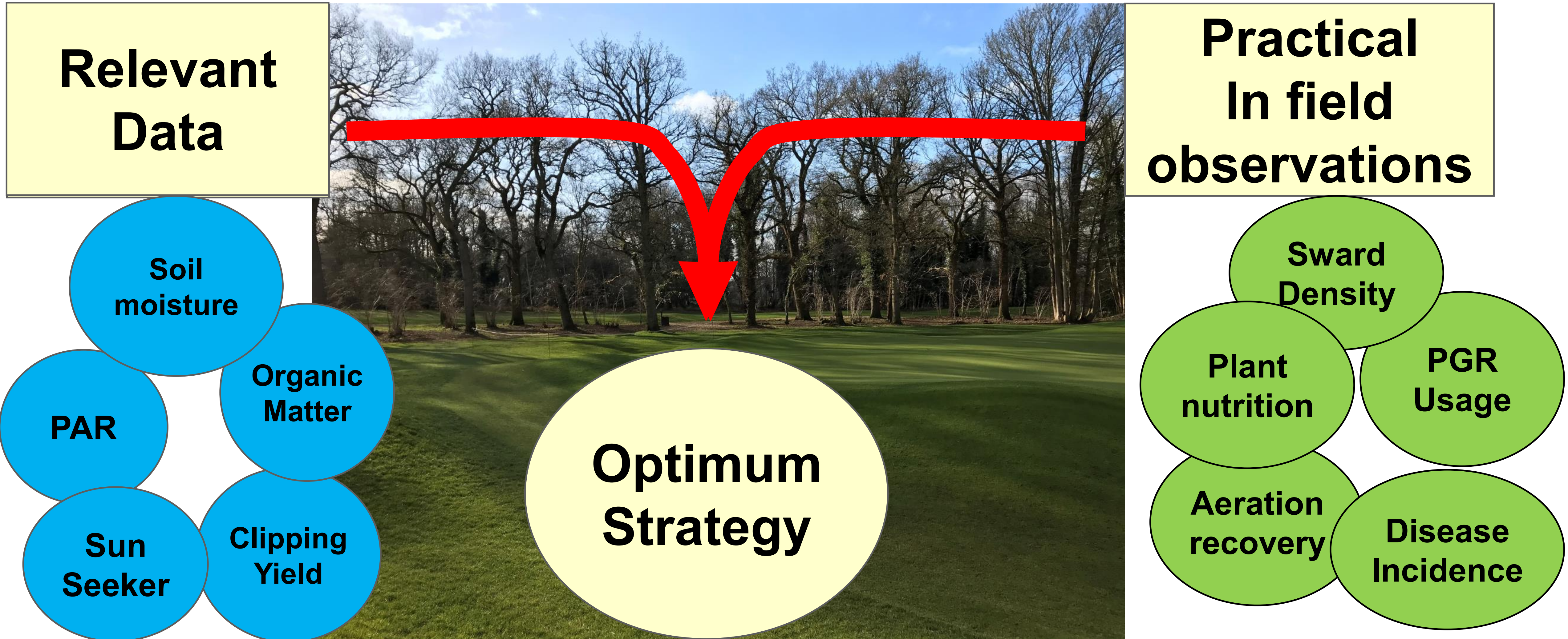
Data and field observations



Climatic Parameter	Unit of measurement
Air Temperature	Min , max, mean temperature in °C or °F
Relative Humidity	Min , max, , mean relative humidity in %
Rainfall	Amount in mm & Intensity in mm per hour
Wind	Speed , direction, maximum wind gust @ 2m
Solar radiation	Measured in watts per m2
U.V radiation	Reported as an index
Dewpoint	Calculated from an equation using temperature and humidity in °C or °F
Evapotranspiration (E.T)	Calculated from the Penman-Monteith equation utilising solar radiation, temperature, wind speed & humidity

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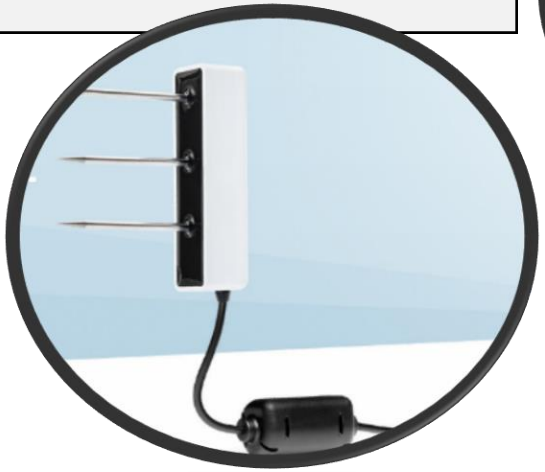
Measured Parameter	Unit of measurement
Leaf wetness	Intensity rating 0-15 and duration in minutes
Soil Temperature	in °C or °F
Soil Moisture	In vmc – capable of multi-depth sensing
Soil Salinity	In micro siemens
PAR Radiation	Plant-available light measured in watts per m2



Climatic Parameter	Agronomic parameter usage
E.T and rainfall	Soil moisture surplus / deficit
Air Temperature	Growth Degree Days & Growth Potential
Relative Humidity & air temperature	Utilised in Smith Kerns Dollar Spot model
Leaf wetness & air temperature	Utilised in Anthracnose probability model
Leaf wetness, air temperature, relative humidity, dewpoint and leaf wetness intensity and duration	Utilised in Microdochium nivale probability model

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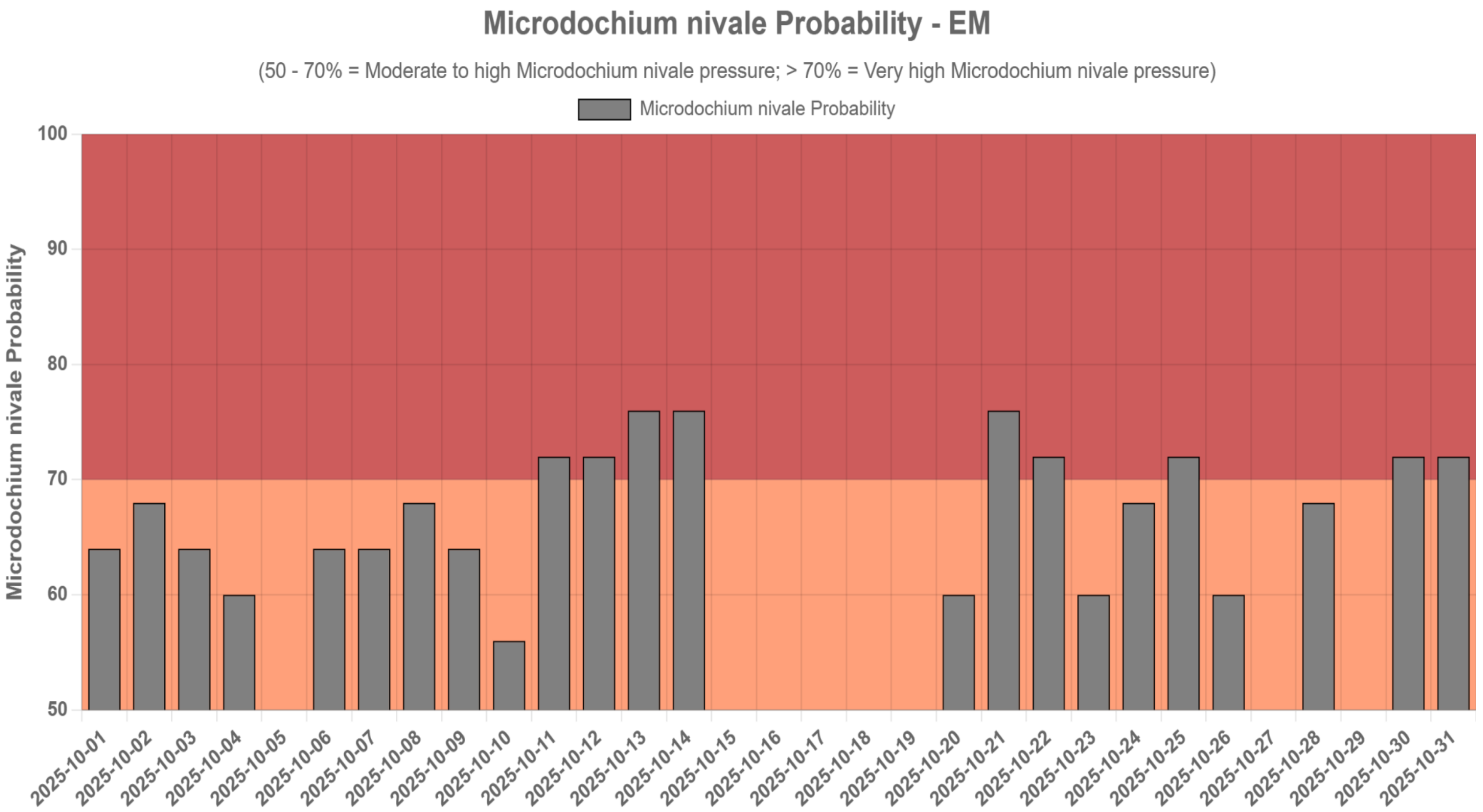

Displays data Converts data into agronomic parameters

This is our beta version Microdochium nivale probability model. You'll note the vertical axis runs from 50% probability and above, so when you see no readings then it means the disease probability level is low. From 50-70% probability denotes medium to high disease pressure and >70% denotes very high disease pressure. In practice we tend to see scarring from this disease occur when we have consecutive days of disease pressure either within the 50-70% probability level or above. Please feel free to send your feedback to markh@weatherstations.co.uk.

PRODATA Reports

  

Worked examples

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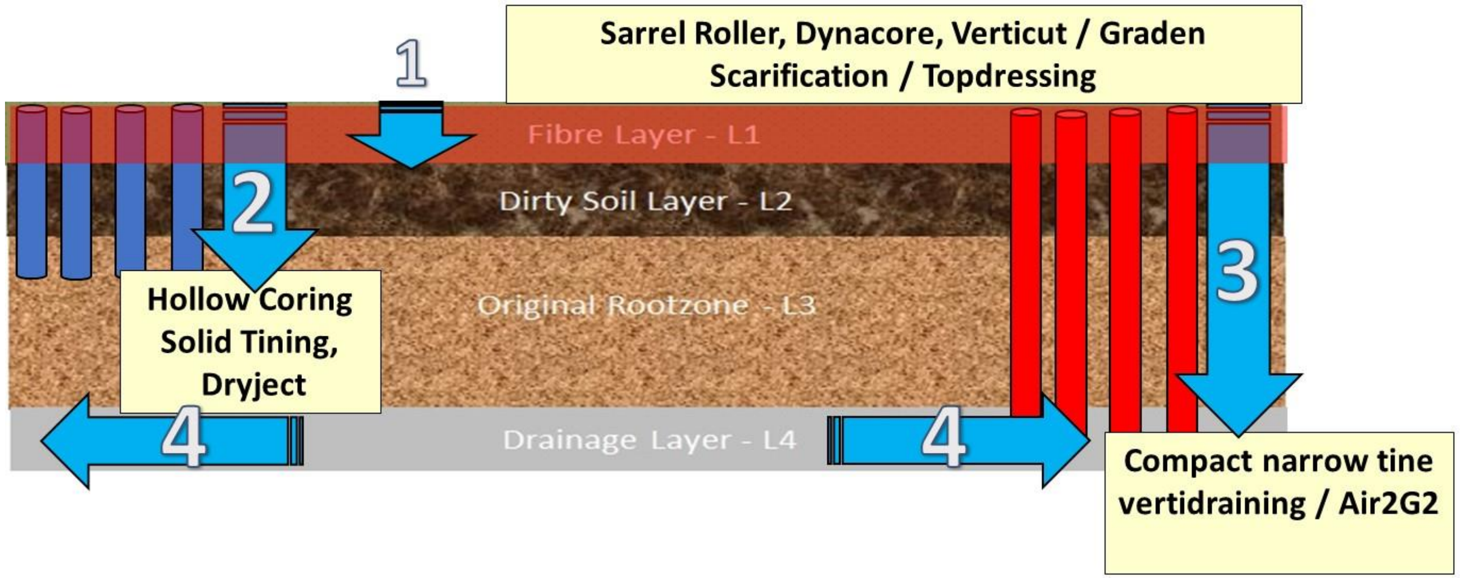
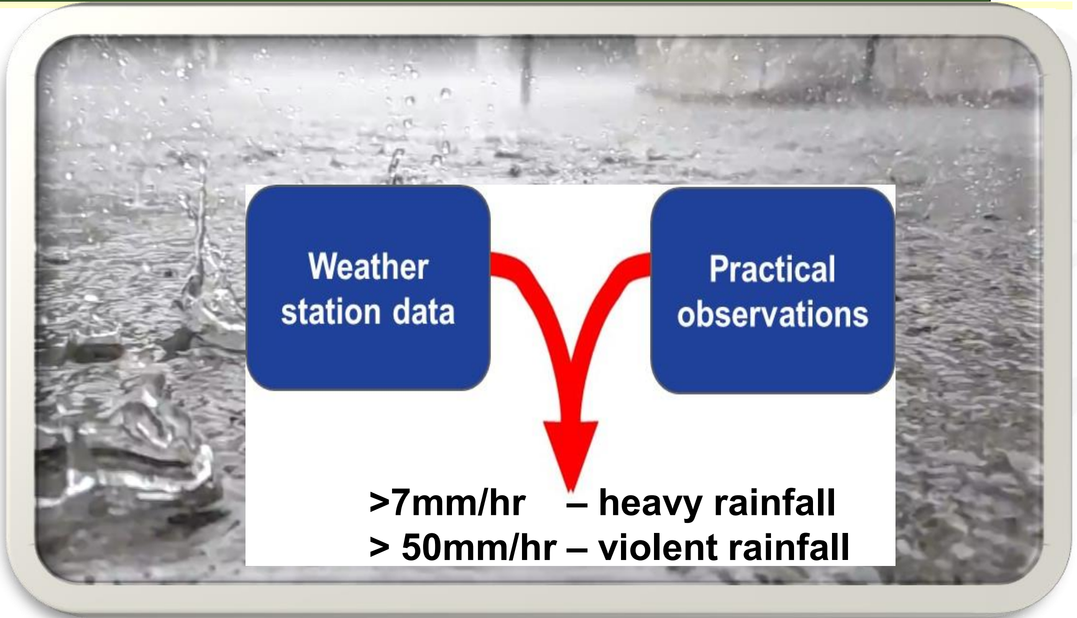
Rainfallexp: WL TheOxfordshiregc, September 2024

Day	Total Rain mm	Rain max mm/hr	Rain max time
1	0.0	0.0	00:00
2	0.0	0.0	00:00
3	0.2	0.2	06:00
4	0.0	0.0	00:00
5	5.0	22.6	16:00
6	0.4	0.2	11:00
7	0.0	0.0	00:00
8	12.0	48.0	18:00
9	0.0	0.0	00:00
10	3.0	37.8	19:00
11	1.6	18.0	17:00
12	3.0	50.0	20:00
13	0.2	0.2	02:00
14	0.0	0.0	00:00
15	1.4	7.2	20:00
16	0.0	0.0	00:00
17	0.0	0.0	00:00
18	0.0	0.0	00:00
19	0.0	0.0	00:00
20	0.0	0.0	00:00
21	1.2	2.6	14:00
22	19.2	88.6	16:00
23	104.0	59.4	06:00
24	2.8	3.0	00:00
25	11.4	41.0	21:00
26	14.6	11.0	21:00
27	6.6	10.4	03:00
28	0.0	0.0	00:00
29	0.4	0.2	20:00
30	6.8	6.4	07:00
Overall	193.8	88.6	Day 22



A modern rootzone has to be able to move water through quickly and have good air-filled porosity as well. High intensity rainfall events are on the increase.

Using rainfall and rain rate data to support strategic decisions on aeration and drainage



Month	1991-2020 Rainfall Anomaly	2024 Rainfall	vs. 1991-2020 Anomaly	2025 Rainfall	vs. 1991-2020 Anomaly
January	58.90	65.00	10%	76.00	29%
February	42.13	110.20	162%	49.60	18%
March	39.79	81.80	106%	9.40	-76%
April	48.97	72.00	47%	16.20	-67%
May	52.31	71.00	36%	30.40	-42%
June	46.25	21.80	-53%	28.80	-38%
July	45.23	62.00	37%	47.80	6%
August	53.30	35.80	-33%	47.60	-11%
September	49.90	193.80	288%	75.20	51%
October	68.90	66.20	-4%	50.60	-27%
November	69.97	68.20	-3%	94.60	35%
December	58.09	45.60	-22%	70.00	21%
Total	633.74	893.4	41%	596.2	-6%

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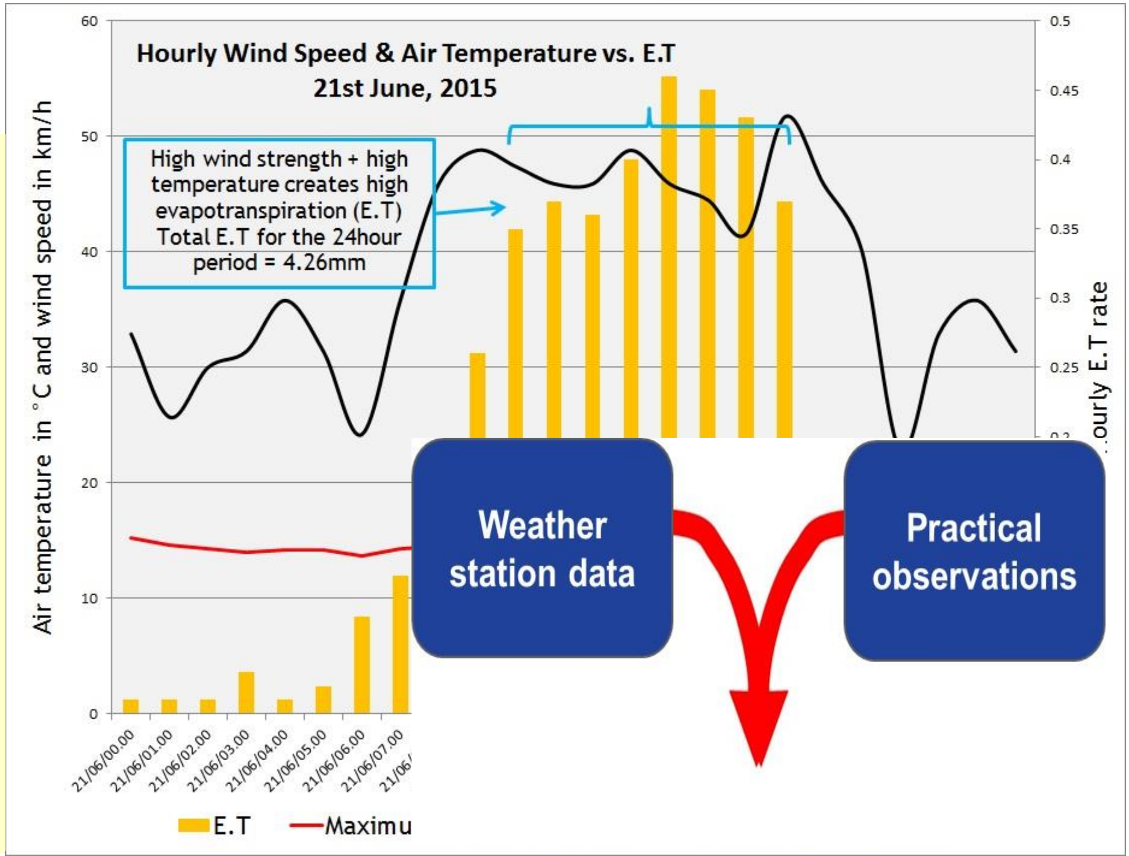
Benchmarking your weather stats from a climatic perspective

MonthlySummary_SoilMoistureStatus: WL TheOxfordshiregc, June 2025

Day	Total Rain mm	Total ET mm	SMS / SMD (month) mm
1	0.0	4.19	-4.2
2	0.0	4.27	-8.5
3	5.2	2.95	-6.2
4	0.0	3.00	-9.2
5	10.4	1.75	-0.6
6	0.0	4.09	-4.6
7	7.0	2.01	0.3
8	0.2	3.78	-3.2
9	0.0	3.48	-6.7
10	0.0	3.43	-10.1
11	0.0	3.35	-13.5
12	0.2	2.69	-16.0
13	0.0	5.16	-21.1
14	0.0	4.19	-25.3
15	0.0	4.29	-29.6
16	0.0	4.55	-34.2
17	0.0	5.49	-39.7
18	0.0	5.28	-44.9
19	0.0	5.69	-50.6
20	0.0	4.55	-55.2
21	0.0	3.73	-58.9
22	0.0	3.68	-62.6
23	0.6	4.55	-66.5
24	0.4	3.99	-70.1
25	0.0	3.89	-74.0
26	0.2	4.67	-78.5
27	4.6	4.88	-78.8
28	0.0	5.05	-83.8
29	0.0	4.04	-87.9
30	0.0	5.89	-93.8
Overall	28.8	122.56	-93.8

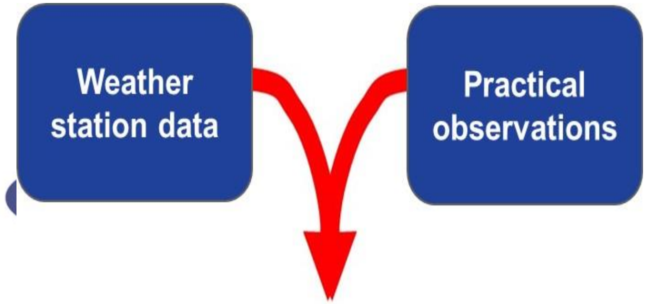
What % of E.T do you replace with irrigation ? Typically, 50-60% is my experience on fine turf rootzones



Annual Report: WL TheOxfordshiregc, 2025

Month	Rainfall (mm)	ET (mm)	SMS/SMD (mm)
Jan	76.0	9.4	66.6
Feb	49.6	16.2	33.4
Mar	9.4	50.9	-41.5
Apr	16.2	86.7	-70.5
May	30.4	107.4	-77.0
Jun	28.8	122.6	-93.8
Jul	47.8	110.6	-62.8
Aug	47.6	95.6	-48.0
Sep	75.2	60.0	15.2
Oct	50.6	25.3	25.3
Nov	94.6	14.1	80.5
Dec	70.0	8.2	61.8
Total	596.2	706.9	-110.7

E.T data provides a basis for water usage year-on-year and of course playability



Annual Report: WL TheOxfordshiregc, 2024

Month	Rainfall (mm)	ET (mm)	SMS/SMD (mm)	GDD (0°C)	GDD (6°C)	GP
Jan	65.0	13.2	51.8	157.6	37.0	3.8
Feb	110.2	19.0	91.2	238.0	77.2	7.5
Mar	81.8	39.1	42.7	256.3	78.6	7.8
Apr	72.0	66.5	5.5	290.3	111.1	10.7
May	71.0	89.2	-18.2	429.6	243.6	22.7
Jun	21.8	113.5	-91.7	444.2	264.2	22.9
Jul	62.0	99.1	-37.1	525.7	339.7	27.7
Aug	35.8	93.5	-57.7	541.2	355.2	28.9
Sep	193.8	46.4	147.4	421.5	241.5	21.4
Oct	66.2	27.7	38.5	361.8	175.8	16.4
Nov	68.2	10.1	58.1	228.2	74.9	7.1
Dec	45.6	8.4	37.2	223.2	47.3	5.5
Total	893.4	625.8	267.6	4,117.6	2,046.1	182.4

Annual Report: WL TheOxfordshiregc, 2025

Month	Rainfall (mm)	ET (mm)	SMS/SMD (mm)	GDD (0°C)	GDD (6°C)	GP
Jan	76.0	9.4	66.6	115.1	11.6	1.9
Feb	49.6	16.2	33.4	139.5	26.2	3.1
Mar	9.4	50.9	-41.5	226.1	69.2	6.9
Apr	16.2	86.7	-70.5	327.0	147.0	13.4
May	30.4	107.4	-77.0	415.9	229.9	20.9
Jun	28.8	122.6	-93.8	533.2	353.2	25.3
Jul	47.8	110.6	-62.8	582.3	396.3	28.5
Aug	47.6	95.6	-48.0	553.4	367.4	29.0
Sep	75.2	60.0	15.2	413.3	233.3	21.0
Oct	50.6	25.3	25.3	354.5	168.5	15.7
Nov	94.6	14.1	80.5	261.4	108.2	10.4
Dec	70.0	8.2	61.8	223.2	59.9	6.2
Total	596.2	706.9	-110.7	4,144.9	2,170.7	182.2

Growth-Degree-Days and Growth Potential are two different growth models.
They behave differently in an annual summary comparison

March 2024

Day	GDD 0°C base	Cumulative Annual GDD 0°C base	GDD 6°C base	Cumulative Annual GDD 6°C base	GP	Cumulative Annual GP
1	4.5	400.1	0.0	114.2	0.05	11.31
2	4.3	404.4	0.0	114.2	0.05	11.36
3	2.4	406.8	0.0	114.2	0.02	11.38
4	4.6	411.4	0.0	114.2	0.05	11.43
5	6.4	417.8	0.4	114.6	0.11	11.54
6	5.9	423.7	0.0	114.6	0.09	11.63
7	6.7	430.4	0.7	115.3	0.12	11.75
8	6.3	436.7	0.3	115.6	0.10	11.85
9	8.4	445.1	2.4	118	0.22	12.07
10	7.9	453	1.9	119.9	0.19	12.26
11	7.2	460.2	1.2	121.1	0.14	12.4
12	10.0	470.2	4.0	125.1	0.34	12.74
13	11.6	481.8	5.6	130.7	0.51	13.25
14	11.8	493.6	5.8	136.5	0.53	13.78
15	11.6	505.2	5.6	142.1	0.51	14.29
16	8.7	513.9	2.7	144.8	0.24	14.53
17	11.7	525.6	5.7	150.5	0.51	15.04
18	10.6	536.2	4.6	155.1	0.41	15.45
19	11.6	547.8	5.6	160.7	0.51	15.96
20	12.3	560.1	6.3	167	0.58	16.54
21	10.9	571	4.9	171.9	0.44	16.98
22	9.3	580.3	3.3	175.2	0.28	17.26
23	6.2	586.5	0.2	175.4	0.10	17.36
24	7.8	594.3	1.8	177.2	0.18	17.54
25	8.2	602.5	2.2	179.4	0.20	17.74
26	9.5	612	3.5	182.9	0.30	18.04
27	7.1	619.1	1.1	184	0.14	18.18
28	7.3	626.4	1.3	185.3	0.15	18.33
29	8.9	635.3	2.9	188.2	0.25	18.58
30	8.7	644	2.7	190.9	0.24	18.82
31	7.9	651.9	1.9	192.8	0.19	19.01
Overall	256.3	651.9	78.6	192.8	7.75	19.01

April 2025

Day	GDD 0°C base	Cumulative Annual GDD 0°C base	GDD 6°C base	Cumulative Annual GDD 6°C base	GP	Cumulative Annual GP
1	9.0	489.7	3.0	110	0.26	12.18
2	9.7	499.4	3.7	113.7	0.32	12.5
3	11.8	511.2	5.8	119.5	0.53	13.03
4	13.9	525.1	7.9	127.4	0.76	13.79
5	10.3	535.4	4.3	131.7	0.37	14.16
6	9.0	544.4	3.0	134.7	0.26	14.42
7	8.2	552.6	2.2	136.9	0.21	14.63
8	8.1	560.7	2.1	139	0.20	14.83
9	7.2	567.9	1.2	140.2	0.15	14.98
10	8.2	576.1	2.2	142.4	0.20	15.18
11	11.6	587.7	5.6	148	0.50	15.68
12	14.2	601.9	8.2	156.2	0.78	16.46
13	11.1	613	5.1	161.3	0.46	16.92
14	9.1	622.1	3.1	164.4	0.27	17.19
15	10.6	632.7	4.6	169	0.40	17.59
16	10.0	642.7	4.0	173	0.34	17.93
17	9.1	651.8	3.1	176.1	0.27	18.2
18	10.4	662.2	4.4	180.5	0.39	18.59
19	12.4	674.6	6.4	186.9	0.60	19.19
20	9.7	684.3	3.7	190.6	0.32	19.51
21	10.7	695	4.7	195.3	0.41	19.92
22	10.4	705.4	4.4	199.7	0.38	20.3
23	10.2	715.6	4.2	203.9	0.37	20.67
24	10.0	725.6	4.0	207.9	0.35	21.02
25	9.8	735.4	3.8	211.7	0.33	21.35
26	11.8	747.2	5.8	217.5	0.53	21.88
27	14.2	761.4	8.2	225.7	0.79	22.67
28	14.9	776.3	8.9	234.6	0.85	23.52
29	15.4	791.7	9.4	244	0.90	24.42
30	16.0	807.7	10.0	254	0.93	25.35
Overall	327	807.7	147	254	13.43	25.35

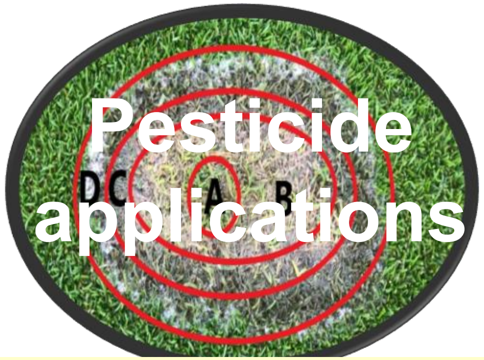
Or we may look at our GDD stats to determine the feasibility of January hollow coring….

Looking a the GDD stats we can compare the two years.

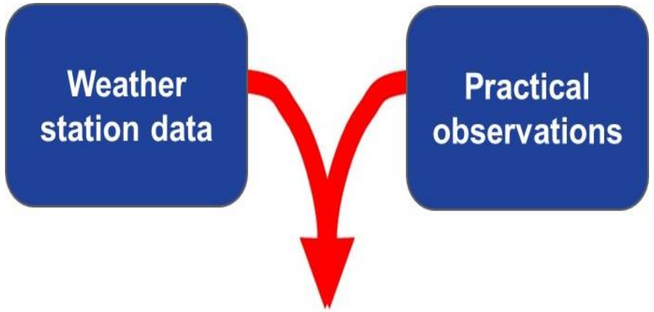
Day	GP	Cumulative Annual GP	S-K Probability %	M.nivale Probability - WLL sensor 1 %
1	0.63	150.6	18.3	48.0
2	0.81	151.41	20.0	56.0
3	0.92	152.33	25.4	48.0
4	0.57	152.9	23.8	48.0
5	0.57	153.47	23.0	40.0
6	0.75	154.22	22.0	44.0
7	0.67	154.89	21.3	52.0
8	0.71	155.6	18.3	48.0
9	0.36	155.96	21.4	64.0
10	0.67	156.63	25.2	52.0
11	0.36	156.99	24.2	68.0
12	0.14	157.13	23.2	76.0
13	0.59	157.72	24.0	76.0
14	0.47	158.19	24.8	80.0
15	0.42	158.61	24.9	72.0
16	0.38	158.99	26.8	64.0
17	0.60	159.59	27.3	40.0
18	0.55	160.14	22.1	40.0
19	0.71	160.85	[illegible]	[illegible]
20	0.63	161.48	25.6	80.0
21	0.53	162.01	26.1	68.0
22	0.41	162.42	26.5	56.0
23	0.24	162.66	27.5	52.0
24	0.18	162.84	21.7	48.0
25	0.21	163.05	0	60.0
26	0.16	163.21	0	56.0
27	0.47	163.68	0	44.0
28	0.53	164.21	0	48.0
29	0.32	164.53	0	48.0
30	0.29	164.82	0	64.0
31	0.81	165.63	19.0	48.0
Overall	15.66	165.63	-	-

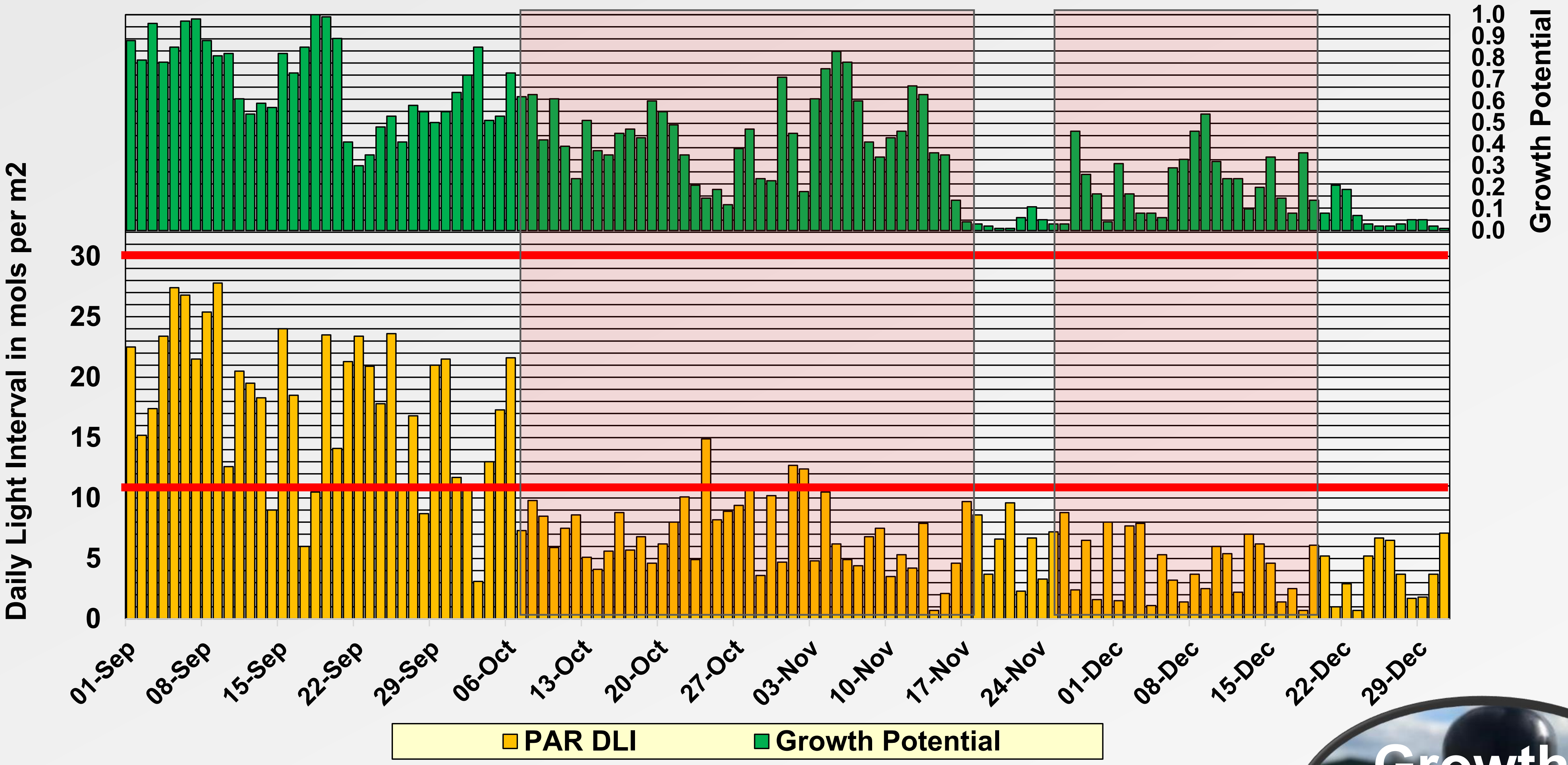
Let's assume I made an application on the 1st of October…

If we sum the consecutive daily G.P figures we can see we would have reached a figure of 10 on 19th October, so that's 18 days of efficacy…

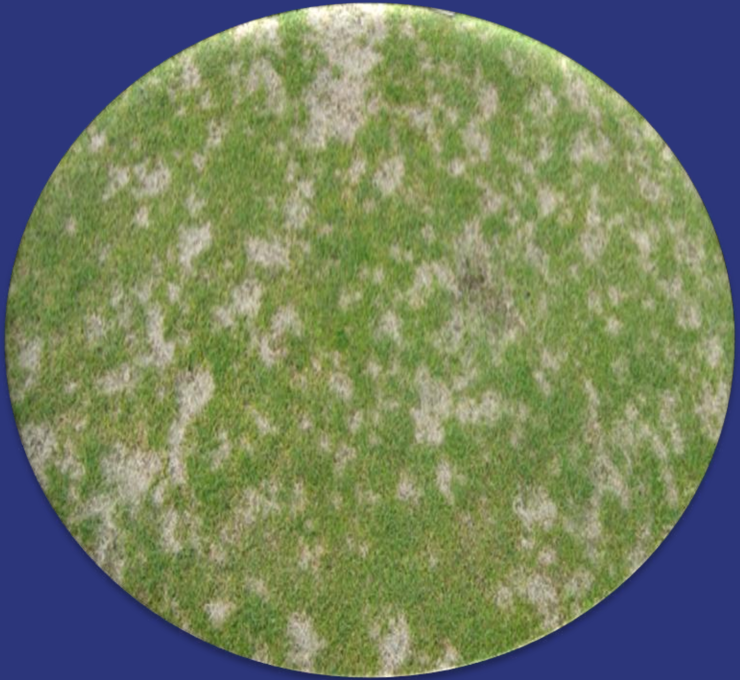


From previous research work I have determined that a good systemic fungicide application lasts around 10 cumulative G.P





The growth – light conundrum
With climate change, growth is continuing later into the autumn / winter but light levels are not high enough to support that growth….



Disease Modelling

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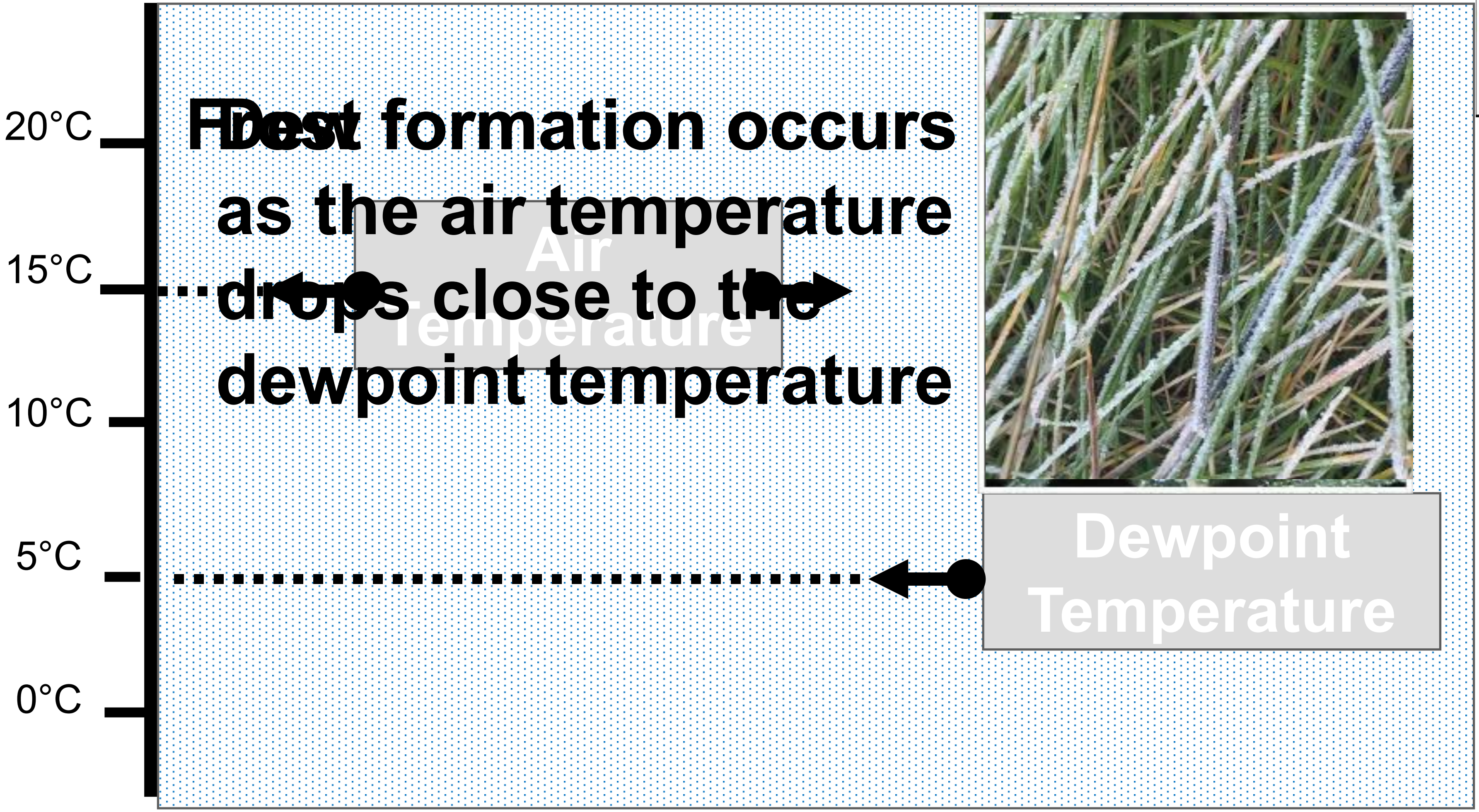
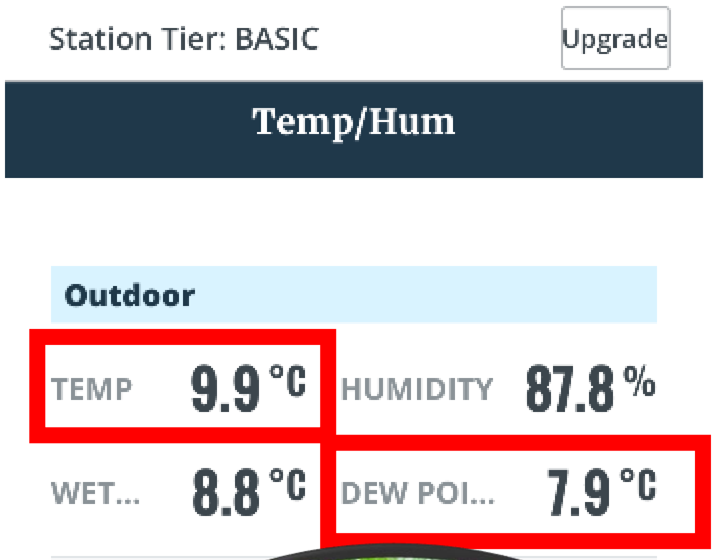
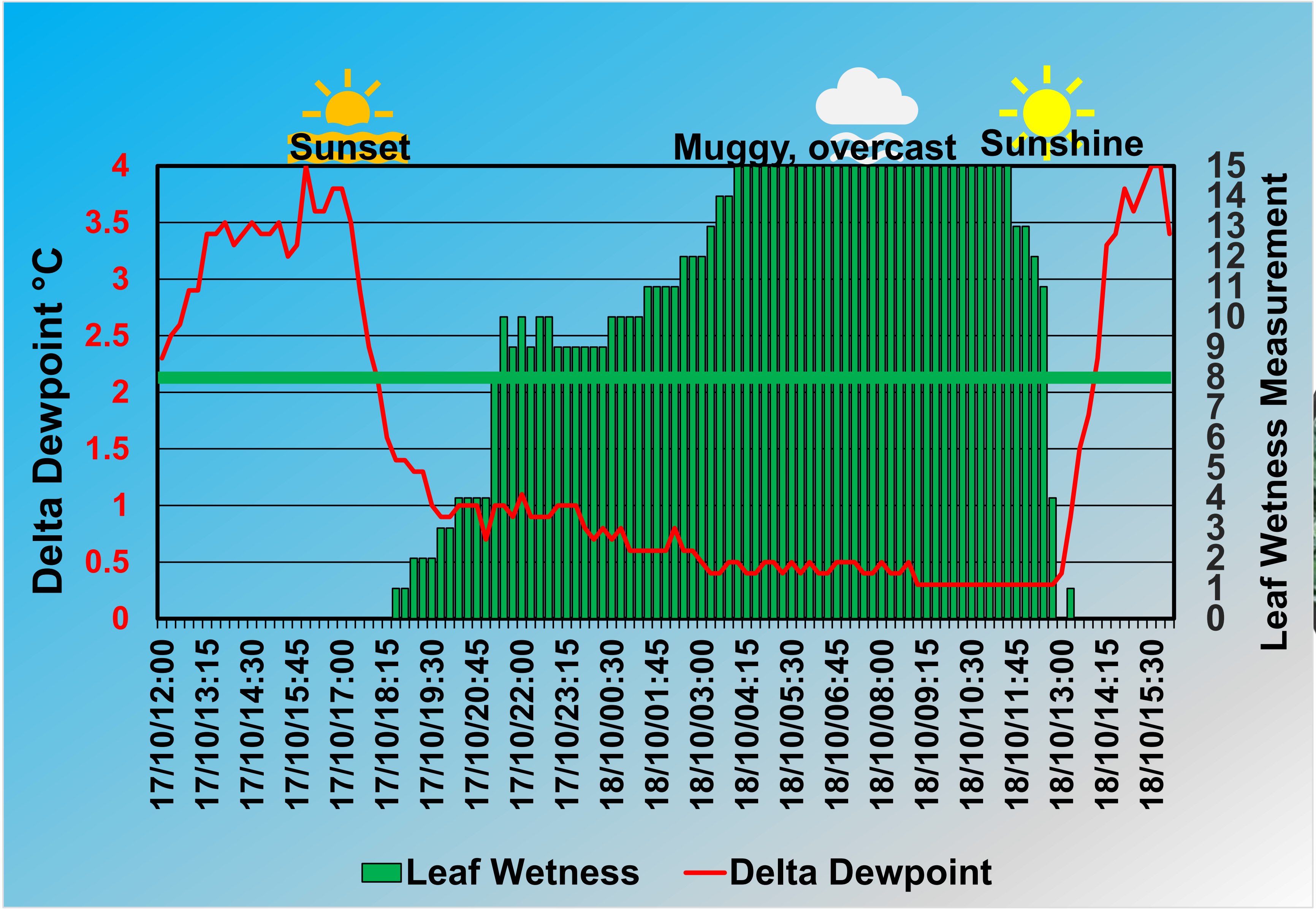
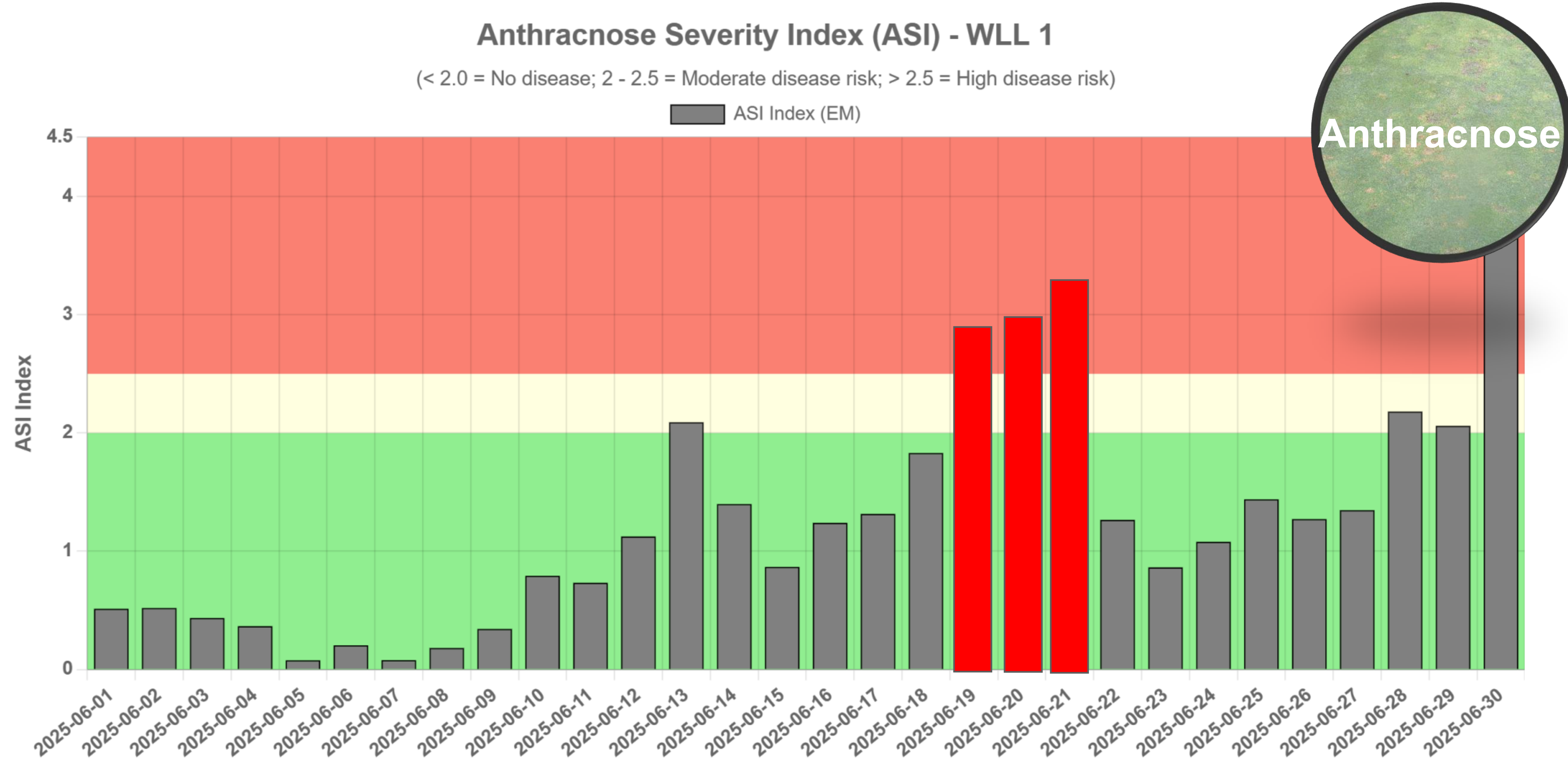


$$\text{Dew Point} = \frac{243.12 \times \left\{ \ln\left(\frac{RH}{100}\right) + \frac{17.62 \times T}{243.12 + T} \right\}}{17.62 - \left\{ \ln\left(\frac{RH}{100}\right) + \frac{17.62 \times T}{243.12 + T} \right\}}$$

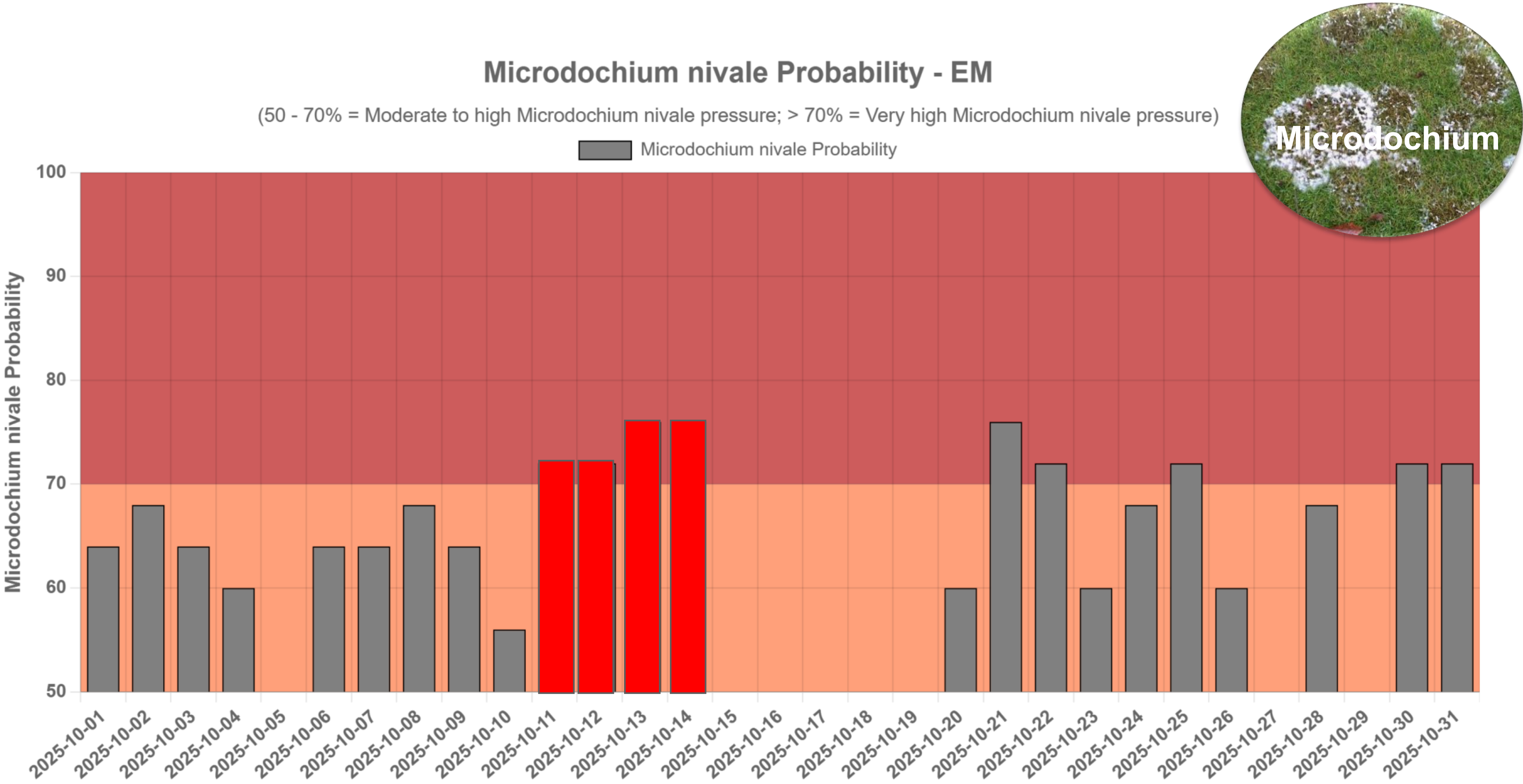




This graph represents 14 hours of plant leaf wetness with dew re-forming after physical removal until midday. Plant leaf wetness drives foliar pathogen development.

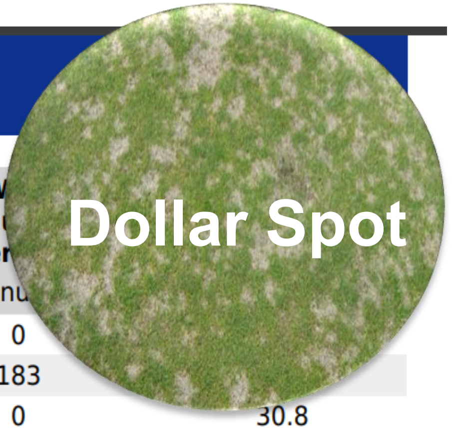


ASI stands for Anthracnose Severity Index - A disease model originally developed in the U.S by Karl Danneberger and Joe Vargas and now modified for European climatic conditions. The model uses temperature and leaf wetness data from the Davis weather station sensors. The aim of this model is to identify the initial disease activity trigger associated with Anthracnose (Colletotrichum cereale) so that either preventative fungicide applications can be made and / or BMP's (as developed by Rutgers University) put into place. Readings > 2.5 strongly suggest disease activity.



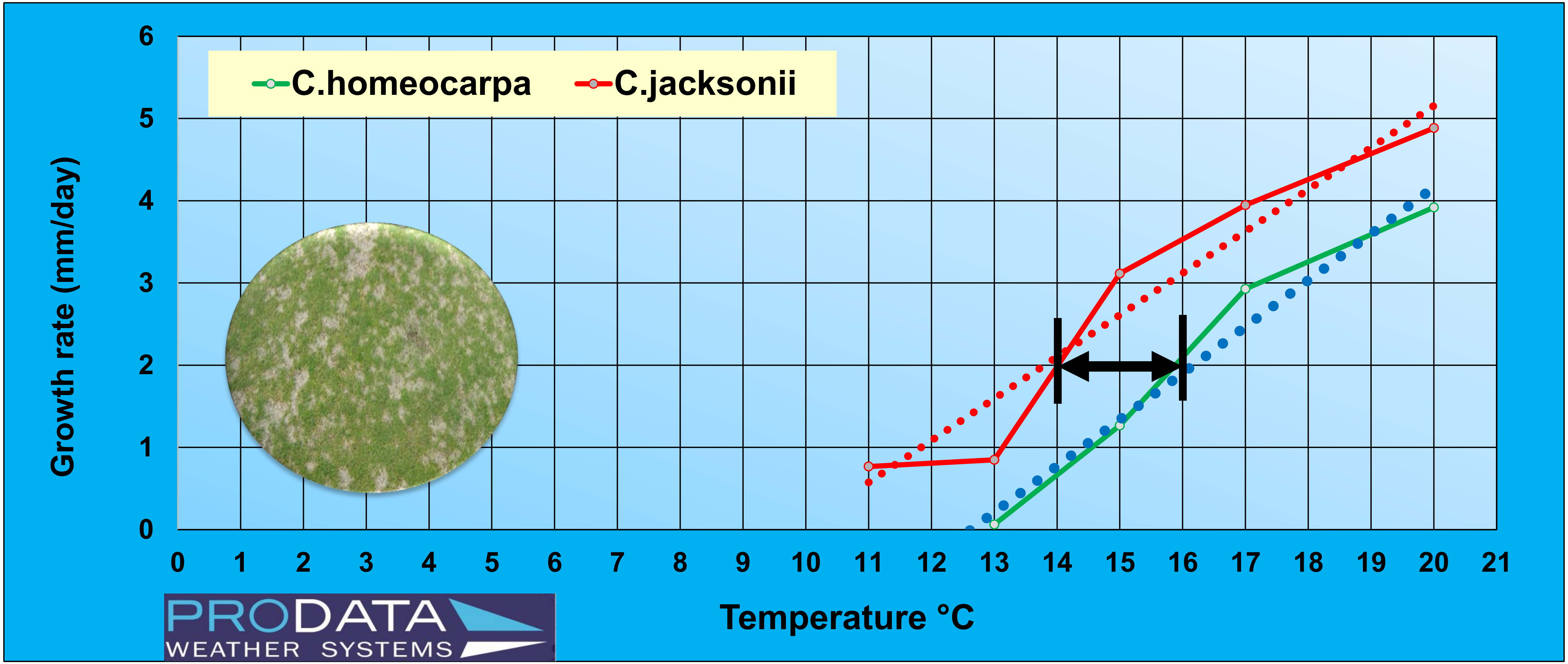
This is our beta version Microdochium nivale probability model. You'll note the vertical axis runs from 50% probability and above, so when you see no readings then it means the disease probability level is low. From 50-70% probability denotes medium to high disease pressure and >70% denotes very high disease pressure. In practice we tend to see scarring from this disease occur when we have consecutive days of disease pressure either within the 50-70% probability level or above. Please feel free to send your feedback to markh@weatherstations.co.uk.

Overnight Leaf Wetness Report - 6345: WL TheOxfordshiregc, July 2025



Day	T mean (overnight) °C	RH mean (overnight) %	Dew Point Mean (overnight) °C	Low Dew Point Delta (overnight) °C	Low Dew Point Delta Timestamp (overnight)	Leaf Wetness 1 mean (overnight)	Leaf W Min (over minu	
1	21.8	82	18.9	1.7	05:00	0.6	0	[illegible]
2	18.1	87	16.0	1.0	05:00	6.3	183	[illegible]
3	10.8	72	6.3	1.9	05:00	1.3	0	30.8
4	13.4	76	9.5	1.4	05:00	2.4	52	22.8
5	16.6	75	12.4	2.6	05:00	1.8	64	21.8
6	15.7	91	14.4	0.7	05:00	6.6	188	19.8
7	14.8	83	12.2	0.8	05:00	4.4	86	19.9
8	12.5	84	10.1	1.3	05:00	9.6	249	21.7
9	11.8	81	8.9	1.3	04:00	3.1	58	25.1
10	17.3	83	14.6	1.1	05:00	3.4	43	21.8
11	18.4	79	15.2	1.2	05:00	2.2	10	21.8
12	18.7	75	14.3	1.7	05:00	0.6	0	21.8
13	16.2	85	14.1	0.7	05:00	1.6	7	27.7
14	18.8	73	13.7	1.6	06:00	0.5	0	26.6
15	13.2	84	10.9	1.7	03:00	11.7	420	27.0
16	14.2	92	13.0	0.9	05:00	15.0	540	26.1
17	16.9	82	13.9	1.7	03:00	0.5	0	29.7
18	18.9	90	17.3	0.7	06:00	3.0	3	32.6
19	18.4	85	16.0	1.5	06:00	2.1	44	38.2
20	17.0	92	15.6	0.9	06:00	15.0	540	42.1
21	12.5	89	11.0	0.6	06:00	0.7	0	42.2
22	15.4	90	14.0	0.9	06:00	15.0	600	42.1
23	15.7	91	14.4	0.7	04:00	9.6	291	39.8

The Davis weather station shows a peak in overnight temperatures, humidity and leaf wetness duration on the 15th and 16th, 3 days earlier.



Research work funded by Prodata and carried out at an independent laboratory shows that isolates of Dollar Spot have distinctively different temperature vs. growth profiles. In 2026 we will add a low temperature Dollar Spot model to Prodata Reports..

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Summary

Weather stations can improve turf management decision-making and communication strategies by providing key data.

E.T is one of the most useful calculated parameters but does need the station to have a solar radiation sensor.

Growth models, both GDD and G.P can assist with PGR, nutrition and fungicide applications.

Real-time, disease modelling using on-site data for Anthracnose, Microdochium and both temperature variants of Clarireedia will also help support IPM strategies.

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Thanks for listening..

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