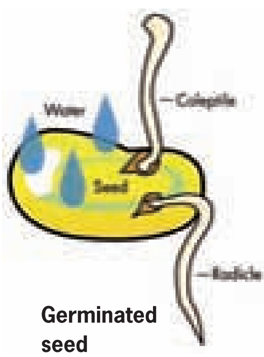
RESPONSE OF GRASS SEED GERMINATION RELATIVE TO SOIL TEMPERATURE

Gerard van 't Klooster looks at the remarkable results of temperature germination trials

One of the most frequent enquiries we get from Course Managers and greenkeepers is about germination times for particular grass seed species or mixtures. The traditional response has been a very general statement in relation to a specific species, for example 7-10 days for perennial ryegrass (Lolium perenne) and 14-21 days for smooth-stalked meadowgrass (Poa pratensis). But, as our research at Barenbrug discovered during a recent germination trials programme, there are significant differences in temperature germination response not only between species, but also between different cultivars within a species.

The germination process

Grass seed

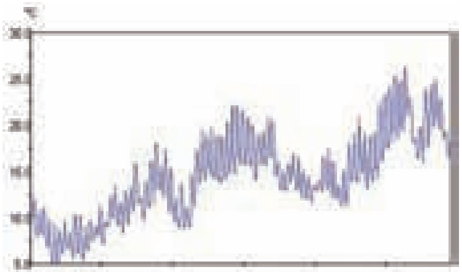


Germinated seed

Germination of grass seed begins when sufficient temperatures are present and adequate moisture is available for absorption; the larger the seed the more water is required. Moisture taken in results in a cascade of signals that direct development; Gibberellin hormones signal the production of enzymes which function to break down the starchy endosperm for nourishing the embryo. The radicle (primary root) is the first structure to emerge from the embryo, followed by the coleoptile, or primary shoot (see diagram below). Green leaf tissue emerges to begin the photosynthetic process to provide energy for successful establishment of the emerging plant.

Trial objectives

The increased performance and presentation demands placed upon natural turf surfaces during recent years have been further compounded by the effects of climate change. One of the most influential factors is the inconsistency of seasonal temperatures; cold temperatures in late spring (soil temperatures of just 80C), warm winters (soil temperatures remaining at 100C or above) and extremely hot periods during summer months (soil temperatures at +300C). Graph 1 (see below) shows the differences in soil temperatures at Barenbrug Research in Holland during the cold, late spring of 2006. The temperature influence is an extremely important point to note. The opportunity for turf managers to have access to temperature response germination data cannot be



underestimated. Having the information to select individual cultivars and mixture formulations for increased percentage germination at different soil temperatures, combined with other desirable characteristics, will offer real practical solutions.

Graph 1. Variation of soil temperatures at 4in (100mm) depth of soil during April to June 2006.

Discussions with end users, combined with experience from our own trials, made it apparent there were significant differences in germination temperature response between cultivars within the same species. Observations of turf trials for many years showed consistency in temperature germination response for the same individual cultivar. These experiences inspired more research into the germination process; this particular characteristic would become a very influential part of cultivar selection when formulating seed mixtures for successful seeding or overseeding, particularly given the demands of reduced or enforced renovation windows. It was with this objective in mind that our company began temperature germination response trials.

Trials methodology

In 2005, we began working with the University of Hohenheim in Germany to research the germination temperature response of different cultivars of Poa pratensis.

The joint research programme became the first series of trials to explore a more detailed examination of the germination process. Poa pratensis was the first species selected for the pilot germination experiment, because the general understanding of the germination and establishment period within this species is a notoriously slow process, therefore any significant differences could offer real practical value. The ability to germinate or achieve higher percentage germination at cooler (or warmer) soil temperatures could significantly assist the establishment period or renovation window.

The optimum germination temperature range for Poa pratensis is accepted as 16-320C. Five different cultivars were tested for speed of germination under different temperature regimes. The experiment was conducted on a temperature gradient plate. This temperature gradient plate has 196 protected cells and the temperature of the cells can be adjusted between 0-300C. The temperature range for the trial was set from 5-350C. All the cultivars were tested in three replications. 25 seeds per replication were sown on the germination paper in each cell. This is the same protocol as would be used in an official International Seed Testing Association (ISTA) test, but with a different temperature scale (lower and higher). Only seed lots with a positive ISTA germination certificate (certified seed, as per the official label sown onto a bag of grass seed) were used (see Graph 2 below). Every 12 hours seeds which had successfully germinated were counted and recorded.

Cultivars of other species of amenity turf grasses, including Lolium perenne and Festuca rubra spp., have been independently trialled by us for temperature germination response. The experiments were again carried out using a temperature gradient plate. The temperature gradient was set to a range of 10-300C. All the cultivars were tested in two replications and assessed (counted) in the same way as the official ISTA test. An important part of the protocol was also to test different seed lots to see if the influence of the seed lot on germination was bigger than the specific cultivar influence.

One of the key benefits of Lolium perenne is that as a species it generally has the ability to begin the germination process at cooler soil temperatures. Research and practical experience has shown that germination of Lolium perenne at relatively low temperatures of 7-100C is possible, although there are again differences within cultivars, with some needing relatively higher temperatures than this to germinate.

Trial results

Poa pratensis

The Poa pratensis trial revealed significant differences in temperature germination response at both low and high temperatures relative to the species.

Table 1 shows the data results of the smooth-stalked meadowgrass trial (University of Hohenheim). Note the significant difference of relative high and low temperature percentage germination.

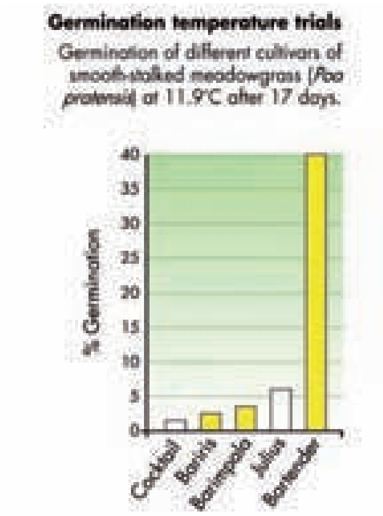
TORO. Count on it.

Average germination rate (%)

Temp(°c)	Bartender	Julius	Bariris	Cocktail	Barimpala
35.0	56.00	20.00	22.67	66.67	82.00
32.7	89.33	45.33	60.00	82.67	94.00
30.4	90.67	52.00	57.33	74.67	88.00
28.1	92.00	66.67	24.00	76.00	88.00
25.8	80.00	40.00	9.33	86.67	72.00
23.5	76.00	44.00	10.67	69.33	62.00
21.2	70.67	52.00	9.33	81.33	62.00
18.8	61.33	45.33	9.33	73.33	30.00
16.5	62.67	46.67	2.67	53.33	30.00
14.2	68.00	21.33	8.00	33.33	32.00
11.9	41.33	8.00	4.00	2.67	6.00
9.6	9.33	0.00	0.00	0.00	0.00
7.3	0.00	0.00	0.00	0.00	0.00
5.0	0.00	0.00	0.00	0.00	0.00

Table 1. Germination percentage for 5 Poa pratensis cultivars.

Graph 2 (below) represents the significant cool temperature, high percentage germination capability (41 per cent) of a particular cultivar of Poa pratensis, Bartender, in comparison with four different cultivars of the same species (less than 10 per cent)



Graph 2. Percentage germination at 11.90C after 17 days

Lolium perenne

Lolium perenne is an extremely variable species in relation to characteristics such as fineness of leaf, wear tolerance, shade tolerance and tolerance to close mowing. There are circumstances when a combination of these characteristics in conjunction with temperature response germination could be invaluable. Table 2 shows the results of the laboratory trials in Holland at low temperature, 100C day temperature and 70C night temperature. Note the high percentage germination (+80 per cent) of several cultivars after just 14 days at this temperature. Sowing different combinations of cultivars for different rootzone/soil temperatures could significantly influence the rapid germination and subsequent establishment and performance of the sward.

Crop Name			Ryegrass, perennial		Ryegrass, perennial		Ryegrass, perennial	
Description			14 days germination		25 days germination		35 days germination	
Rating Unit			PLANT		PLANT		PLANT	
Sample Size			100		100		100	
Entry No.	Entry Name	Rate Unit						
1	Barclay		1	i	64	f	78	e-i
2	Barball		61	c	94	ab	95	Ab
3	Barcredo		0	i	55	g	70	I
4	Barrage		31	ef	72	ef	75	Ghi
5	Barluxe		0	i	36	h	54	J
6	Barlinda		0	i	64	f	79	e-h
7	Barmona		6	hi	62	f	70	I
8	Bardessa		17	f-i	72	ef	79	e-h
9	Barsportivo		88	ab	95	ab	96	Ab
10	Sabor		8	hi	72	ef	83	d-h
11	Pinnacle		11	ghi	80	de	91	a-d
12	Bareine		77	ab	99	a	99	A
13	Bartwingo		6	hi	85	bcd	88	Bcd
14	Bardoria		24	fg	68	f	75	Hi
15	Premier II		42	de	92	abc	94	Abc
16	Bargold		88	ab	96	ab	96	Ab
17	Romance		69	c	80	de	83	d-g
18	Barminton		89	ab	98	a	98	A
19	Adeline		90	ab	97	a	98	Ab
20	Barlennium		74	b	90	abc	90	a-d
21	Barlady		95	a	96	ab	96	Ab
22	Bareuro		83	ab	95	ab	95	Ab
23	Barvites		58	c	83	cd	84	Def
24	Barsoccer		48	cd	72	ef	76	f-i
25	Barillion		53	cd	83	cd	85	De
26	Barsunny		86	ab	93	ab	94	Abc
27	Bardorado		86	ab	95	ab	96	Ab
28	Barblack		83	ab	96	ab	96	Ab
29	Pinnacle II		24	fg	88	a-d	90	a-d
LSD (P=.05)			10.8		6.2		5.5	
Standard Deviation			6.6		3.8		3.4	
CV			13.26		4.54		3.87	
Grand Mean			50.09		83.24		87.23	
Bartlett's X2			53.941		40.599		29.958	
P(Bartlett's X2)			0.005*		0.17		0.619	
Replicate F			1.725		1.614		1.51	
Replicate Prob(F)			0.186		0.207		0.228	
Treatment F			80.183		47.355		28.872	
Treatment Prob(F)			0.000		0.000		0.000	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls) Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 2. Germination temperature for different perennial ryegrass cultivars.

Conclusion

Germination temperatures for individual cultivars of Poa pratensis cultivars are significant. Cultivars such as Bartender have an excellent germination percentage capability at lower temperatures combined with a wide temperature optimum. Conversely, Barimpala has an excellent germination percentage capability at higher temperatures with a more limited germination percentage at the perceived 'optimum' germination temperatures.

There is a significant difference in the temperature germination response of perennial ryegrass cultivars. Certain cultivars show a significantly high germination rate of +80 per cent with a soil temperature of 100C.

The Hohenheim research programme revealed a very surprising result; a cultivar of Poa pratensis, Bartender, can – unlike other cultivars of the same species – germinate at soil temperatures as low as 70C. As a result of these findings, Bartender was included in the formulation of a special mixture for Falkirk Stadium, in Scotland, where it again proved its ability to germinate successfully at cooler soil temperatures. This enabled it to compete and establish with the Lolium perenne in the mixture and to effectively provide the required characteristics for this particular project.

At the other end of the scale, different cultivars can germinate successfully at temperatures higher than 300C. This rootzone temperature can be found in many stadiums throughout Europe in the summer. The majority of Poa pratensis cultivars will have very low germination percentage at these high temperatures. A cultivar of Poa pratensis, Barimpala, has been used for many years in Italy and other southern European countries with great success. The data from the temperature germination research in Germany clearly demonstrated why this particular cultivar performs so well. It is important to understand why individual cultivars perform particularly well given certain constraints, and in the case of Barimpala, the research data concurred with results in the field to provide the explanation. Naturally, germination is a key factor, but successful establishment is vital. To increase the chances of this, turf managers should take great care with seeding or overseeding, paying particular attention to adequate irrigation. When overseeding, it is important to delay nutrient input until a high percentage of successful germination is reached, otherwise you will only be feeding the existing sward which will out-compete the new, more desirable grasses.

It is imperative that Course Managers and greenkeepers have access to vital information such as temperature germination response. Good germination is not only the start, but could be the key to seeding and overseeding success. Other key characteristics remain extremely important, but there are certainly times when temperature germination response will be the key to a solution. Our company is continuing germination temperature response trials to screen both existing and, most importantly, new cultivars from the breeding programme.

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References

(1) How grass grows http://www.ahnrit.vt.edu/portfolio/howgrassgrows/howgrassgrows.swf
(2) International Seed Testing Association (ISTA)