



GOLF GREENS

Suitability of grass
species for golf greens
in the UK and Ireland.



Introduction and Methods



In July 2006, Barenbrug initiated a four-year trial with STRI at Bingley to determine which grass species, or combination of species, were most suitable for use on golf greens in the UK.

The trial also assessed the effect of maintenance regimes on the species in question.

The success of this trial also led to the sowing of a similar trial at Druids Glen Golf Club in September 2009 to answer the same questions in Ireland.

Both trials involved sowing out a broad range of golf green seed mixtures and monocultures on a sand-dominant root zone and assessing their performance after an establishment period.

In the Bingley trial, all seed treatments were maintained under two separate regimes; "standard input" maintenance and "low

input" maintenance and subjected to golf wear simulation after establishment.

At Druids Glen, the plots were maintained under a standard maintenance programme only and wear simulation was not applied.

Both trials were independently assessed by STRI by means of a range of measurements across a spectrum of traits. Details of the mixtures and monocultures and assessments in each trial can be seen in Table 2.

This booklet summarises the main findings of each trial, and offers some conclusions to answer the question,

"Which grass species are most suitable for golf greens in the UK and Ireland?"

Bingley	Standard Maintenance	Low Input Maintenance
Sowing Date	11 July 2006	
Mowing Frequency	3 x per week	3 x per week growing season
Mowing Height	4mm growing/6mm winter	6mm growing/7mm winter
N input Ha/annum	120kg	40kg (additional if required)
Irrigation	ET replacement	ET replacement
Chemicals	As necessary	
Mechanical Control	Verti-cut	Brush
Overseeded	September 2006 & May 2007	September 2006 & May 2007
Treatments	12 seed mixtures, 3 replications, randomised block design	
Wear applied	22 July 2008 - conclusion of trials	

Druids Glen	Standard Maintenance
Sowing Date	September 2009
Mowing Frequency	As necessary
Mowing Height	31mm
Nutrition/Irrigation/Chemical	As necessary
Mechanical Control	Verti-cut
Treatments	9 seed treatments, 3 replications
Wear applied	None

Table 1: Trial setup and conditions at Bingley and Druids Glen.

STRI Bingley Trial Seed Treatments

T01	"BAR ALL BENT" browntop bent (50% BarKing : 50% Heriot)
T02	"BAR FESCUE" (25% Barcrown : 25% Barmalia : 25% Barbirdie : 25% Bargreen II)
T03	"BAR 2" 80% fescue: 20% browntop bent (50% Barcrown : 30% Bargreen II : 20% BarKing)
T04	"BAR PLATINUM" (30% Bargold : 25% Barcrown : 25% Barmalia : 20% Bargreen II)
T05	"BAR 22" (35% Barcrown : 35% Bargreen II : 30% Hardtop)
T06	100% Bengal (creeping bent)
T07	"BAR DUO" (50% BarKing : 50% Bengal)
T08	"BAR 40" (40% Barkoel: 60% Hardtop)
T09	80% fescue: 20% highland bent (40% Barbirdie : 40% Bargreen II : 20% Highland)
T010	100% Vesper (velvet bent)
T011	100% Trueputt (Poa annua)
T012	100% Penn G6 (creeping bent)

STRI Bingley Trial Measurements Recorded

Visual Merit	Assessed monthly from 12/01/07 to 25/11/10
Surface hardness (Clegg Hammer)	Assessed six times (Sep-07, Apr-08, Jun-08, Aug-08, Sep-09, Oct-10)
Botanical Composition	Assessed five times (Apr-08, Jul-08, Sep-09, May-10, Oct -10)
Disease incidence	Red thread, Fusarium, Take-all assessed
Treatments	9 seed treatments, 3 replications
Wear applied	None

Druids Glen Trial Seed Treatments

G1	"BAR ALL BENT" browntop bent (50% BarKing : 50% Heriot)
G2	100% BarKing (browntop bent)
G3	100% Bengal (creeping bent)
G4	"BAR DUO" (50% BarKing : 50% Bengal)
G5	100% AS 0803 (creeping bent)
G6	100% creeping bent (50% AS 0803 : 50% Bengal)
G7	100% creeping bent (50% Penn A4 : 50% Penn G6)
G8	"BAR 2" 80% fescue: 20% browntop bent (20% Barcrown : 20% Viktorka : 15% Bargreen II : 15% Barswing : 10% Barlineus : 10% BarKing : 10% Heriot)
G9	"BAR FESCUE" (25% Viktorka : 25% Barcrown : 20% Barswing : 15% Bargreen II : 15% Barlineus)

Druids Glen Trial Measurements Recorded

Visual Merit	Assessed twiced (11 Aug 2010 and 02 Nov 2011)
Surface hardness (Clegg Hammer)	Assessed four times (15 Dec 2009, 11 Aug 2010, 05 Jul 2011 and 02 Nov 2011)
Botanical Composition	Assessed twice (11 Aug 2010 and 02 Nov 2011)



Results Bent-grasses

MAIN FINDINGS

Browntop bent maintains a more appealing golf green surface with less ingress from *Poa annua* than that of creeping bent.

The trials assessed the performance of four types of bent-grasses used for golf greens – *Agrostis capillaris* (browntop bent), *Agrostis stolonifera* (creeping bent), *Agrostis canina* (velvet bent) and *Agrostis castellana* (highland bent).

At Bingley, botanical composition of the plots was recorded throughout the trial. **Figure 1** shows the final readings taken in October 2010 of browntop and creeping bent plots under standard maintenance.

The graph clearly highlights the high level of *Poa annua* ingress that took place in the creeping bent plots (Bengal and Penn G6). Approximately 20 per cent of the sward at the end of the trial was *Poa annua*. The majority of this ingress took place during winters and early springs throughout the trial, which is likely to be a result of the creeping bent.

The main findings are:

Browntop bent maintains a more appealing golf green surface with less ingress from *Poa annua* than that of creeping bent.

becoming dormant in this time, and being slow to commence growth in spring.

Interestingly, blending Bengal creeping bent with BarKing browntop bent (BAR DUO) reduced *Poa* ingress

dramatically. It appears that the winter performance of BarKing combined with summer activity of a creeper is a successful combination. It should be noted that the performance of BAR DUO at Druids Glen was less impressive.

BAR ALL BENT (100% *capillaris*) also out-performed the 100% creeping bent plots, allowing less than 10% *Poa* ingress over the course of the trial.

The Druids Glen trial results show a strong correlation with those at Bingley.

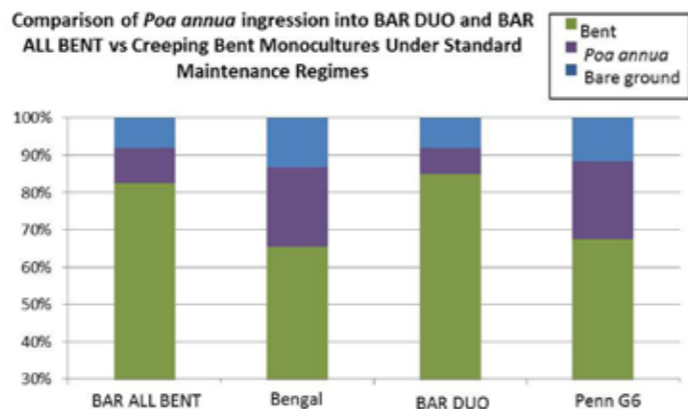


Figure 1: Botanical composition of browntop and creeping bent plots after over 4 years trialling under the standard maintenance regime.

Treatment	% <i>Poa</i> 02/11/11
BAR ALL BENT browntop bent	9.7
100% BarKing browntop bent	7.0
100% Bengal creeping bent	17.7
BAR DUO 50:50 browntop:creeping	16.3
100% AS 0803 creeping bent	10.7
50:50 Bengal:AS 0803 creeping bent	12.7
50:50 Penn A4;Penn G6	14.7

Table 3: *Poa annua* ingress of 100% bent plots at Druids Glen trial

Table 3 shows the proportion of *Poa annua* ingress in relevant plots when the final botanical composition analysis took place (2 November 2011).

Again, browntop bent offered a surface that was less susceptible to ingress than creeping bent over time, despite the fact this trial was not under wear simulation.

The tentative conclusion arising from these results is that creeping bent is not a suitable stand-alone grass species for golf greens in the UK, particularly if the golf course is subject to year-round play and wear.

The fast and apparently inevitable ingress of *Poa annua* (predominantly during colder periods of the year) is likely to result in a dramatic reduction in aesthetics and performance of the surfaces in the medium to long-term, which will be time-consuming and costly to rectify.

This conclusion is supported by the independent assessments of visual merit undertaken on the Druids trial.

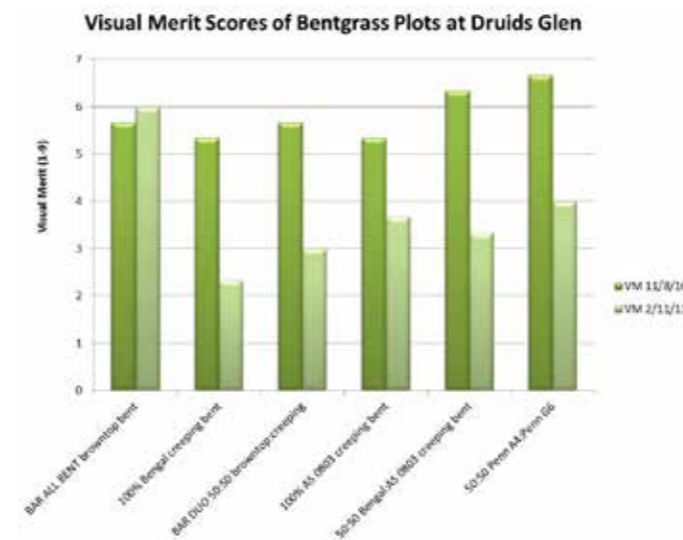


Figure 5: Fescue composition of 100% fescue plots after over 4 years trialling under standard and low input maintenance regimes at Bingley.

Figure 2 shows visual merit scores of "BAR ALL BENT" browntop and creeping bent plots during August 2010 and November 2011.

The combined effects of creeping bent winter dormancy and *Poa annua* ingress are very clear to see, from the measurements conducted in November 2011. In contrast, good quality browntop bent achieved a visually consistent result over this time-frame, pointing to its suitability for year-round golf in Ireland.

At Bingley, botanical composition of the plots was recorded throughout the trial. **Figure 3** shows the final readings taken in October 2010 of 80:20 fescue:browntop and 80:20 fescue:highland bent plots under standard and low input maintenance. The graph clearly highlights the benefit that high quality browntop bent bestows on a greens surface under standard maintenance.

The *Poa annua* composition of the 80:20 browntop plots at the end of the trial was only 7%; in comparison the 80% fescue/20% highland ingress was 31%.

Another interesting point this graph illustrates is how botanical composition can potentially be controlled by maintenance techniques.

For example, the fescue component of the 80:20 mixtures was under more intense pressure and competition when maintained with standard inputs compared with the low input regime. At the conclusion of the trial, the proportion of fescue in the 80:20 plots was approximately 10% higher under wear simulation.

OBSERVATION

A traditional 80% fescue : 20% bent mixture featuring BarKing browntop bent outperforms a blend with Highland bent.

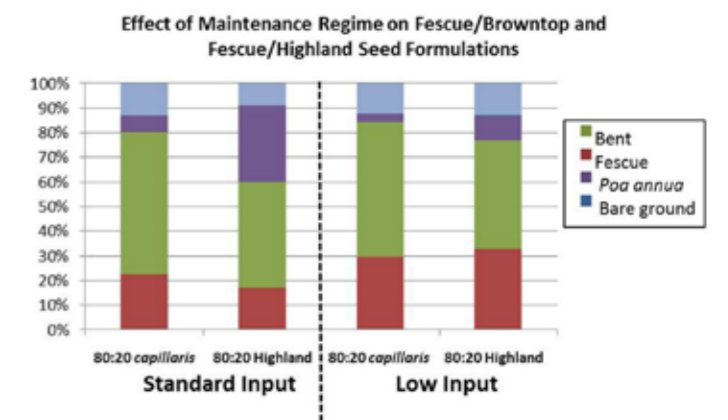


Figure 3: Botanical composition of 80:20 fescue:bent plots after over four years trialling under standard and low input maintenance regime.

In terms of visual merit scores, the 80:20 browntop blend outperformed 80:20 highland plots by a distance. **Table 4** shows the mean visual merit scores throughout the trial period.

At Bingley, Clegg Hammer readings of the plots were recorded throughout the trial. **Figure 4** shows the six separate readings taken for each plot under standard maintenance.

The graph has been standardised; the horizontal line at 0.0 represents “average hardness” across all plots.

In other words, anything below the line is softer than average and anything above the line is harder than average.

The results show a clear trend – plots with a large proportion of fescue are firmer than plots with a large proportion of bent. Velvet bent stands out though in that it produces a surface far softer than any other plot, even under a regime of regular verticutting.

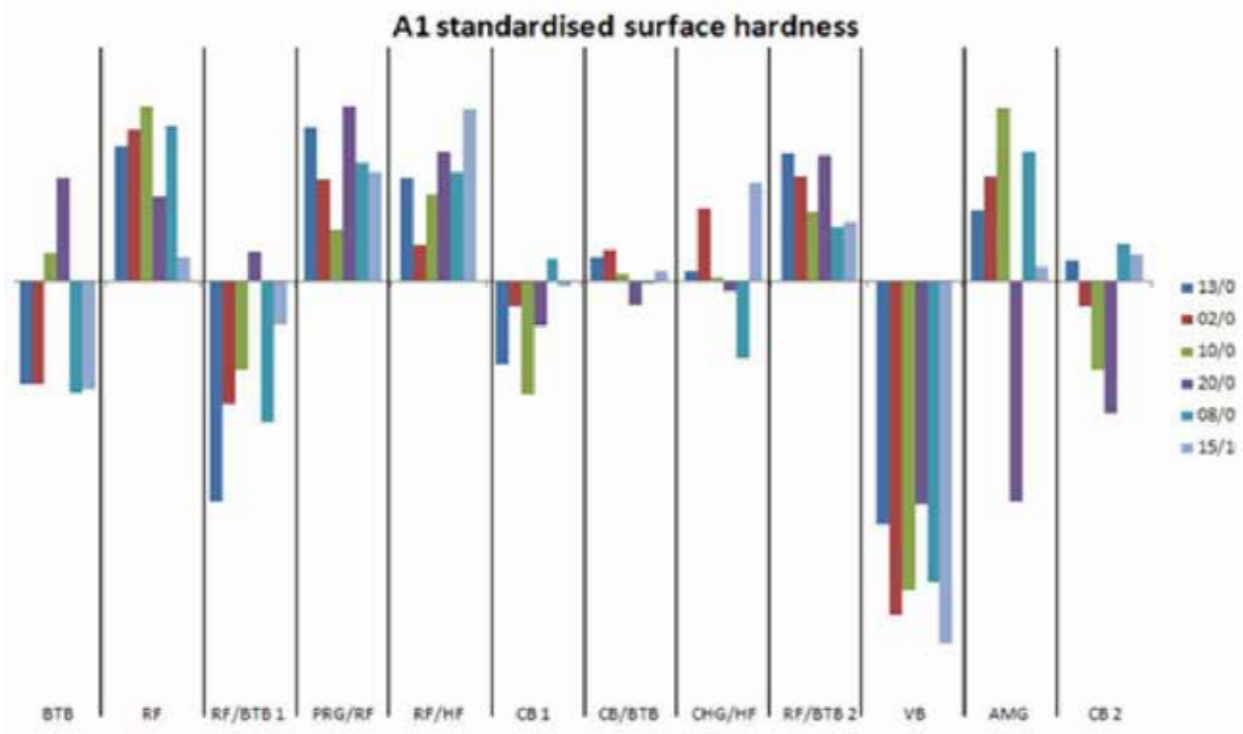
In this trial, softness is a likely to be an indicator of thatch production. The tentative conclusion is that velvet bent is likely to produce a surface that is too soft for yearround golf unless maintained under a very high maintenance regime of thatch removal and dilution.

Mean Visual Merit Scores (1-9)	80:20 browntop	80:20 highland
Standard Input	7.1	3.6
Low Input	6.6	3.6

Table 4: Mean visual merit scores of 80:20 fescue:bent blends throughout Bingley trial

OBSERVATION

Velvet bent produces the softest greens surface of all the mixtures and monocultures trialled.



BTB = browntop bent

RF = red fescue

RF/BTB 1 = 80:20 browntop

PRG/RF = rye/fescue

RF/HF = red fescue/hard fescue

CB 1 = Bengal creeping bent

CB/BTB = 50:50 browntop:creeper

CHG/HF = Barkoel/hardtop

RF/BTB 2 = 80:20 highland

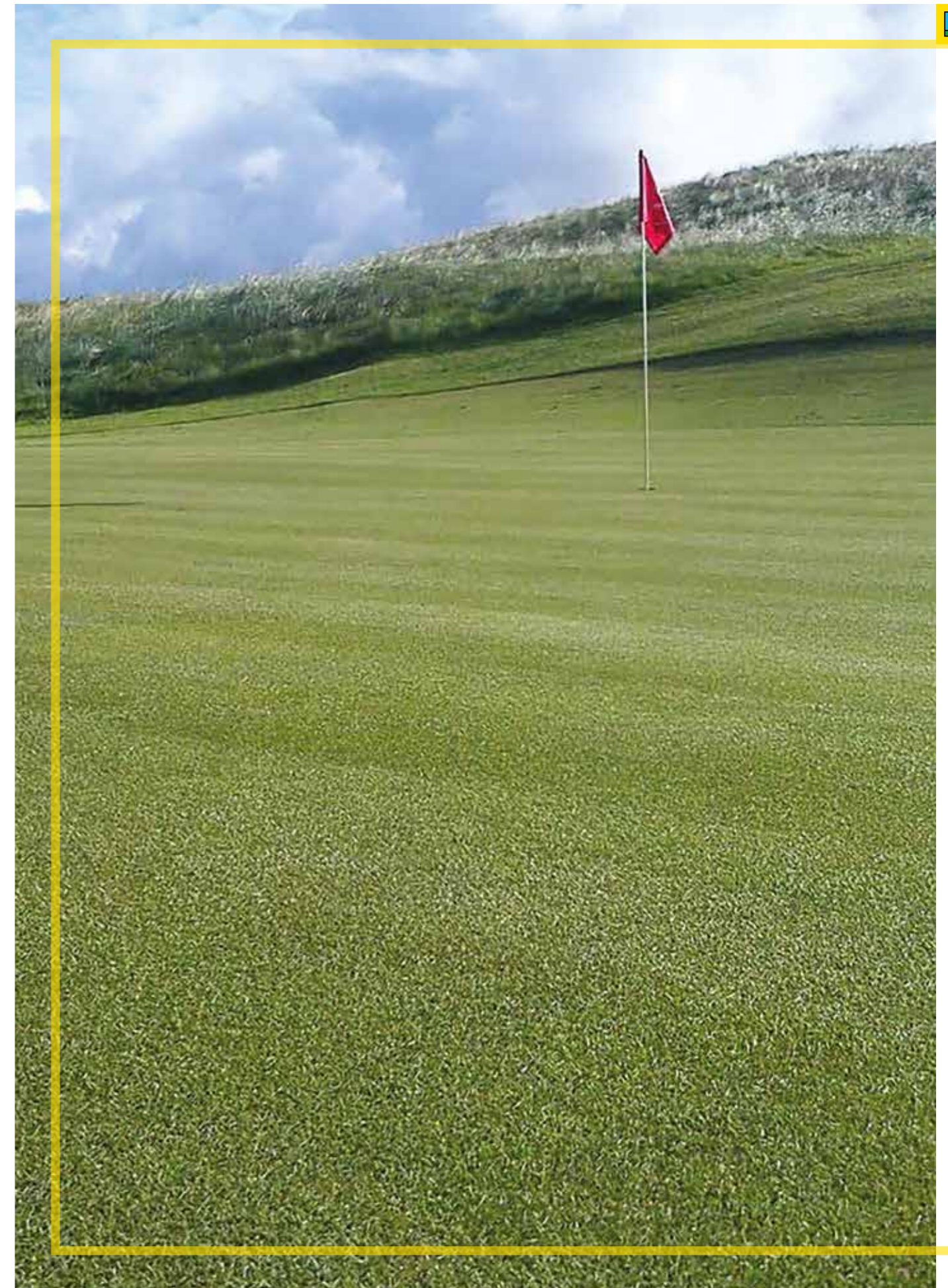
VB = velvet bent

AMG = Poa annua

CB 2 = Penn G6 creeping bent

See **Table 2** for full details

Figure 4: Standardised surface hardness scores (Clegg Hammer) of all seed treatments under the standard maintenance input at Bingley.





Results Fescues

MAIN FINDINGS

Standard maintenance practices with wear adversely affect a pure red fescue green.

At Bingley, botanical composition of the plots was recorded throughout the trial. **Figure 5** shows fescue proportions from the readings of the 100% red fescue plots under standard and low input maintenance.

Under standard input, the red fescue proportion of the plots reduced steadily over the course of the trial; in the first botanical survey the plots contained 83% red fescue, but by the end of the trial this had lowered to only 47%. Poa annua ingressions were the most prevalent result.

The graph highlights two important points; firstly that the red fescue plots diminished in quality more quickly under standard input than low input and secondly that fescue probably requires relatively high inputs initially to successfully establish.

The results from the Druids Glen trial raise an interesting discussion point. **Table 5** shows the high visual merit scores and low Poa ingressions of the red fescue plots under standard maintenance.



Figure 5: Fescue composition of 100% fescue plots after over 4 years trialling under standard and low input maintenance regimes at Bingley.

Remember that wear simulation was not applied to the Druids plots. The mowing height in this trial (down to 3mm) was actually lower than that of Bingley (4mm), which leads to a tentative conclusion that it is the combination of wear (particularly during winter) and a low height of cut that leads to problems with a fescue sward rather than a low mowing height alone.

Treatment	% Poa 02/11/11	Mean Visual Merit
BAR ALL BENT browntop bent	9.7	5.8
100% BarKing browntop bent	7.0	4.0
100% Bengal creeping bent	17.7	3.8
BAR DUO 50:50 browntop:creeping	16.3	4.3
100% AS 0803 creeping bent	10.7	4.5
50:50 Bengal:AS 0803 creeping bent	12.7	4.8
50:50 Penn A4;Penn G6	14.7	5.3
BAR 2 (80% red fescue:20% browntop bent)	8.7	7.2
BAR FESCUE	6.3	7.3

Table 5: Poa annua ingressions and visual merit of all plots at Druids Glen trial. Note performance of fescue mixtures in red

At Bingley, visual merit scores of the plots were recorded throughout the trial. **Figure 6** shows the mean scores at the conclusion of the trial under both inputs.

The strong performance of the 80:20 browntop blend has a significant correlation with the Poa ingressions measurements described earlier in the booklet.

In other words, the ability of a seed treatment to keep Poa out over the course of the trial resulted in a high visual merit score.

The benefits of combining a quality browntop bent with red fescue are plain to see. However, note the same is not true when using inferior quality highland bent.

At Bingley, botanical composition of the plots was recorded throughout the trial. **Figure 7** shows fescue proportions from the readings of the 100% red fescue and 30% hard; 70% red fescue plots under the low input maintenance regime.

The graph illustrates the potential benefits in incorporating hard fescue into a seed mix in areas of the course where a pure fescue sward is desirable under relatively close mowing. Under low maintenance the hard fescue blend appears better able than a traditional red fescue mix to out-compete Poa and weed ingressions over time.

The performance of the hard/red fescue mix under standard maintenance would suggest the blend is not suitable for areas mown below 5mm, but for areas such as tees and surrounds it could be an excellent choice.

The results here are supported by strong evidence from recent trial work at various other locations across the UK (St. Andrews, Castle Stuart, Carnegie Club, Perranporth) that incorporating a proportion of hard fescue (*Festuca ovina duriuscula*) into a red fescue mixture can offer many benefits to the resulting sward when maintained under a low-nitrogen input regime.

Hard fescue's tolerance of drought, salt, heat, extreme pH and prolonged cold are all well documented, and its retention of colour year-round also offers aesthetic value.

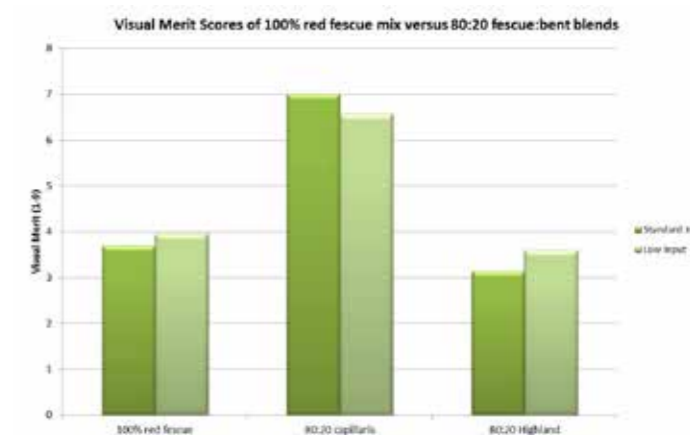


Figure 6: Mean visual merit scores of 80:20 fescue:bent blends and 100% red fescue mixture throughout Bingley trial.

OBSERVATION

Under standard maintenance regimes, red fescue combined with browntop bent is a better option for year-round golf playability under wear.

Comparison of Red Fescue Greens Mix vs. Hard & Red Fescue Mixture Over Time Under a Low Input Regime

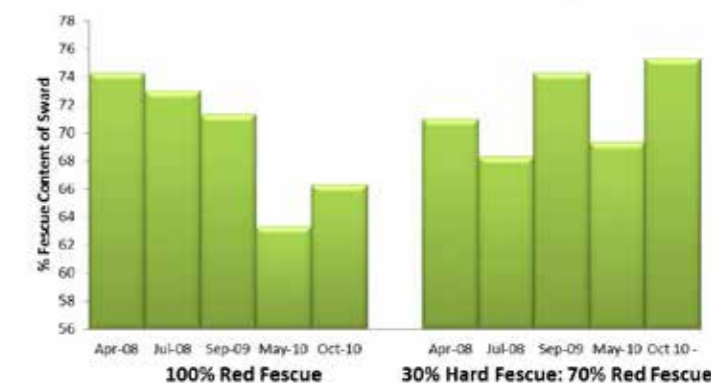


Figure 7: Fescue composition of 100% red fescue and 30% hard; 70% red fescue plots after over 4 years trialling under a low input maintenance regime.

OBSERVATION

Hard fescue combined with red fescue represents a good choice for greens (or other areas) maintained under a low-input regime.



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Discussion

“Which grass species are most suitable for golf greens in the UK and Ireland?”



The results strongly indicate that the preferred grass composition for golf greens under year-round play in the UK and Ireland on a sand-based rootzone is a combination of quality cultivars of red fescue (slender creeping and Chewings) and browntop bent.

The 80:20 red fescue: browntop blend was the top performing treatment in the Bingley trial. In the Druids Glen trial it also performed very well, ranking second overall (both for standard input maintenance). These results can be seen in Table 6.

Clearly not every golf course is the same, but sowing out new greens with a combination of these species is likely to be a recipe for success. If the long-term intention is to have greens dominant with bent-grass, then an adjustment of the percentage make-up of the mix (e.g 50% fescue: 50% browntop) may be in order.

The fescue component is still likely to aid establishment, and prevent widespread disease (e.g. take-all patch) during the early life of the green. Similarly, if the long-term goal is to have fescue-dominant greens (e.g. a links course), sowing with a

small percentage of browntop bent, by weight is still likely to be beneficial, particularly during periods of winter wear.

Greens with 100% red fescue or 100% creeping bent composition would not be recommended for year-round golf based on these results. If a golf course is able to close for play during winter months, successful maintenance of greens with these species would be far more achievable.

These species are well known for providing excellent golf green surfaces elsewhere in the world, but are not best suited to the combined effect of climate and golfing pressures in the UK and Ireland.

Finally, it is worth highlighting the poor performance of the Trueputt (Poa annua) plots at Bingley, which ranked in last place for visual merit of all the seed treatments under trial.

The result was of no surprise, but serves to reinforce the opinion that anyone working with annual meadowgrass golf greens should be looking to integrate more suitable grasses into their surfaces for year-round golf.

Bingley Treatment	Standard Input Mean Visual Merit	Druids Glen Treatment	Standard Input Mean Visual Merit
BAR 2 (80% red fescue: 20% browntop bent)	7.1	BAR FESCUE	7.3
BAR DUO 50:50 browntop:creeping	6.5	BAR 2 (80% red fescue: 20% browntop bent)	7.2
BAR ALL BENT browntop bent	6.0	BAR ALL BENT	5.8
Vesper	5.5	50:50 Penn A4;Penn G6	5.3
Bengal	4.9	50:50 Bengal:AS 0803 creeping bent	4.8
Penn G6	4.6	100% AS 0803 creeping bent	4.5
BAR FESCUE	4.3	BAR DUO	4.3
BAR PLATINUM	4.1	100% BarKing browntop bent	4.0
BAR 40	3.6	50:50 Bengal:AS 0803 creeping bent	3.8
BAR 22	3.6		
80:20 Highland	3.6		
Trueputt	2.3		

Table 6: Mean visual merit scores of all treatments under standard input throughout Bingley and Druids Glen trials.



“What about overseeding?”

The data presented here is clearly most applicable to the consideration of sowing or turfing newly constructed golf greens.

Overseeding is certainly a very different issue, as the components of the current sward must be considered prior to selecting an appropriate seed mixture.

The results do point to some general advice however, which is summarised as follows: Browntop bent and red fescue (slender creeping and Chewings) are likely to be the species that offer the best chance of long-term success from an overseeding programme in the UK and Ireland.

Combining these species in a single blend for overseeding is not generally considered best practice however, as red fescue has a better chance of successful establishment when sown deeper in the ground than browntop bent, and vice versa. If both species are to be integrated into the sward, they should be sown separately and by differing methods.

If the current sward is dominated by Poa annua, browntop bent is likely to be the most suitable species with which to overseed. Successful establishment will help to promote better year-round surfaces through increased disease resistance, winter wear tolerance and better root structure.

If the current sward is dominated by bentgrass, overseeding with browntop bent will help in maintaining the surface going forward. If conditions are conducive, overseeding

with red fescue may also help to improve the greens further by improving aspects such as disease resistance, drought tolerance and summer green-speed.

If the current sward is a blend of fescue and bent, overseeding with both of these species (in separate applications) may be advisable. It is likely that the focus will be on red fescue cultivars however, as generally speaking the fescue population in the sward is likely to diminish at a faster rate than the browntop bent (due to the combination of wear, winter and close mowing).

Finally, if the current sward is fescue dominant, overseeding with this species will be vital to prevent Poa annua ingress. Integrating some browntop bent would also be advisable, particularly if the greens are subject to winter wear.

In 2012, Barenbrug initiated a dedicated overseeding trial with STRI at Bingley on the same area of rootzone as the original golf green trials addressed in this document.

This new research was concluded in 2015 and highlights the importance of cultivar selection in gaining success as part of an overseeding programme. The trial results, and other recommendations relevant to overseeding, can be found in our “Overseeding Golf and Bowling Greens” Guide.



Discover our Overseeding Golf and Bowling Greens guide to find out more detailed advice about overseeding: www.barenbrug.co.uk









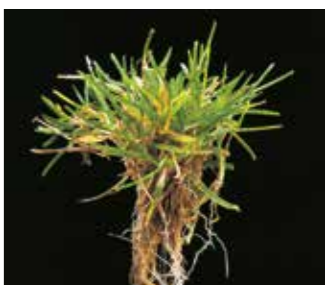
Sowing and Seeding Rates

Sowing rates - Kilograms (kg) required				Area coverage		
Standard Areas	5g/m ²	20g/m ²	35g/m ²	Seed Rates (per 20kg bag)	Coverage	
Football	4,050m ²	-	80	150	5g/m ²	4,000m ²
Football	10,800m ²	-	225	375	10g/m ²	2,000m ²
Rugby	6,900m ²	-	150	225	15g/m ²	1,333m ²
Tennis	262m ²	-	5.5	10	20g/m ²	1,000m ²
Cricket	520m ²	-	10.5	18	25g/m ²	800m ²
Bowls	1,600m ²	8	32	56	30g/m ²	666m ²
Golf	500m ²	2.5	10	17.5	35g/m ²	571m ²

Guide to Species Characteristics

Species	Soil Conditions				Maintenance							
	Seeds per gram (g)	Optimal pH range	Humidity	Salt tolerance	Maintenance level	Fast establishment	Rhizomes / Stolens / Tufted	Shade tolerance	Nitrogen requirement	Water requirement	Thatch build-up	
<i>Agrostis capillaris</i> Browntop bent	14,000	5.6 -7.0	medium	moderate	medium	poor	R	good	Medium	Medium	High	
<i>Agrostis stolonifera</i> Creeping bent	16,000	5.6 -7.0	high	good	intensive	poor	S	good	Very high	High	Very high	
<i>Festuca rubra rubra</i> Strong creeping red fescue	1,000	5.5 -6.8	low	weak	low	average	R	very good	Low	Low	Medium	
<i>Festuca rubra commutata</i> Chewings red fescue	1,000	5.5 -6.8	low	weak	low	average	T	good	Low	Low/medium	High	
<i>Festuca rubra litoralis</i> Slender creeping red fescue	1,000	5.5 -6.8	low	good	low	average	R	good	Low	Low	High	
<i>Festuca ovina</i> Sheeps fescue	2,000	4.5 -5.8	very low	weak	very low	average	T	average	Very low	Low/very low	Low	
<i>Festuca trachyphylla</i> Hard fescue	2,000	4.5 -7.5	very low	good	very low	average	T	very good	Very low	Low/very low	Low	
Rhizomatous Tall Fescue (RTF)	400	5.5 -7.0	high	good	medium	average	R	very good	Medium	Very low	Low	
<i>Festuca arundinacea</i> Tall fescue	450	5.5 -7.0	high	good	medium	average	T	very good	Medium	Very low	Low	
<i>Lolium perenne</i> Perennial ryegrass	700	5.8 -7.4	medium	medium	medium	good	T	average	High	Medium	Low	
<i>Poa pratensis</i> Smooth-stalked meadowgrass	3,300	5.8 -7.5	medium	weak	medium	poor	R	poor	High	Medium	Medium	
<i>Poa trivialis</i> Rough-stalked meadowgrass	5,500	5.8 -7.2	high	weak	medium	average	S	average	High	High	Medium	
<i>Poa annua</i> Annual meadowgrass	6,500	5.5 -7.5	high	weak	intensive	average	T	good	High	High	Medium	
<i>Koeleria macrantha</i> Crested hairgrass	3,000	5.5 -8.0	low	good	very low	average	R	good	Very low	Low/very low	Very low	
<i>Deschampsia caespitosa</i> Tufted hairgrass	3,800	5.5 -6.5	high	medium	low	good	T	excellent	Medium	High	High	

Knowledge Turf Grass Identification

 <p>PERENNIAL RYEGRASS <i>Lolium perenne</i></p>	 <p>SMOOTH-STALKED MEADOWGRASS <i>Poa pratensis</i></p>	 <p>SLENDER CREEPING RED FESCUE <i>Festuca rubra litoralis</i></p>
 <p>STRONG CREEPING RED FESCUE <i>Festuca rubra rubra</i></p>	 <p>CHEWINGS RED FESCUE <i>Festuca rubra commutata</i></p>	 <p>BROWNTOP BENT <i>Agrostis capillaris</i></p>
 <p>CREEPING BENT <i>Agrostis stolonifera</i></p>	 <p>HARD FESCUE <i>Festuca trachyphylla</i></p>	 <p>TALL FESCUE <i>Festuca arundinacea</i></p>
 <p>TUFTED HAIRGRASS <i>Deschampsia caespitosa</i></p>	 <p>CRESTED HAIRGRASS <i>Koeleria macrantha</i></p>	 <p>ANNUAL MEADOWGRASS <i>Poa annua</i></p>

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Conditions of sale

In case of unavailability Barenbrug UK Limited reserves the right to substitute any variety in any mixture with one of similar merit.

Any change will be detailed on the bag.

The placing of an order constitutes an acceptance of our terms and conditions of sale by the buyer.

Full terms and conditions can be found at www.barenbrug.co.uk.

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