1

Benefits of White Clover

- **Increased** herbage quality compared to grass-only swards in the summer months.
- **Increased** dry matter (DM) intake in summer and autumn.
- **Higher** milk production and liveweight gain.
- **Nitrogen fixation** – white clover fixes N from the atmosphere making it available for plant growth.
- **Lower** requirement for N fertilizer application in summer

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Latest dairy research

- Eight years (2013-2020) of research at Moorepark.
- Grass-only grazing system receiving 250 kg fertiliser N/ha per year.
- grass-white clover system receiving 150 kg N/ha per year.
- Both grazing systems were stocked at 2.74 cows/ha.

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Table 1. Average herbage production, sward white clover content and milk production of a grass-only sward receiving 250 kg N/ha and a grass-white clover sward receiving 150 kg N/ha at Moorepark from 2013-2020, and of grass-only and grass-white clover swards receiving 250 kg N/ha at Clonakilty from 2014-2017

	Moorepark		Clonakilty	
	Grass-only 250 kg N	Grass-white clover 150 kg N	Grass-only 250 kg N	Grass-white clover 250 kg N
Stocking rate (cows/ha)	2.74	2.74	2.75	2.75
Annual herbage production (t DM/ha)	13.5	13.4	15.6	16.8
Silage fed during lactation (kg DM/cow)	259	333	350	430
Average sward clover content (%)	-	22.0	-	23.1
Milk solids yield per cow (kg)	490	510	437	485
Concentrate fed (kg/cow)	438	438	391	391
Net profit (€/ha)	1,974	2,082	2,369	2,674

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Nitrogen fixation

Nitrogen fixation is the process whereby white clover can fix N from the atmosphere and make it available for plant growth through a process called biological N fixation.

This N is then available for uptake by white clover and other plants, mainly perennial ryegrass, in the sward.

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The quantity of N fixed by a grass white-clover sward depends on a number of factors including:

- Sward white clover content – N fixation increases as clover content increases.
- N fertiliser application rate – N fixation declines with increasing N application.
- Soil temperature - N fixation increases as soil temperature increases.
- Solar radiation (sun light) – more sunlight, more fixation.

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Table 3. Quantity of N fixed at different N application rates	
N fertiliser application rate (kg N/ha)	**Quantity of N fixed in grass white clover swards (kg N/ha)**
100	100-150
150	90-130
200	70-100
250	0-40

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How does white clover grow?

- There are three stages of white clover growth from germination to full establishment. These are:

Rosette Phase → Expansion Phase → Clonal Phase

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Rosette phase	Expansion phase	Clonal phase
•Reliant on central taproot •Few branches •Small spread •Rosette plant form •Plant size – 10-20 cm •Phase lasts approx. three months •**Clover does not fix N in this phase** •Important to graze during this phase to promote growth (without damaging plant)	•Reliant on central taproot •Rapid expansion – up to 15 branches, 25-30 cm in size •Initially rooting is poor on the stolons and careful grazing is required to avoid damage •Six months post-sowing roots strengthen but plant still reliant on central taproot for nutrient uptake •12 months post-sowing taproot begins to die – can take up to 2.5 years for all taproots in the sward to die •**12-18 months post-sowing N fixation begins** •Good grazing management is crucial for stolon development	•No taproot. Reliant on adventitious roots which form at the nodes of the stolons •Normal status of clover in established swards (Figure 1) •**Clover actively fixing N** •Stolons last for 12-18 months. New stolons produced at the terminal bud •New stolons become independent plants and this cycle continues each year •Good grazing management helps maintain stolon production and white clover persistence in grazing swards

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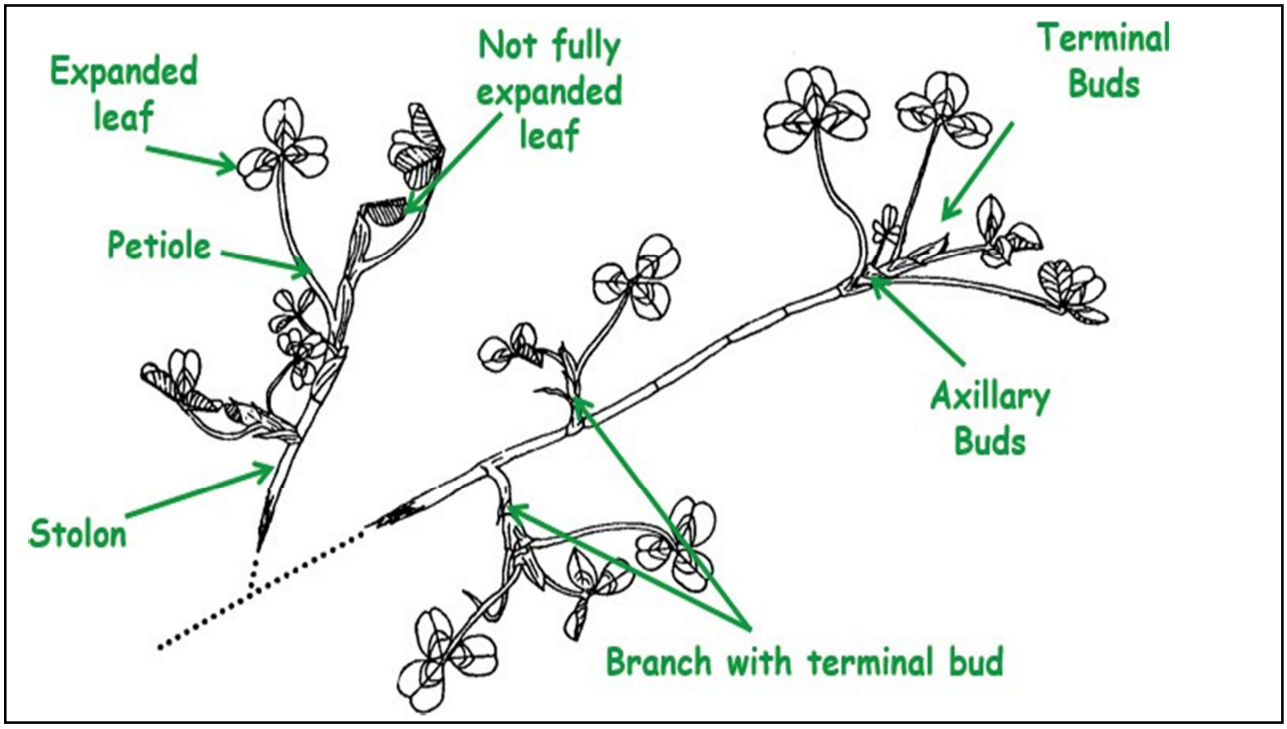

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Grazing management for white clover swards

Spring

- Target early spring grazing – this benefits white clover growth
- Avoid poaching/damaging swards – poaching reduces white clover content in the sward
- Be flexible – use on/off grazing, graze wetter paddocks in drier weather, etc.
- Target post-grazing sward height of 3.5 cm

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Mid-season (April to July)

- Maintain pre-grazing herbage mass between 1,300 and 1,600 kg DM/ha (8 to 10 cm)
- Target post-grazing sward height of 4.0 cm
- Chemical N fertiliser may be reduced on swards with good white clover content (≥ 25%) (see Figure 2 for guideline sward clover content and section on N fertiliser strategies)

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Autumn

Build grass on the farm from early to mid-August by extending rotation length

Close the farm in rotation from early October

Target post-grazing sward height of 3.5 to 4.0 cm on the final rotation

Avoid poaching/damaging swards

Be flexible – use on/off grazing, graze wetter paddocks in drier weather, etc.

Chemical N fertiliser may be reduced in August on swards with good white clover content (≥ 25%) (section on N fertiliser strategies below)

Close paddocks with a high sward white clover content (i.e.

> 30%) towards the end of the final rotation (end of October to start of November)

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- An average annual sward white clover content of approx.
- 20 – 25% is desirable for animal and sward production benefits.
- Sward white clover content increases through the spring, into summer and generally peaks in August/September (Figure 2).
- Good grazing management is key to maintaining sward white clover content.

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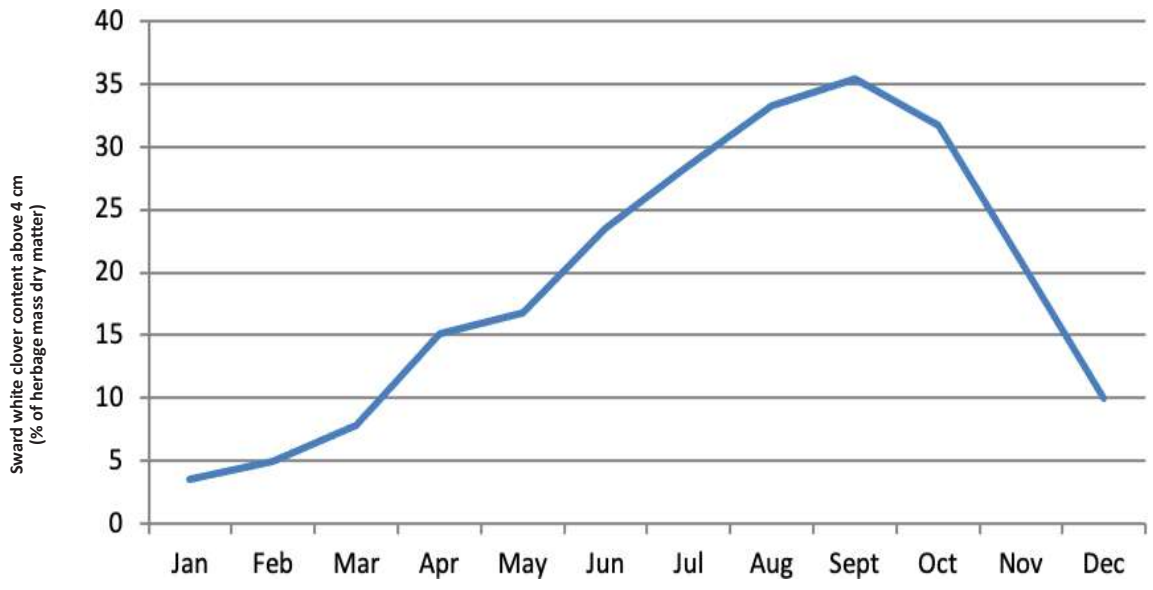

Figure 2. Average annual sward white clover content across the year

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Nutrient Management

White clover does not have the ability to fix N for the first 12 to18 months post-sowing.

Nitrogen fertilizer is important during this period to encourage growth and development.

White clover needs a higher soil temperature for growth than grass.

Grass starts growing at soil temperatures of 5-6°C while white clover needs soil temperature of 8°C.

As a result, the contribution of white clover to the sward in early spring is low.

As our systems have a requirement for pasture to feed animals in early spring, N fertiliser must be applied at similar rates to those used in grass-only swards

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Table 4. Nitrogen fertilizer application rates by rotation for white clover in dairy swards	
Date (rotation)	**N fertiliser application (kg N/ha)**
Mid-late January	28
Mid-March	28
April (2nd rotation)	33
Early-May (3rd rotation)	9
Late -May (4th rotation)	9
June (5th rotation)	9
Early-July (6th rotation)	9
Late-July (7th rotation)	9
August (8th rotation)	9
Mid-September	12
Total	**150**

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Table 5. Nitrogen fertiliser application rates by rotation for white clover in drystock swards (up to 2.0 L.U/ha)	
Date (rotation)	**N fertiliser application (kg N/ha)**
Early-mid Feb	20
April (2nd rotation)	20
May (3rd rotation)	12
June (4th rotation)	12
Late July/early August	12
Early-Sept (7th rotation)	14
Total	**90**

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Macro- and micro- nutrients

White clover has a poor competitive ability to absorb most soil nutrients compared to grass due to the different characteristics of the root systems of the two species.

Perennial ryegrass has a denser longer, thinner and more finely branched root system compared to white clover.

As a result, white clover is generally at a disadvantage when it comes to nutrient uptake from the soil.

Soil pH is critical for white clover development.

White clover is more sensitive to lower soil pH than grass.

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Soil pH should be greater than 6.3. (Recommended Soil Ph is 6.5 – 6.8)

Low soil pH reduces soil nutrient availability for plant growth.

Low pH soils can be deficient in plant available calcium (Ca) and magnesium (Mg) which are necessary for rhizobia (N fixing bacteria) survival.

In low pH soils manganese (Mn) and aluminum (Al) toxicity can have a major effect on white clover development.

Formation of nodules for N fixation is reduced below soil pH 5.8

White Clover requires a minimum soil index 3.

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Establishing a grass-white clover sward on your farm

Establishing white clover on farm will take a number of years using a combination of reseeding and over-sowing.

Incorporating white clover in a full reseed is the most reliable method of establishing white clover and provides the best opportunity for weed control.

Over-sowing is a simple and low cost method of introducing white clover into swards.

Success is very much dependent on soil fertility, weather conditions at sowing, soil moisture, post-sowing grazing management and competition from the existing sward.

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Reseeding

Aim	Aim to reseed as early in the year as possible (April, May, June) when soil temperatures are high and increasing, and there is adequate opportunity for weed control.
Soil	Soil sample for P, K and pH.
Spray off	Spray off the old pasture with a minimum of 5 L/ha of glyphosate; allow a minimum of 7 to 10 days after spraying before cultivating.
Prepare	Prepare a fine, firm seedbed.

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Reseeding

- Use grass and white clover varieties from the Irish Recommended List.
- Cattle sowing rate - 28 to 30 kg/ha of grass plus 3.5 to 5.0 kg of medium leaved clover.
- Sheep sowing rate - 25 to 28 kg/ha of grass plus 5.0 to 6.0 kg of small leaved clover.
- Avoid sowing white clover seed too deep - sowing depth approx. 10 mm.
- Roll well to ensure good contact between the seed and the soil.

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Over - sowing

- Do not over-sow old 'butty' swards with a low content of perennial ryegrass – white clover will not establish well in these.
- Control weeds before over-sowing white clover as weed control options afterwards are more limited.
- Some herbicides have a residue of up to 4 months – always check the residual time on the label of the product or seek advice on a suitable weed control product.

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Over - sowing

Take a representative soil sample for P, K and pH analysis and correct soil fertility prior to over-sowing.

Optimum soil fertility when over-sowing will help increase the chances of success.

White clover seed can be broadcast onto the sward or stitched in using a suitable machine.

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Over - sowing

Over-sow directly after grazing (≤ 4 cm post-grazing sward height) or after cutting the paddock for surplus bales – ideally only over-sow three to four paddocks at a time.

Sow at a rate of 4.0 to 6.0 kg of white clover seed/ha.

Soil contact post over-sowing is one of the most crucial factors affecting germination.

- Roll paddocks post-sowing to ensure soil contact.
- Apply watery slurry (if available) – ideally around 2000 gallons/ac.

Reduce N fertiliser post over-sowing for one to two rotations to reduce grass growth.

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Broadcasting with a fertiliser spreader:

Mix clover seed with 0:7:30 fertiliser and only add white clover to the spreader when you are in the field to avoid white clover settling at the base of the spreader.

Do a maximum of 1 ha at a time (to avoid seed settling) and spread in 2 directions across the field.

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Weed control in reseeded and over-sown grass-white clover swards

Reseed	Over-sown
• Weeds in new reseeds are best controlled when grass is at the two to three leaf stage. • Docks and chickweed are two of the most critical weeds to control; it is important to control these at the seedling stage. When white clover is included in the sward use a clover safe herbicide	• Control established weeds before over-sowing as weed control options post-sowing will be limited. • Consider residue time of non- clover safe sprays from application of spray to over-sowing the white clover - it can vary from one to four months. • For established grass-white clover swards the herbicides Eagle and Prospect are white clover safe options. • All pesticide users should comply with the regulations as outlined in the Sustainable Use Directive (SUD).

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Grazing management to prevent bloat

1

Bloat can be an issue in swards with high white clover content.

2

Bloat can occur at any time of the year, but it is more likely to occur in the second half of the year when white clover content in the sward is highest.

3

Good grassland management can minimise and prevent the risk of bloat.

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Bloat prevention

- Avoid switching between grass-only and grass-white clover swards (as much as is possible).
- Keep post-grazing sward height at 4 cm, not below.
- When entering a grass-white clover paddock in risky conditions (high white clover content / hungry animals / wet morning / very lush pasture) provide a small area in the paddock for the first 2-3 hours after turn-out to prevent the initial gorging on white clover.
- Provide anti-bloating agent in the water supply – starting the day prior to entering the risky paddock.
- Check cows after initial turnout and regularly for first three hours of grazing during high risk periods.

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White clover varieties

- White clover cultivars are categorised by leaf size.
- *Small leaf white clover*
  - Lower yielding
  - More persistent
  - Tolerant of tight grazing, e.g. sheep grazing
- *Medium leaf white clover*
  - Intermediate for yield and persistency
  - Suitable for cattle grazing

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White Clover Varieties

- *Large leaf white clover*
  - Higher yielding
  - Aggressive and can dominate a sward
  - Include in silage swards
- *Small leaf white clovers are recommended for sheep grazing and medium leaf white clovers for dairy or beef cattle grazing*

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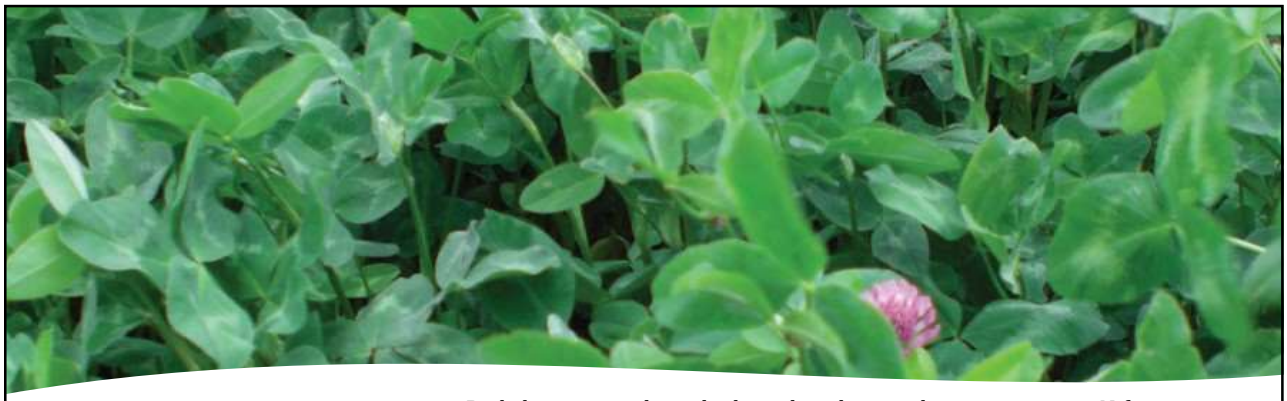

Red clover

- Red clover is a relatively drought tolerant, deep tap rooting, N fixing legume that is primarily used for silage production but can also be grazed by cattle or sheep in the autumn.
- It offers high yields of high-quality forage and can fix 150-200 kg N/ha per year.
- Red clover has a different growth habit to white clover and requires different management to optimize its performance.

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Red clover sward management

Red clover seeding rate - 20 to 22 kg/ha of grass seed plus 7 to 10 kg/ha of red clover seed. White clover can also be added to the mix at a rate of 1 kg/ha if required.

In the establishment year, red clover should be allowed to flower before harvesting the first cut of silage to help root development and the growth of the bacteria that fix N.

In subsequent years, silage harvesting should occur at intervals of six to eight weeks, any time between bud development and early flowering.

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Red clover sward management

- Three to four silage cuts can be taken each year.Approximately 80-90% of total annual yield will be obtained from silage cuts completed by late July-early August. The final cut should be taken no later than mid-October.
- In the autumn, herbage should be cut or grazed (ideally in October) without poaching, soil compaction and physical damage to the plant crowns.
- Cut silage crops to a residual height of 7-8 cm above ground level.
- Optimum post-grazing sward height is 6 cm.
- Optimum over-wintering sward height is 4-6 cm above ground level.

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Red clover varieties

- There are no official red clover evaluation trials in Ireland so red clover varieties are not included in the Recommended List of Grass and Clover Varieties published by the Department of Agriculture, Food and the Marine each year.
- Therefore, the United Kingdom (UK) Recommended List of Red Clover Varieties should be used when selecting a red clover variety

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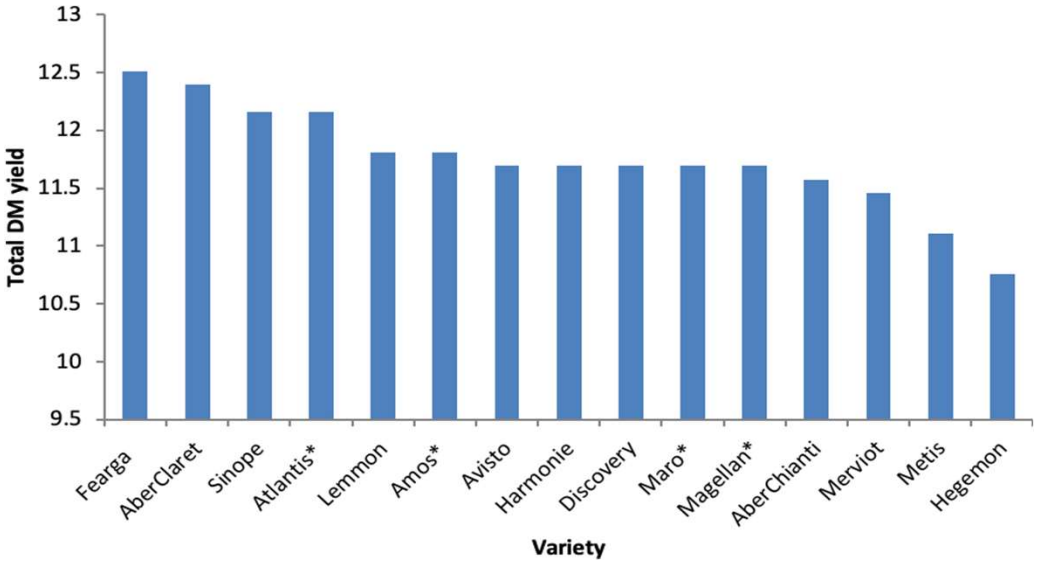

Total annual yield (Average = 100 at 11.69 t DM/ha) of varieties on the UK Red Clover Recommended List 2020-2021. (* = Tetraploid

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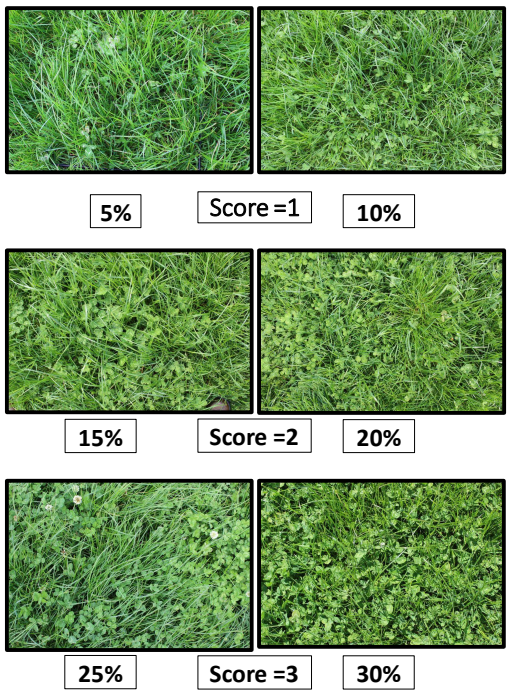

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35% Score = 4 40%

45% Score = 5 50%

Score = 6

>60%

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THANK YOU FOR YOUR ATTENTION ANY QUESTIONS?

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