

Timothy – the plant and its use on New Zealand farms

J.F.L. CHARLTON¹ and A.V. STEWART²

¹Greenfields Communications, Palmerston North

²Pyne, Gould, Guinness Limited, Christchurch

¹dericpat@ihug.co.nz

Abstract

Timothy is an important pasture species in many cool-temperate regions of the world, particularly those with cold winters and moist summers. In New Zealand, this perennial grass has been used traditionally for mixed pasture in cool moist areas of the southern South Island. It is valued for hay as it retains good feed quality even when seedheads are present. Timothy's flowering and tillering response is different from perennial ryegrass, leading to a high tiller turnover in summer and making it vulnerable to mismanagement, pests and drought. Timothy's inherent digestibility and quality is no greater than perennial ryegrass but because of its late flowering nature, its quality is retained longer in pastures. This, combined with its lack of endophyte and higher clover content, commonly allows a greater animal performance from pastures.

This paper reviews timothy's features and on-farm performance, explains how its features produce its characteristic performance, and considers its potential in current New Zealand grazing systems in different regions.

Keywords: grazing, pasture, seeds mixtures, timothy

Introduction

Timothy (*Phleum pratense*) is an important perennial grass in many of the world's regions with moist summers and cold winters where it is commonly cut for hay. In New Zealand, it has traditionally been used as a component in seeds mixtures. It is rarely dominant in a pasture so most farmers are unaware of its performance or contribution to their grazing systems. Nonetheless, it is a worthwhile contributor of high quality feed in southern South Island conditions where it is usually included in pasture seeds mixtures (N. Hopkins, I.J. Russell, pers. comm.). In addition, timothy evaluations have often shown improved animal performance over perennial ryegrass pastures (Caradus 1988), including improved milk production in Taranaki (Johnson & Thomson 1996).

It therefore seems worthwhile to review features and use of this grass, explain how its features produce timothy's characteristic performance, and reconsider its potential in current grazing systems.

The plant

Timothy originated in Europe but was first valued as pasture grass in the United States. It was widely promoted from 1720 onwards, initially by a farmer named Timothy Hanson – hence its common name.

It is an upright perennial grass with larger leaves than perennial ryegrass, forming a relatively open sward that mixes well with clovers and other species. It has dull, flat, hairless, smooth leaves, swollen tiller bases or corms, and tall "pipe-cleaner" seedheads. Timothy thrives in cool-temperate New Zealand regions and on fertile, heavy soils, rather than summer-dry regions (Levy 1951; Langer 1973).

When compared with the commonly used grasses, such as perennial ryegrass, timothy is late flowering, tending to head 6–10 weeks later than ryegrass. It has less production in winter but commences spring growth early (Hume & Lucas 1987), giving it a long period with high quality leafy pasture.

Timothy is endophyte free in New Zealand although the endophyte, *Epichloa typhina*, has been found overseas (Leuchtman & Schardl 1998; G.C.M. Latch pers. comm.).

Where timothy grows

Soils

Timothy prefers moist soils of moderate to high fertility (Sampson *et al.* 1951; Langer 1973), a soil pH of 5.5–7.0 and is only slightly less tolerant of soil aluminium than perennial ryegrass (Wheeler 1995).

Drought tolerance

Timothy has shallower roots than perennial ryegrass (Garwood 1967) and is more sensitive to drought (Molyneus & Davies 1983). It is also less tolerant of waterlogging during the growing season than perennial ryegrass or tall fescue (Thomas & Norris 1979), but will tolerate winter flooding well (Mudd & Mair 1961). As a consequence, timothy responds well to irrigation in drier regions.

Shading

Timothy thrives in partial shade and can even survive heavy shade (Shaw & Cooper 1973). In shaded conditions, however, its carbohydrate reserves are lower and flowering can be delayed or suppressed (Heide 1994).

How timothy grows

Establishment

Timothy is slower to establish than perennial ryegrass, with Stevens *et al.* (1993) reporting a yield of only 28% of ryegrass over the first 6 months. Its establishment can be slowed further by low germination when soil temperatures are below 10°C (Charlton *et al.* 1986), and by low seed weights (Jones *et al.* 1995; Andrews *et al.* 1997).

Flowering and tillering

Timothy differs from perennial ryegrass in lacking a winter requirement for flowering (vernalisation), although both require long days (Cooper & Calder 1964). This difference is crucial to its tillering behaviour and its response to pasture management.

Although autumn-formed tillers behave in a similar way to those of perennial ryegrass, by flowering and subsequently dying off during the next summer, tillers formed by timothy during spring behave differently. In perennial ryegrass these remain vegetative, because their flowering response has not been initiated by winter cold, and a good proportion survive the summer. In timothy however, these tillers will almost all elongate as they initiate flowering, and significantly almost all die during the following summer whether they have actually flowered or not. This means that, unlike perennial ryegrass, almost all timothy's tillers must be replaced during summer, making it vulnerable during this period (Langer 1956, Jewiss 1966).

This high tiller death in summer is a behaviour pattern more similar to annual ryegrass than perennial ryegrass (Jewiss 1966). Timothy's ability to replace tillers during this period is explained by its corms, swellings at the base of its tillers. They act as an important storage organ for carbohydrates, which build up to maximum levels during heading, and decline as new replacement tillers are formed in summer. These corms form during spring on the basal node of each tiller, and enlarge to reach full development at seed maturity. In favourable conditions, secondary corms may be produced in autumn and accumulate carbohydrate reserves critical for winter survival in cold winter climates (Barnard 1964; Evans 1958; White 1973).

Whether spring tillers of timothy develop flowerheads or simply elongate, depends on another unusual

mechanism. As temperatures increase during spring and summer, flowerhead development is suppressed. Initially the mechanism reduces flowerhead size, and finally, tillers are formed that lack any flowerhead at all. This mechanism interacts with shading, nutrition, management and genetic origin, and is stronger in northern European material than that from southern Europe (Cooper 1958; Cooper & Calder 1964; Hay & Heide 1983; Heide 1994; Langer 1956). Langer (1956) termed these elongated non-flowering tillers "blind tillers" and they cannot be induced to flower by long days, although auxiliary tiller branches can (Cooper 1956). Because they are elongated with an elevated growing point, they show poorer survival under close grazing than those that do not elongate (Stevens *et al.* 1993).

Often the blind tillers become prostrate, root at the nodes and become stoloniferous, allowing the grass to spread in old pastures (Cooper 1958).

These flowering responses also have important consequences for seed production particularly as spring tillers will frequently have only short seedheads, resulting in lower yields and smaller seed (Langer 1956).

Pasture management of timothy through the spring and summer must be aimed at:

- Building up the carbohydrate reserves before summer, a technique that has been shown to improve post-flowering tiller replacement dramatically in other grasses (Black and Chu 1989, Matthew *et al.* 1991). The build-up of carbohydrate reserves is reduced under frequent close grazing, shading, and high night temperatures (Pollock & Jones 1979) all limiting subsequent tiller replacement.
- Maximising growth potential during summer, and minimising stress and pest damage. In particular, pest damage, notably by Argentine stem weevil (*Listronotus bonariensis*), can be severe during this period (Goldson 1982). Reducing drought stress during summer is also likely to be critical.

Pests and diseases

Timothy is susceptible to severe attacks from black field cricket (*Teleogryllus commodus*) (Blank & Olson 1987), grass grub (*Costelytra zealandica*) (Farrell & Sweeney 1974) and Argentine stem weevil despite showing some tolerance of larval mining (Goldson 1982).

More recently, there is evidence that pasture mealy bug (*Balanococcus poae*) is a problem in Canterbury (Pearson 1989, C. Pennell pers. comm.). In one trial, numbers reached 2219/m², compared with 854/m² for endophyte-free perennial ryegrass and 30/m² for endophyte-infected perennial ryegrass.

Under regular grazing, diseases are unlikely to be a major problem in New Zealand, but they may be important in hay crops or in autumn-saved pasture. Three diseases are commonly found: leafspot, (*Cladosporium phlei* = *Heterosporium phlei*), leaf streak (*Cercosporidium graminis* = *Scolecotrichum graminis* = *Passalora graminis*) and stripe rust (*Puccinia striiformis*) (Skipp & Hampton 1996).

Timothy cultivars

Commercial cultivars are usually hexaploid, with a chromosome number of 42, but diploid, tetraploid and octoploid forms also occur (Cenci *et al.* 1984, Neilson and Nath 1961).

Timothy cultivars can be classified according to flowering time, with early cultivars developing seedheads around early December and late cultivars heading around late December. Early-flowering cultivars are usually more erect and less densely tillered than later-flowering ones, with a greater tendency to produce flowerheads in late summer.

Timothy breeding for New Zealand

Historically, the most outstanding timothy cultivar developed in New Zealand was 'Grasslands Kahu' (Corkill 1949), bred from the cultivars 'S48' and 'S51', both originating from mild coastal areas of Britain, a climate most similar to southern New Zealand. 'S48' from Dorset, and 'S51' from Aberystwyth, Wales (Hall 1948).

Germplasm from mild winter coastal climates is unique amongst timothy cultivars as all other cultivars in the world originate from much colder winter zones requiring superior winter hardiness (Ueda 1990). The excellent adaptation of 'Kahu' is reflected in its consistently superior performance in New Zealand trials, where over 400 lines have been tested over 70 years (Caradus 1978; Corkill 1949; Gorman 1950a; 1950b; Lambert 1950; Maunsell & Scott 1996; Stevens *et al.* 1993; Stewart unpublished; K.H. Widdup pers. comm.).

Local ecotypes from Southland are earlier flowering than 'Kahu', but are less productive and persistent in trials. The poorest performers were erect hay-type cultivars bred in colder Northern Hemisphere countries, particularly those from Canada and Scandinavia, some of which are imported and sold here. They have inferior production and persistence, compared with 'Kahu', under New Zealand grazing conditions.

A breeding programme in Gore used recurrent selection within 'Kahu' to develop a cultivar 2 weeks earlier to head, now released as 'Grasslands Charlton' (K.H. Widdup, pers. comm.). This has improved seed

yields without losing 'Kahu's' valuable features. Another new early flowering cultivar, 'Ceres Viking', was selected from material collected in 50-year-old pastures in Westland, possibly also of 'S48/S51' origin. This cultivar is finer tillered than 'Kahu' and is likely to better tolerate close sheep grazing.

Future breeding prospects

Although timothy is used in countries with colder winters and is known for its winter hardiness and lack of drought tolerance, it occurs sporadically at higher altitude in the Mediterranean climatic region despite being absent from the international collections kept by Northern hemisphere breeders (Cenci *et al.* 1984). The occurrence of timothy in a Mediterranean climate may at first appear unusual but the presence of a corm may be crucial to its survival over the dry summer. The presence of grasses with corms is uncommon outside the Mediterranean (Burns 1946). The performance of such material in the Mediterranean climate regions has been found to be poorer initially, but because of its adaptation and summer dormancy, it gave a greater yield and persistence than Northern European cultivars over 6 years (Bianchi & Ciricofolo 1978; Cenci & Pagiotti 1979; Cenci 1979; Cenci *et al.* 1984).

In Canterbury, the best Mediterranean material has shown a 20–40% improvement in cool season growth over 'Kahu' (A.S. Stewart, unpublished data). This opens up the prospect of improving the cool season growth and drought tolerance of timothy in New Zealand.

Pasture quality and animal performance

Timothy has a good reputation for producing pasture and hay of high feed quality, as well as a good reputation for high palatability, with calves showing a preference for timothy over ryegrass and legumes (Hunt and Hay 1990).

However, a critical look at the literature suggests that its feed quality, like any grass, depends on the flowering stage and growing conditions of the pasture when measurements are made (Mika 1983). When fed at the same digestibility level, perennial ryegrass was superior to timothy, because of a 5–15% higher voluntary feed intake (Jones 1971; Minson *et al.* 1964; Miles *et al.* 1969). This was related to a slower rate of passage and a longer retention time in the gut (Patil 1969), an effect attributed to higher lignin content, and the proportion and composition of timothy's digestible fibre (Walters 1974). Animal performance may be further limited in some situations by timothy's low sodium levels (Jones 1971; Sherrell 1978; Smith *et al.* 1978; Smith 1981).

However, despite a lower quality at any given growth stage, timothy pastures frequently provide quality and animal performance advantages over those of perennial ryegrass, and this is largely explained by the following four factors:

- Timothy's later flowering, compared with perennial ryegrass, means that the decline in feed quality associated with seedhead emergence, is delayed, allowing digestibility levels to be maintained from October to December, over a longer period than ryegrass. In liveweight gain studies conducted over this period, animal performance has been found to be superior to perennial ryegrass by 30–60% (McLean *et al.* 1962; Stevens *et al.* 1993) or over the whole year by 13% (Davies & Morgan 1978). Similarly with dairy cows, Johnson & Thomson (1996) found that timothy gave a 5% advantage in milk yield, an increased milk fat from 5.26 to 5.36%, and an increase in milk solids from 1.26 to 1.36 kg/cow/day. These advantages were not apparent in autumn when both pasture species remained leafy (Johnson & Thomson 1996; McLean *et al.* 1962).
- Timothy/white clover pastures usually contain up to 50% more white clover than perennial ryegrass pastures (Anon. 1952; Corkill 1954; Gooding & Frame 1997; Stevens *et al.* 1993; Watkin 1975) giving an improved animal performance (Stevens *et al.* 1992).
- Timothy's decline in feed quality as seedheads develop is less than in perennial ryegrass (Minson *et al.* 1964) and its reproductive tillers remain green longer and continue to accumulating carbohydrates, even after the seed matures (Pollock & Jones 1979). Timothy hay, cut at this mature stage, is therefore of superior feed quality to that made from perennial ryegrass.
- As an endophyte-free grass, timothy is superior to endophyte-infected perennial ryegrass pastures, and this difference is more pronounced during summer and autumn, particularly when conditions become dry.

Timothy on the farm

Regional use

As the species is at its best on heavier soils in cooler summer areas, and prefers on-off grazing systems to close continuous grazing, timothy is most suitable for southern South Island regions, though it can be selectively used in other regions where the conditions might suit it. Its retention of quality for longer periods than perennial ryegrass may encourage dairy farmers to try it in some North Island regions. It has been included

in dairy pasture evaluations at the Dairying Research Corporation's farm in Hamilton (Thom *et al.* 1999; E.R. Thom, pers. comm.) and since being sown in autumn 1996, has contributed well, especially during 1998, mixed with endophyte-free ryegrass pastures receiving irrigation.

On-farm trials in Canterbury and some other northern South Island areas (T.J. Fraser, pers. comm.) indicate it can be included in mixtures for less stressful grazing systems, when soil conditions encourage its persistence. In Southland, timothy recovers well from heavy grazing and treading pressure during winter, but not in summer.

Grazing management

Timothy's tillering and flowering behaviour explains why lax rotational grazing is so critical for the persistence of this grass. Its greatest sustainable yield is achieved by leaving a residual sward height of 30–50 mm (Stevens *et al.* 1993).

Compared with perennial ryegrass, it is slower to recover from grazing (Gooding & Frame 1997) and is less tolerant of trampling.

In seed mixtures

Timothy can be included in most seed mixtures designed for fertile moist pastures, as it is a less aggressive grass component than ryegrasses or cocksfoot. In southern South Island pastures it is usually included when establishing pastures on fertile lowland soils in mixtures with white and/or red clovers, but can also grow compatibly with other perennial legumes, including lucerne and birdsfoot trefoil, and the grazing herbs, chicory and plantain.

Pasture species known to be too aggressive for growing with timothy include Italian ryegrass and dense types of perennial ryegrass, hybrid ryegrass, cocksfoot, and possibly tall fescue. Palatability affects timothy's ability to compete, as it tends to be selectively overgrazed as other pasture grasses decline in quality.

Timothy can be sown in autumn and spring when soil temperatures are above 10°C (Charlton *et al.* 1986) at 3–5 kg/ha in a mixture, or at 6–8 kg/ha when used as the sole grass. Its poorer competitive ability prevents timothy being used for under-sowing existing pasture.

Conclusion

Timothy has been an underrated grass that is known to contribute well in many New Zealand pastures. It is recommended as a component of any rotationally grazed pasture on well drained summer-moist soils for farmers seeking to grow high quality pasture feed for producing top quality milk, meat and wool.

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