Factors affecting the persistence of clovers in grass-clover pastures

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Grass-legume pastures are the basis of the dairy industry in the Southern Cape. The grasses used include annual and perennial ryegrass, tall fescue and cocksfoot. The legume component consists of red and white clovers. While pure grass pastures generally have higher dry matter production per hectare than pure clover pastures and provide for a more even fodder flow, clover pastures provide a higher quality fodder than grasses. With good management a high proportion of clover can be maintained in grass pasture without compromising the total dry matter production of the pasture. With grass-clover pastures not only its forage quality increased but, through their process of fixing atmospheric nitrogen and the recycling of fixed nitrogen, clovers reduce the requirement for inputs of inorganic nitrogen.

The production potential of a perennial grass-clover pasture depends mainly on the stability of the grass-clover ratio. For optimum quantity and quality of herbage a clover content of 30-50% is needed. As the contribution of clovers to total dry matter production of the pasture increases above 50%, so the dry matter production per hectare is significantly reduced. If, however, clover's contribution is below 30% then there will be a reduction in the nutritional value of the pasture. For example, cows grazing pastures which have a 25% or 50% clover component produce 22% and 33% more milk respectively than pastures which have a 0% clover component at the same dry matter availability per hectare.

Due to the different growth forms and growth requirements of perennial temperate grass and of clovers, and differences in palatability of the plants, most farmers find it extremely difficult to maintain a sufficient percentage of clover in their pastures. Grasses tend to be vigorous growers and, given the opportunity, will out-compete the clovers. The management of grass-clover pastures therefore puts greater emphasis onto ensuring that the requirements for optimal growth of clovers are maintained.

Factors influencing the persistence of clovers

Soil fertility

Optimum pasture production depends on correct management of soil fertility. The persistence of legumes in a grass-legume pasture depends largely on the physical and chemical status of the soil and moisture availability. Deeper, well drained soils, will normally be allocated for deep rooted legume plants e.g. lucerne while grass-clover pastures are well suited to shallow soils provided adequate moisture is available.

Annual soil sampling is necessary to monitor soil nutrient levels. Soil analysis will then indicate whether or not additional nutrients are necessary to raise soil nutrient status to the required levels, or simply to apply nutrients to ensure maintenance of current levels. Once the maintenance rates have been established, soil sampling can be undertaken every second year. The main advantage of soil analysis will be achieved by repeated testing over a number of years. A picture of trends in soil fertility status of the farm, on a camp basis, will then be build up. This can be used to monitor progress to achieve or maintain nutrient levels. This is an extremely important tool for the management of soil fertility in each pasture on the farm.

Grass-clover pastures are in the first place fertilized to raise soil fertility levels to the levels required for optimum growth and nitrogen fixing potential. Secondly to maintain the level of fertility by replacing nutrients lost through grazing and leaching.

Compared with grasses, white clover is a poor competitor for phosphorus (P), sulphur (S) and potassium (K). Competition with grasses also lowers clover's response to these nutrients (P, S and K). Inadequate levels of these nutrients will have a negative effect on clover yield and persistence.

The plant needs large amounts of macro nutrients compared to micro nutrients. The most important macro nutrients are nitrogen (N), phosphorus (P), potassium (K) and sulphur (S). The micro elements include all trace elements such as copper (Cu), molybdenum (Mo) and zinc (Zn). Recommended soil fertility levels for grass-clover pastures are P > 30 ppm, K 80-100 ppm, S >11 ppm, Cu >1.0 ppm, Zn >1.0 ppm and Mn 10-15 ppm for optimum production.

Soil pH is also important for clover growth and therefore, lime should be applied where the soil pH is below optimum levels (pH 5.5 [KCL]) for clovers. Liming also promotes nodulation, improves the use of P and increases molybdenum availability, which is essential for nitrogen fixation in clover.

Factors as soil fertility and the availability of water determine the composition of a pasture. Irrigation scheduling and grazing utilization determine the persistence of the pasture. Grass-clover pasture for dairy cows under full irrigation, where irrigation is scheduled with tensiometers installed at a depth of 150 mm, the pastures is grazed when 2500 kg DM/ha is available and pasture residual after grazing is 1300 kg DM/ha, the following pasture types are recommended:

Perennial ryegrass at 12 kg/ha.
Perennial white clover at 4 kg/ha.
Perennial red clover at 4 kg/ha.

If the pasture is utilized with dairy cows and followers which can include dry cows or low producing cows and only supplementary irrigation is available, grasses like tall fescue and Cocksfoot are included in the ryegrass-clover mixture. Tensiometers will still be used for scheduling but will be installed at a depth of 200 mm. The pasture will be grazed at 1900 to 2200 kg DM/ha and the stocking rate will be increased to allow for a pasture residual of 1000-1200 kg DM/ha after grazing.

The following pasture are recommended:
Perennial ryegrass at 4 kg/ha.
Tall fescue at 4 kg/ha.
Cocksfoot at 4 kg/ha.
White clover at 4 kg/ha.
Red clover at 4 kg/ha.

The same management factors do apply to kikuyu over-sown with a mixture of perennial ryegrass (8 kg/ha), perennial white clover (4 kg/ha) and perennial red clover (4 kg/ha). It is critical that the residual pasture after grazing must not be higher than 1200 kg DM/ha and the grazing rotation must not be shorter than 24 days during spring and between 28 to 30 days during summer and autumn.

Nitrogen.
Single applications of N during the autumn and early winter (25-50 kg N/ha), when the clover is dormant, will boost grass production at critical times without affecting clover N fixation or the clover composition. However, it is important to avoid heavy nitrogen application during the spring in order to ensure recovery of the clover stolon population after the winter.

Temperature.
Temperature has a significant effect on the growth and N-fixation of grass-clover pastures. The production of grass-clover pastures decrease at lower temperatures. Ryegrass has an optimum air temperature for growth of 18°C. White clover reaches a maximum growth rate at 25°C. For these reasons ryegrass-clover pasture tends to be ryegrass dominant during the winter and usually show an increase in white clover in spring and summer.

Ryegrass will react on N fertilization at temperatures as low as 5°C. White clover requires temperatures between 9°C and 27°C for growth and nitrogen fixation. This ability of ryegrass to react to nitrogen at low temperatures and the inactiveness of white clover at these temperatures, creates the opportunity for strategic nitrogen application. This will stimulate higher grass production during the winter without affecting the botanical composition or the N fixation of the clovers.

Soil moisture content.

Low soil moisture levels coinciding with high temperatures (>30°C) reduce clover growth. Maintaining soil moisture content is a critical management requirement for optimum production and botanical composition of grass-clover pasture. Clover growth is reduced as soils become dry and high temperatures prevail. Soil moisture management depends on rooting depth of the pasture species, the growth rate of the plants, soil type and the availability of water. A useful tool available to the farmer for scheduling irrigation is the tensiometer. This instrument, if placed at the correct depth and is correctly maintained, will provide a good indication of moisture availability to the plants. For example, on the Estcourt soil types of the George area a tensiometer depth of 150 mm and a maximum reading of -25 kilopascal (Kpa) are recommended for grass-clover pastures. The shallow rooted clovers need an irrigation system that can provide 10-15 mm of water on a frequent basis (2-3 times a week).

Cultivars and competition.

The choice of cultivars has an important influence in grass-legume mixtures in terms of their dry matter yield, botanical composition and animal production. Research has shown that the persistence of clovers was higher in mixtures with perennial ryegrasses than in mixtures with an additional component of tall fescue grass or in tall fescue grass-clover mixtures. Tall fescue-clover mixtures have a higher stocking rate than ryegrass-clover mixtures but also have a low average daily gain (ADG) resulting in a low animal production. For this reason the traditional grass-clover pasture mixtures, where the grass component consisted of perennial ryegrass and tall fescue (cv's Nui and Festal) were replaced by a mixture where the grass component consisted of only perennial ryegrasses (cv's Bronsyn, Ellett). This resulted in a more stable grass-clover ratio and higher animal production.

However, in some areas tall fescues are still grown as a part of the grass-clover mixtures. This is probably because farmers favour the higher late spring and summer production of tall fescue compared to perennial ryegrass. The tall fescue cultivars AU Triumph and Dovey are most popular because they germinate quickly and establish well. The grazing management of this mixture differs from the ryegrass-clover mixture in the sense that a higher stocking rate is required. The reason for this is that most of the tall fescue grasses become unpalatable if not grazed short in a short rotation system (24-28 days cycle). To achieve this, a pasture residual of 1000-1200 kg DM is required.

Cultivars and seeding rate

The choice of cultivars has an important influence on the dry matter production, botanical composition and animal production of grass-clover pasture. Clover is more persistent in perennial ryegrass pasture than in tall fescue pasture. In comparison with ryegrass-clover pasture, tall fescue-clover pasture has a higher carrying capacity but a lower animal production potential. Tall fescue is also not as palatable as perennial ryegrass. This causes the selective grazing of the ryegrasses and clovers in the mixture and leads to the shading of these plants by the tall fescue. In spite of this, farmers keep Tall fescue in their grass-clover pasture. The main reason for this is that tall fescue has a higher summer and autumn production than perennial ryegrass. The management of tall fescue pasture also differs from that of perennial ryegrass pasture. Tall fescue has a higher carrying capacity and therefore should be grazed with a shorter rotation.

Grazing management.
Pasture trials at Outeniqua Research Farm have shown that a hectare of grass-clover pasture can produce between 18 and 20 tonnes of dry matter (DM) a year. However, the dry matter intake was only between 11 and 14 tonnes of DM per year. On average 35% of this feed was going to waste. It has been estimated that on many farms 50% or more of potential feed is going to waste. Although the same trend was also found in Australia, they also found that there were farms where seventy and eighty percent of pasture which is grown is consumed.

Good management system is based on the optimum production (kg DM/ha/day) of high quality, palatable dry matter and the highest possible animal intake (kg DM/cow/day). To obtain these goals the pasture should be grazed at a point where the ryegrass tillers are mature (three leave stage). If the pasture is allowed to get older the third ryegrass leaf will die, resulting not only in pasture waste, but also in unpalatable roughage and in the shading of the growth points of the ryegrass and clover. This will prevent the development of new tillers and -stolons. Not only will the life of the pasture be shortened but the clover component will also decline.

Correct grazing intervals and grazing intensity are the only management practices that will ensure optimum utilization of grass-clover pasture. However, the intensity of grazing and grazing intervals should not be measured in time or in pasture height but by the availability and residual of pasture (kg DM/ha). Ryegrass-clover should be grazed at 2000-2400 kg DM/ha with a residual of 1100-1300 kg DM/ha. This will ensure an intensive grazed pasture with the shortest possible rotation. This system will also ensure that the grazing frequency will vary with the seasons and the intensity of grazing will stay the same. Grass-clover pastures managed this way have shown higher clover content during spring compared to pasture grazed at a low intensity with a long rotation (residual 2000-2400 kg DM/ha).

Pasture intake is reduced by the feeding of concentrates. In a study done at Outeniqua Research Farm Jersey cows grazed mainly on ryegrass-clover were fed 0, 2.4, 4.8, or 7.2 kg of concentrate per day over two lactations and produced 12.8, 15.2, 15.8 and 17 kg of fat corrected milk per day respectively. The feeding of each additional kg of concentrate resulted in production of 1.0, 0.71 and 0.58 kg fat corrected milk (FCM). The poor response to concentrate feeding can be attributed to substitution of pasture by concentrates. The substitution rate (SR) can be calculated as follows: SR = 0.093 X kg of concentrate fed per cow/day. Feeding of high levels of concentrates will result in reduced pasture intake, higher feed cost and under-utilization of pasture.

Pests.
Slugs, mole crickets, black maize beetles, aphids, cutworms, spittlebugs and army worms have been identified in established pastures. The negative effects of these pests have not been quantified. These pests may have a detrimental effect on the persistence of planted pastures.

Conclusions
A number of factors are important for clover growth and persistence in a mixed grass-clover pasture. It is important that they all need to be addressed in order to achieve increased clover content. The goal should be to increase clover content without reducing annual pasture dry matter yield. Higher clover content will improve milk yields for the same levels of dry matter available in the pasture. Unfortunately we are way behind the leading milk producing countries where it comes to the quantification of the factors that influence pastures persistence. The pasture production, the amount of pasture utilized by our animals and the actual cost in relation to our production cost will be the only guidelines that will tell us if we can produce our milk competitively on an international market.