grass roots

Newsletter of the Grassland Society of Southern Africa

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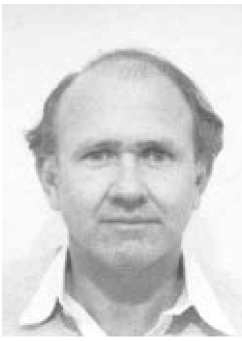
Message from the GSSA President



DAVE GOODENOUGH
GSSA PRESIDENT

I welcome the opportunity to update you on recent developments in our Society, particularly with regard to its administration, our new-look newsletter "Grass Roots" and forthcoming congresses. GSSA Council recently appointed Mrs Lolly Stuart of "Stuart Communications", Pietermaritzburg, to take over the administration of the GSSA. All future accounts for annual subscriptions will be processed by Stuart Communications, to which payments in favour of GSSA should be made.

Mrs Stuart has also agreed to produce our new GSSA newsletter, "Grass Roots" which will replace the "GSSA Bulletin". Graham Peddie, who was previously responsible for producing the Bulletin, will work closely with Mrs Stuart in providing her with brief reports, articles and photographs of interest to all GSSA members and others in related fields.

Your support for "Grass Roots" is essential if we are to publish this planned eight-page newsletter every quarter. If there is, for example, a farmers day, pastures or veld course to be held in your region which will be of interest to GSSA members and others, please inform Mrs Stuart or Graham accordingly, AND follow up with a brief summary of the farmers day you attended, AND preferably with a few photos with captions and names of those in the photo.

"Grass Roots" is YOUR newsletter and we need YOUR contributions! Please also provide names and addresses to Stuart Communications of organisations and libraries in your area who would also be interested in receiving the GSSA's "Grass Roots" newsletter.

Your GSSA Council has also recently discussed holding farmers days in different regions under the auspices of the GSSA at which top scientists and farmers will be asked to address subjects of interest to GSSA members and others. A publication of the day's proceedings will be made available to all attending and tours to a farm(s) in the area are also envisaged. More details will follow! Please contact me or other members of the GSSA Council if you feel such a farmers day should be organised in your area.

We are all looking forward to the joint GSSA/SASAS congress to be held at Christiana Aventura from 13 to 17 May 2002, inclusive. Should you have any queries in this regard please phone the congress organisers at 018-299 6707.

The VIIth International Rangelands Congress, to which all GSSA members are invited, is to be held in Durban from 26 July to 1 August 2003. For more details, visit the IRC 2003 website at www.ru.ac.za/rgi/irc2003/IRC2003.htm OR contact Sue Bumpsteed Conferences, P/Bag X37, Greyville, 4023 (Telephone 031-3032480; Fax: 031-3129441; or email: delegates@sbconferences.co.za). This congress will replace the normal 2003 GSSA annual congress.

Your proactive support for the GSSA is essential if our Society is to continue to make a meaningful impact in Southern Africa.

With best regards
Dave Goodenough
PRESIDENT

APRIL 2002 *in this issue:*

GSSA members involved at Cedara farmers day

A number of GSSA members were involved in a farmers day held over two days in late August at Cedara, jointly organised by the KwaZulu-Natal Department of Agriculture and Environmental Affairs and the ARC-Range and Forage Institute.

"Temperate forages and their role in livestock production" was the theme and over 200 farmers and company representatives attended. Talks on, "Know your cultivars – tall fescue, ryegrass, fodder radish, forage cereals and teff" and "Breeding ryegrass cultivars with improved forage quality" highlighted new forage cultivars recently developed at Cedara and how they compare with imported cultivars.

Other presentations on the necessity for irrigation scheduling, the importance and management of soil organic matter, measuring your pastures with a disc meter, the influence of fertilizers on intake of Italian ryegrass and the need for good quality roughage for the high producing dairy cow, were also very well received.

Characterisation of goats on pastures was also discussed. This is a new project in which the nutrient requirement and forage intake rates of goats, as well as the suitability of different grasses, legumes, shrubs and mixtures to goats, is being assessed.

A number of seed companies were also involved on the day and farmers were able to view various different forage cultivars which are currently marketed in South Africa.

This farmers' day was a great success and more are envisaged in the future.

LEFT:
Farmers gathered at various stands to hear the latest on temperate forages.

PHOTO: JOHN TUNGAY

RIGHT:
Dave Goodenough and Dr Dieter Reusch of the ARC-RFI spoke about their new ryegrass and tall fescue varieties.

PHOTO: JOHN TUNGAY

LEFT:
Sigrun Kassier of the ARC-RFI and Dr Amie Aucamp, Director of the ARC-RFI, discussing one of the new ARC-RFI winter-vigorous ryegrass varieties.

PHOTO: JOHN TUNGAY

RIGHT:
Richard Reynolds of the KZNDA & EA demonstrating the disc meter for measuring pastures.

PHOTO: JOHN TUNGAY

LEFT:
Sheila Elliot of the KZNDA & EA talked on the evaluation of different pastures for goats.

PHOTO: JOHN TUNGAY

Attention all GSSA members

This newsletter has been sent to all GSSA members, whether you have paid your subscriptions or not. Please note that future newsletters will not be distributed to unpaid members, so we urge you, in order to benefit from this association, to please get your account up to date if this is presently outstanding.

For account enquiries, please contact Priscilla, tel: 033-3425779

Planted Pastures Tour of the Cape

The GSSA fully supported the planted pastures tour of the Cape held in August last year, co-ordinated by GSSA President Dave Goodenough, of the ARC-Range and Forage Institute. Many of the 61 participants who joined the tour party for a day or more were GSSA members.

The tour kicked off with a very interesting visit to the Bathurst Research Station where an overview of the beef production norms off kikuyu, K11 kweek, stargrass and Panicum/lucerne pastures was presented by Neels de Ridder. Then on to Trevor Simpson's farm near Alexandria where Trevor and Mick Willis discussed dairying off kikuyu pastures and how to manage kikuyu pastures to ensure good forage quality.

The following day three farms were visited in the Tsitsikamma under the leadership of Andrew Beckerling, Frank Weitz, Tom Daines and Rob Phillips. David Masterson, a dairy farmer, spoke about the role of kikuyu, ryegrass, stooling rye and teff. At the next farm, Andrew Masterson, a top Friesland breeder, spoke on breeding for top milk yields and oversowing pastures. At Rob Ballantyne's farm, perennial ryegrass pastures were viewed and Andrew Beckerling gave a very interesting talk on how they go about disc-measuring and managing their ryegrass pastures. Soil compaction is also an issue of great concern in the Tsitsikamma and Andrew demonstrated a held-held soil compaction probe which determines whether there is an underling soil compaction problem.

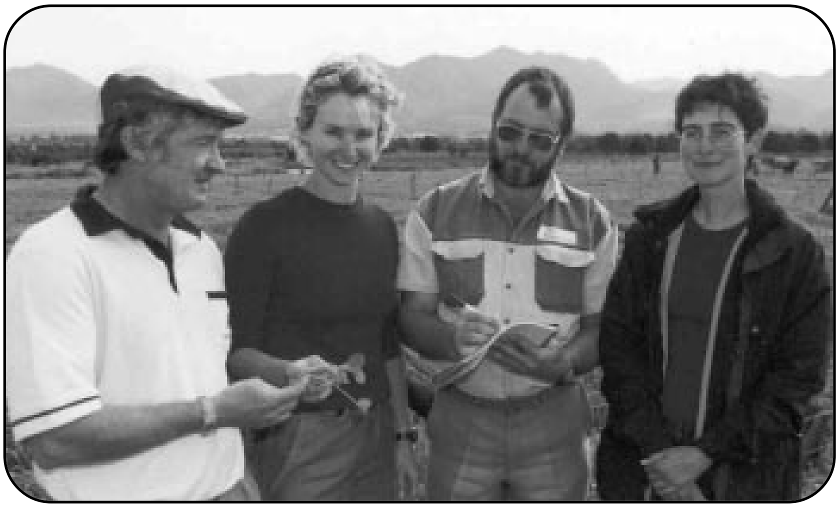
The next day, those who stayed overnight at The Wilderness awoke to several whales frolicking just beyond the waves, but it was back to "work" and a visit to the Outeniqua Research Station, just outside George. Here tour leaders for the day, Dr Robin Meeske, Philip Botha, Willem Burger, Dr Mark Hardy and Hennie Gerber discussed the latest techniques used for oversowing kikuyu with white and red clover and ryegrass, the economic implications of pasture choice, fertilizer trials and pasture measurement using the rising plate meter. The Dargle versus NCD Enhancer ryegrass grazing trial, where milk yields and various other criteria are being compared, was then viewed. Results from the national ryegrass cultivar trial were also of great interest to all.

That afternoon the tour party visited two farms near The Wilderness where Bruce Holmes (dairy) and Jake and Ben Crowther (beef) spoke about how they manage their kikuyu and ryegrass pastures.

The last farm to be visited en route home was Pierre Hart's dairy farm near Komga. Here the management technique used in the *Desmodium* legume pastures was discussed. It was also interesting to note that Pierre prefers Italian ryegrass cultivars such as Concord to Westerwolds ryegrass cultivars such as Midmar because they persist far longer into the late spring months than a Midmar ryegrass pasture would do.

It was agreed by one and all that this tour was very informative and an opportunity to meet numerous researchers, farmers and advisers, all with a common interest in planted pastures.

ABOVE: Graham Peddie (Dundee), Christi Visagie (Nooitgedacht), Dave Goodenough (tour co-ordinator from Cedara), Prof. Kevin Kirkman (University of Natal), Philip Botha (Outeniqua) and Annelene Swanepoel (Elsenburg) were some of the 61 tour participants.



LEFT:
John Cunningham, Jean Doxey and John Morrison (all from Cedara) and Dorette Muller (Nooitgedacht) discussing a kikuyu pasture oversown with white clover at the Outeniqua Research Station.

RIGHT:
Christine Koenig and Christy Webb (both students from the University of Natal), Dr Piet Pieterse (University of Pretoria), Dr Johan Marais (Cedara) and Bryan Mappledoram (Roodeplaat) were also on tour.

LEFT:
Theunis Coetzee (Jeffrey's Bay), Richard Reynolds (OSCA, Zululand), Sheila Elliot (Cedara), Melanie Glaum (Cedara College) and Ian Marot (Cedara) discussing the Outeniqua pastures.

Objectives of the GSSA include:

- √ **Promote and advance the science and technology of rangeland and pasture production**
- √ **Create awareness, opportunities and participation in southern Africa for range and pasture scientists, technologists and farmers**
- √ **Promote the equitable, efficient and sustainable use of the natural resources**
- √ **Encourage liaison with other societies of similar interest**

DIE EVALUASIE VAN LUSERNKULTIVARS ONDER BEWEIDING

G.W.D.R. Conradie[+] , Dr. M. Hardy[++], T. Oberholzer en W. Langenhoven[++]
[+] Elsenburg Landbounavorsingsentrum, Privaatsak XI Elsenburg, 7607
[++] Tygerhoek, Posbus 25, Riviersonderend, 7250

Hierdie referaat is gelewer op die Lusern Mini-Simposium (11-12 September 2001) te Upington. Die artikel gee 'n kort oorsig van die vier fases waaruit weidingsnavorsing bestaan en wat elke fase behels. Die klem val op die beginsels van hoe weidingstoleransieproewe uitgevoer word en wat geskikte proefparameters is. Die resultate tov watter kultivars die hoogste presteerders was, was vir die doel van die bespreking van minder belang. Aan die hand van 'n praktiese voorbeeld, uitgevoer in die Riviersonderend-distrik van die Suid-Kaap, word verduidelik hoe weidende diere in fase 2 van weidingsnavorsing ingesluit word. Alhoewel 'n wisselweidingstelsel aanbeveel word vir lusernweidings, word droëlandlusernweidings algemeen aanhoudend bewei in die Suid-Kaap. Dit is weens praktiese probleme wat in die weiding/gewas stelsel ondervind word waar kampe meestal groter as 30 ha is en daar gewoonlik te min kampe per skaaptrop beskikbaar is. Gevolglik is dit belangrik dat lusern kultivars vir skaapproduksie in die Suid-Kaap onder beide aanhoudende en wisselweiding geëvalueer word. Die doel van die proef was dus die evaluasie van verskillende lusernlyne en kultivars onder droëlandtoestande oor beide weidingstelsels (aanhoudend vs. wisselweiding) teen dieselfde weidruk. Ses lusernlyne en twee lusernkultivars (SA Standaard en CUF101), is in April 1997 op Tygerhoekproefplaas (Skaliegronde, Riviersonderend-distrik) gevestig en het gestrek oor 'n periode van drie jaar. Driemaandelikse planttellings is in elke perseel oor beide beweidingsiklusse (aanhoudende vs. wisselweiding) bepaal. Verskeie gevolgtrekkings kon uit resultate gemaak word. Eerstens het kultivarverskille ten opsigte van aanhoudende en wisselbeweiding voorgekom. Tweedens het die seisoenale DM-produksie (kg DM.ha^{-1}) van lusern kultivars en/of lyne visueel meer vertoon by wisselweiding as teenoor aanhoudende beweiding. Derdens het aanhoudende beweidings veroorsaak dat plantdigtheid (%Plante.m^{-2}) baie vinniger afneem as met wisselweiding. Vierdens het lusern kultivars en/of lyne op enige stadium van waarneming (3 tot 21 maande na eerste beweiding) altyd 'n laer plantdigtheid (%Plante.m^{-2}) by aanhoudende beweiding in vergelyking met wisselweiding gehad. Plantdigtheid is 'n riglyn t.o.v. weidingtoleransie van lusern kultivars. Dit is egter ook belangrik om die produksiepotensiaal van kultivars onder beweiding in ag te neem wat bestuursbeperkings van die weiding/gewas stelsel inkorporeer. Daar is verskeie aspekte vir aandag vir toekomstige weitoleransie proewe in die Suid-Kaap in hierdie artikel vermeld. Laastens, daar is geen sin in die aanbeveling van kultivars wat oorleef onder 'n swaar weidruk, maar wat nie voldoende voer vir volhoubare, ekonomies lewensvatbare diereproduksie produseer nie.

For the full article, see the GSSA website: www.gssa.co.za

Revegetation of bare patches in the Karoo: an evaluation of various techniques

N. Visser, J.C. Botha and B. Witbooi
Department of Agriculture – Western Cape, Private Bag X1, Elsenburg, 7606

Bare patches cover large areas of the Great Karoo. The surface soil of these bare patches is severely compacted, limiting moisture penetration. Perennial plants are rarely found in these areas. Bare patches are usually the result of degradation processes, mainly severe overgrazing and patch selection. Severe drought may also initiate the formation of such bare patches

Five different techniques were tested on a bare patch of about 100 ha on the farm Hillmore near Beaufort-west, which receives an average annual rainfall of 190 mm, with an annual rainfall of 364 mm during the study period. Soils were clayey loam with a very low carbon content (0.3 %). These techniques were combinations of: oversowing (seed); covering with branches (branches); till to a depth of 100 mm (tilled); and a control with no treatment (control). Fifteen kg seed/ha of a seed mix comprising *Atriplex semibaccata, Cenchrus ciliaris, Chaetobromus dregeanus, Pteronia membranancea* and *Tripteris sinuatum* was broadcast onto the soil surface in the oversowing treatments.

Best establishment of plants was obtained from the tilled-seed-branches treatment while the control and seed treatments had very poor establishment, which can be attributed to unfavourable soil surface conditions and the absence of a microhabitat. *Pentzia incana* (0.03-1.26 plants/m^2) and *C. dregeanus* (0.01-1.36 plants/m^2) were the most common species. Over-sown species showing the best germination were *C. dregeanus* (1.3 plants/m^2) and *T. sinuatum* (0.2 plants/m^2). Tilled-seed-branches treatment gave the best results but was the most expensive. Tilled-seed treatment was almost as successful, but is much cheaper than the labour intensive brush packing.

Revegetation of bare patches goes hand in hand with mechanical disturbance of the soil to increase water infiltration and to provide physical barriers to slow water movement across the soil surface, to limit the effects of raindrop impact, reduce soil temperature and to catch wind-blown seed and organic matter. In addition viable seed of desirable species such as *P. incana, T. sinuatum, C. dregeanus, Aridaria* spp and *Galenia* spp. can be introduced.

For the full article, see the GSSA website: www.gssa.co.za

THE PERSISTENCE OF CLOVERS IN GRASS-CLOVER PASTURES

Philip Botha
Department of Economic Affairs, Agriculture & Tourism:
Southern Cape ADC, Outeniqua Experimental Farm, PO Box 249, George, 6530

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. Red and white clovers form the legume component. 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 is forage quality increased but, through their process of fixing atmospheric nitrogen and the recycling of fixed nitrogen, clovers reduce the requirements 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 (Martin, 1960). 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 is a loss in quality of dry matter availability to livestock. 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 (Harris, 1997).

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.

In this paper factors such as soil fertility, soil moisture, fertilization requirements and the frequency and intensity of grazing on the persistence of clovers in grass-clover pastures will be discussed. Details provided have been gained from research conducted in the Southern Cape, and from the literature.

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 utilize 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 a international market.

For the full article, see the GSSA website: www.gssa.co.za

Feedback on the Annual Meeting of the Society for Range Management, at Kansas City, Mo.

Richard Hurt
ARC – Range & Forage Institute, P.O. Box 1190 Hilton 3245; E-mail: info@mvelo.co.za

I was fortunate to attend this meeting with the objective of marketing the VIIth International Rangeland Congress scheduled to be held in Durban in July 2003. From the outset I would like to express my gratitude to David Grossman, Luthando Dziba, Noks Mgxashe and Baldwin Negovhela for their help in setting up and manning the stand, especially during my bouts of tick-bite fever!

The SRM meetings are somewhat different to our GSSA annual congress, and not in the least by the number of delegates (some 1 500 registered!). The meeting is very business orientated with a host of different activities being organised during the convention by various committees and working groups within the SRM. The activities range from pure science sessions, to meetings of their Board of Directors, Advisory Council and other committees, to accreditation and other exams, to contests, to auctions, to social functions. The business committees are aimed at developing specific agendas that are believed to be important in meeting the aims of the Society or for the discipline of range science as a whole.

In addition to business, however, the meeting also addresses scientific goals and a number of plenary and more concurrent symposia, workshops and sessions allow for the reporting of new science and breaking range management issues. Huge emphasis is placed on student activities at all levels, post-graduate, graduate and even scholar. In all these cases, students undertake their own research and are expected to write up their findings and report them at the annual meeting. This is definitely a field in which the GSSA should start investing in close collaboration with those academic institutions that offer range and forage science or related curricula. At present we are only involved at two levels; first, scholars are encouraged to undertake projects allied to range and forage science and report on these at the regional school science expositions; and second, deserving graduate and post-graduate students in range or forage science are passively awarded GSSA medals for their achievements. I believe that we are not doing enough to proactively encourage scholars and under-graduate students to develop an interest in the discipline, and this is particularly evident in the lack of capacity in range and forage science currently being experienced by most southern African research institutions.

The meeting also included a large trade exhibition. In general, the convention is attended by a considerably higher proportion of producers than is the annual GSSA meeting, and consequently a trade exhibition is not out of place. Exhibitions varied from some 30 industry-related stands to displays by the various chapters or regional branches of the SRM, to school and university displays. This could be something for the GSSA to consider at its annual congress, particularly from the point of giving some exposure to our Member Institutes.

The IRC was allocated a complementary stand by the organisers where we set up posters, maps and brochures to market the event. A TV with VCR was provided for a SATOUR video on the tourism potential of South Africa as back up for potential delegates. There was huge interest in the event from academics to administrators to researchers to graziers. It seems that because South Africa is the first African country to host the IRC, we can expect an abnormally higher number of delegates and accompanying persons than usual. Many potential delegates were attracted by the relatively cheap congress and associated holiday due to the weak Rand. We gave out pin-on bead South African flags to potential delegates, and these turned out to be an absolute hit amongst the Americans!

In conclusion, I would like to express my gratitude to all who made this trip and marketing exercise possible.

- SRM members for making the marketing trip feasible and waiving certain fees (Jim O'Rourke, outgoing president; Urs Kreuter, chair of the International Affairs Committee; Ann Harris, SRM administrator; Larry Pollard, trade exhibition organiser).
- The IRC Organising Committee for funding the trip, and Sue Dungan and Lynne du Toit for organising exhibition and marketing material, and tickets and visas at short notice.
- The Director of the ARC-RFI for the time to be involved in the organisation of a major event as the IRC and the time to attend the meeting.
- And last but not least, my South African colleagues who assisted with the stand.

I have e-copies of the abstracts and programme of the event, and any interested members may contact me for these.

Grassroots: Newsletter of the Grassland Society of Southern Africa: Vol 1(1) Addendum 3. April 2002

The persistence of clovers in grass-clover pastures

Philip Botha

Department of Economic Affairs, Agriculture and Tourism: Southern Cape ADC, Outeniqua Experimental Farm, PO Box 249, George, 6530

Introduction

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. Red and white clovers form the legume component. 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 is forage quality increased but, through their process of fixing atmospheric nitrogen and the recycling of fixed nitrogen, clovers reduce the requirements 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 (Martin, 1960). 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 is a loss in quality of dry matter availability to livestock. 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 (Harris, 1997).

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.

In this paper factors such as soil fertility, soil moisture, fertilization requirements and the frequency and intensity of grazing on the persistence of clovers in grass-clover pastures will be discussed. Details provided have been gained from research conducted in the Southern Cape, and from the literature.

Factors influencing the persistence of clovers

1. Soil fertility.

Optimum pasture production depends on correct management of soil fertility. The persistence of legumes in a grass-legume pasture depend 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 pasture 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. That can be used to monitor progress to achieve or maintain nutrient levels. This picture 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 fertilize to raise soil fertility levels to the levels required for optimum growth and nitrogen fixing potential. Secondly to maintain that level of fertility by replacing nutrients lost through grazing and leaching.

Compared with grasses, white clover is a poor competitor for phosphorus, sulphur and potassium (Tillman, 1993). Competition with grasses also lowers clover's response to these nutrients. 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 pasture 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 important for clover growth. Lime should be applied where the soil pH is below optimum levels (pH 5.5) for clovers. Liming also promotes nodulation, improves the use of P and increases molybdenum availability, which is essential for nitrogen fixation in clover (Edmeades et al,1984).

2. Nitrogen.

It is not recommended that nitrogen should be applied to grass-clover pastures as the recycling of biologically fixed nitrogen from the legume component is sufficient to support optimum pasture production for most of the year. During the cold winter months, however, the clovers are dormant and grass production is low. The strategic application of nitrogen to these pastures can support increased grass production. 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 (Eckard, 1995; McKenzie *et al*, 1998). 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 (Hoglind and Frankow-Lindberg, 1998).

3. Temperature.

Temperature has a significant effect on the growth and N-fixation of grass-clover pastures. The production of grass-clover pasture decrease at lower temperatures. Ryegrass has an optimum air temperature for growth of 18^{0}C. White clover reach maximum growth rate at 25^{0}C (Curtis and O' Brien, 1994). For these reasons ryegrass-clover pasture tends to be ryegrass dominant during the winter and usually show a increase in white clover content in spring and summer.

Ryegrass will react on N fertilization at temperatures as low as 5^{0}C (Cameron, 1993). White clover require temperatures between 9^{0}C and 27^{0}C for growth and nitrogen fixation (Frame and Newbould, 1986). 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.

4. Soil moisture content.

Low soil moisture levels together with high temperatures (>30^{0}C) reduce clover growth. Maintaining soil moisture content of soils is a critical management requirement for optimum production and botanical composition of grass-clover pasture. Clover growth is reduced as soils dry out 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 15 cm and a maximum reading of -25 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) (Botha, 1994).

5. 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 were 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 grass (cv's Nui and Festal) was replaced by a mixture consisting of only perennial ryegrasses (cv's Yatsyn, Ellett).

This resulted in a more stable grass-clover ratio and higher animal production (Botha and Oberholzer, 1997).

However, in some areas tall fescues are still grown as a part of the grass-clover mixtures. This is because farmers favour the higher late spring and summer production of tall fescue grass 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) (Botha and Oberholzer, 1997). To achieve this a pasture residual of 1000-1200 kg DM is required.

6. Overshadowing.

Light is needed to trigger the growing point of parent clover stolons and -ryegrass tillers to produce new daughter stolons and -tillers. Shading reduces the production of daughter tillers and stolons (Curtis and O'Brien, 1994). The reduction of daughter stolons and -tillers means fewer growing points resulting in lower clover and ryegrass production. Undergrazing is the main cause for the overshadowing of pasture. To prevent undergrazing it is important to implement the correct management practices as discussed under the heading "grazing management".

7. Cultivars and seeding rate:

Mixture 1: (Dairy cows, full irrigation, tensiometer depth 15 cm, graze at 2500 kg DM ha^{-1}, pasture residual 1300 kg DM ha^{-1})

		Cultivar	Kg/ha
Perennial ryegrass	(Lolium perenne)	Bronsyn	6
Perennial ryegrass	(Lolium perenne)	Ellett	6
White clover	(Trifolium repens)	Haifa/Dusi	2
White clover	(Trifolium repens)	Waverley/Landino	2
Red clover	(Trifolium pratense)	Kenland	4

Mixture 2: (Dairy cows with followers, full irrigation, tensiometer depth 15 cm, graze at 2500 kg DM ha^{-1}, residual 1000-1200 kg DM ha^{-1})

		Cultivar	Kg/ha
Perennial ryegrass	(Lolium perenne)	Bronsyn	4

Perennial ryegrass	(Lolium perenne)	Ellett	4
Tall fescue	(Festuca arundinaceae)	Dovey/Barcel	4
White clover	(Trifolium repens)	Haifa	2
White clover	(Trifolium repens)	Waverley/Landino	2
Red clover	(Trifolium pratense)	Kenland	4

Mixture 3: (Dairy cows with followers, supplementary irrigation, tensiometer depth 20 cm, graze at 2500 kg DM ha^{-1}, residual 1000-1200 kg DM ha^{-1})

		Cultivar	**Kg/ha**
Perennial ryegrass	(Lolium perenne)	Bronsyn	4
Tall fescue	(Festuca arundinaceae)	Dovey/Barcel	4
Cocksfoot	(Dactylis glomerate)	Cambria	4
White clover	(Trifolium repens)	Haifa/Dusi	3
Red clover	(Trifolium pratense)	Kenland	4

8. Grazing management.

Pasture trials at Outeniqua Experimental Farm have shown that a hectare of grass-clover pasture can produce between 20 and 24 tonnes of dry matter (DM) a year (Botha and Oberholzer, 1997). However, the dry matter intake was only 15,3 tonnes of DM per year. On average 32% 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. These farms also gave the highest profits (Curtis and O Brien, 1994).

A good management system is based on the optimum production (kg DM/ha/day) of high quality, palatable drymatter 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 overshadowing of the growth points of the ryegrass and clover. This will prevent the development of new daughter 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 (Curtis and O'Brien, 1994). 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 Experimental 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)(Meeske, 1996). The poor response to concentrate feeding can be attributed to substitution of pasture by concentrates. According to Faverdine (1991) the substitution rate (SR) can be calculated as follows: SR = 0.093 X kg of concentrate fed cow^{-1} day^{-1}. Feeding of high levels of concentrates will result in reduced pasture intake, higher feed cost and under-utilization of pasture.

9. 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.

Conclusion

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 milkproducing countries where it comes to the quantification of the factors that influence pastures persistence. The pasture production, the amount of pasture utilize 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 a international market.

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THE EVALUATION OF LUCERNE CULTIVARS UNDER GRAZING

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Introduction

Lucerne is the most important pasture and fodder crop in the winter rainfall area of South Africa. Apart from providing high quality feed, it has the highest yield potential of all the legumes cultivated in this area. Lucerne is one of the corner stones of sustainable intercropping and animal production systems. In the year 2000, lucerne cultivation covered an area of 160 000 ha in the Southern Cape. The biggest advantage of this crop is that it can be utilised both for hay production (irrigated) and grazing (mainly dryland).

Pasture research usually consists of 4 phases:

- Phase 1: Introduction and cultivar evaluation
- Phase 2: Tolerance - response to grazing
- Phase 3: Management guidelines for fertilization and utilization
- Phase 4: Animal production potential

Cultivar evaluation consists of cutting trials where grazing is simulated by cutting the pasture with a machine. Cutting is done at a specific height and frequency. If cultivars are evaluated for hay making purposes, cutting is adequate. If cultivars are evaluated for grazing purposes, however, the effect of grazing animals on the persistence of the cultivars needs to be tested. The latter then requires phase 2 trials. This is of particular importance in the Southern Cape, where lucerne is cultivated under dryland conditions for utilization by sheep. Persistence is evaluated by monitoring production potential and plant density over a period of time. Introduction and evaluation of cultivars form a sound base for pasture research (phase 2-4). Introduction and evaluation of cultivars compare the total as well as seasonal dry matter yields of the cultivars. If a pasture crop produces seed or pods suitable for grazing animals, or influencing re-establishment of cultivars, the yield of these seeds and pods must also be measured.

In the Southern Cape, lucerne is utilised by sheep under dryland conditions. Therefore, the longevity of cultivars should be tested under grazing conditions. Longevity can be tested by maintaining production potential, as well as plant density, over a period of time.

A typical production system in the Southern Cape consists of 5-7 years of lucerne, followed by 5 years of cash cropping. During the last years of the cash cropping, barley is undersowed with lucerne. Although intercropping is recommended for lucerne pastures, dryland lucerne pastures are grazed continuously in general. This is mainly because of practical problems experienced in fodder/crop systems where camps are frequently larger than 30 ha and where the number of camps per herd is insufficient. The ideal is to have six camps available per herd. Due to the enormous impact of continuous grazing on individual plants, and the fact that Merino sheep, in particular, graze highly selective, it is recommended that lucerne cultivars with a high degree of grazing resistance/winter dormancy is planted.

Although the production curve of a cultivar is generally based on the persistence of a number of plants over time, the correlation with animal production potential over time is usually weak. Consequently, it is important that lucerne cultivars for sheep production are evaluated under both continuous and rotational grazing. Grazing tolerance is determined through monitoring the changes in the production potential and plant density of a pasture.

Here, the procedure is discussed for the determination of the effect of rotational and continuous grazing on the grazing tolerance of lucerne cultivars. The emphasis was to investigate parameters for the determination of grazing tolerance.

Procedures:

Six lucerne lines and two lucerne cultivars were established on Tygerhoek Experimental Farm (Riviersonderend) in April 1997. Seed was sown in 3x20 m plots with four replications. Before planting lime, phosphate, potassium and trace elements were applied according to the soil analysis. Seed was inoculated and sown in 200 mm rows at 17 kg/ha. The trial was executed under dryland conditions. The mean LT rainfall for the area is 427.5 mm per annum (64% in winter, 36% in summer). The monthly rainfall is shown in Table 1*. Soil samples were taken annually and the relevant corrections were made to ensure adequate levels of macro and trace elements. The trial covered a period of 3 years. Grazing treatments started in the second year of production (April 1998). This was done to simulate the farmers' practice of undersowing barley with lucerne. A similar grazing pressure (number of sheep/ha) for each of the two grazing treatments (continuous and rotational) was maintained. The rotational grazing treatment comprises of a grazing period of one week, followed by five weeks of rest. In the continuous grazing treatment, the sheep were kept on the pasture for 10.5 months of the year.

This is because of practical problems that occurred in the pasture/crop system where the size of the camps usually were greater than 30 ha and therefore there were not enough camps per flock of sheep. There are at the most 2 camps available per flock, while ideally there should be 6 camps per flock. On account of the high impact of continuos grazing on individual plants and the fact that merino sheep graze very selectively, it is generally recommended that lucerne cultivars which have a high tolerance to grazing or is winter dormant should be planted. Even though the production value of a cultivar is based on the amount of plants per square meter able to survive over a given length of time the correlation with animal production over time is usually weak. It is therefore important that lucerne cultivars for the production of sheep be tested under both continuos and rotational gazing. Tolerance to grazing is determined by monitoring the changes in the production potential and plant density of the pasture.

This presentation discusses the procedure used for determining the influence of rotational and continuos grazing on grazing tolerance of various lucerne cultivars.

This experiment is a practical example of how grazing animals are included in phase 2 of pasture research. The emphasis lies more on the principle of how to perform such an experiment and the choice of suitable parameters to use in determining grazing tolerance. The results regarding which cultivars were the best performers, is, for the aim of this discussion, of less importance.

Material and methods

Six lucerne lines (9563, 9642, 9533, 9437, 9640, 9561) and two lucerne cultivars (SA Standard and CUF 101) have been sown in 3m x 20m plots, four replications of each, in April 1997 on Tygerhoek Experimental Farm (soils derived from shale, Riviersonderend district). Before establishment lime, phosphorous, potassium and trace-elements were administered according to the results of soil analysis.
Before sowing, the seeds were inoculated with the correct *Rhizobia* strain and sown in 200 mm rows at 17 $kg.ha^{-1}$. The experiment was conducted under dryland conditions. The long term mean rainfall is 427.5 mm per annum with a distribution of 64% in winter and 36% in summer. Table 1 contains the monthly rainfall of Tygerhoek Experimental farm.

Table 1: Monthly rainfall on Tygerhoek Experimental farm

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1997				51.4	61.5	3 9 . 0	42.0	37.1	9.1	38.0	23.3	10.0
1998	69.4	14.1	40.5	57.3	92.0	25.4	37.9	40.1	17.1	0.0	0.0	0.0
1999	47.8	21.2	35.2	11.6	51.9	15.6	20.8	31.0	54.6	12.0	9.1	13.9
2000	58.0	15.0	149.0	25.0								

Soil was sampled annually and the necessary alterations were made to ensure that no deficiencies of macro- or trace-elements occurred. This experiment has stretched over a period of three years. Grazing (continuos vs. rotational) commenced in the second year of lucerne production (April 1998). In this way the situation in practice (barley, under sowed with lucerne) is taken into consideration. The same stocking rate (sheep/ha) was used under continuous as well as rotational grazing. In the case of rotational grazing, one week grazing was followed by 5 weeks of rest. In the case of continuous grazing the sheep occupied the pasture for 10.5 months of the year. The six week rest period (rotational grazing) was used for the determining of relative production potential of each cultivar / line as a function of continuous, heavy grazing. To be able to determine the grazing tolerance in the shortest possible time (2 years), a heavy stocking rate was used. Three-monthly plant counts were done on each plot in both grazing systems (continuous vs. rotational).

Discussion of results

Figure 1 shows the influence of rotational grazing on the total dry matter production (kg $DM.ha^{-1}$) of the different lucerne cultivars and/or lines for the period April 1998 to May 2000. This graph shows that CUF 101 had the best DM-production (kg $DM.ha^{-1}$) after two years under rotational grazing. In lucerne cultivar trials under irrigation at Elsenburg which were harvested with a machine. CUF 101 showed signs of decline after two or three years. If this current experiment was to be prolonged, CUF 101 would probably start to decline.

Figure 2 shows the influence of rataional grazing on the seasonal dry matter production of the various lucerne cultivars or lines for the period April 1998 go May 2000. This figure shows that cut 5 and 16 taken respectively on 6 June and 4 April 2000 had exceptionally high DM-production (kg $DM.ha^{-1}$) over the whole spectrum of cultivars. One would then compare this data with the monthly rainfall. Logic would suggest that favourable moisture regime was responsible for this increase in DM-production because the same DM-production could not be obtained in corresponding seasons. It is clear that the seasonal DM-production of line 9561compares favourably with that of CUF 101 and SA Standard, the reference cultivars. This information is especially important for extension officers whom have to compile a feed flow programme. The experiment time, however, should have been extended with one year to test the sustainability of the cultivars and lines.

Figure 3 shows the influence of continuous grazing on the relative DM-production potential (kg $DM.ha^{-1}$) of the different lucerne and lines. The first results of the relative DM-production (kg $DM.ha^{-1}$) under continuous grazing were measured on 23 September 1998, roughly 6 months after the commencement of continuous grazing. The second measurement was taken on 22 July 1999. It is common knowledge that the relative dry matter production potential of lucerne cultivars and lines is correlated with the degree of winter dormancy. These two measurements do not take this aspect into consideration. The timing of the first and second measurement of DM-production (kg $DM.ha^{-1}$) of figure 3 (continuous grazing) corresponds with the seasonal DM-production of figure 2 (rotational grazing) in aspect of cut 3 and 10. These two figures (2 & 3) show clearly that cultivars and lines over both measurements commonly performed weaker under continuous grazing in comparison with performance of the same cultivar or line under rotational grazing. The measuring of at least 4 per season (autumn, winter, spring and summer) per annum, in the middle of each season with replicates over both cycles (continuous vs. rotational) would have been more appropriate. Another, even more scientifically correct method would be to have, for every 6-weekly cut under rotational grazing, a corresponding cut under continuous grazing. In this instance, the sampling procedure should include an excluding plot.

Figure 5 shows the influence of rotational grazing on the plant density (%$plants.m^{-2}$) of the different lucerne cultivars and lines over the period August 1998 to February 2000. At the 3-monthly intervals 6-9 and 18 – 21months after grazing commenced, there was an increase in plant density (%$plants.m^{-2}$) of some cultivars under rotational grazing. There are two factors which caused this increase. Firstly the counts were not made on the same spot. Secondly, the summer of 1998 was very dry, with the result that some plants showed no regrowth and were counted as dead. The combination of figures 2 and 4 (figure 5) shows that, under rotational grazing, there exists a negative correlation between plant density (%$plants.m^{-2}$) and the seasonal dry matter production (kg $DM.ha^{-2}$), especially with cultivar CUF. It is possible that CUF has the ability to compensate for a low plant density by increased tillering. To be able to understand this strange result, a more detailed investigation into the data would be necessary.

Figure 6 shows the influence of continuous grazing on the plant density (%plants.m^{-2}) of the different lucerne cultivars and lines over the period August 1998 to February 2000. At the 3-monthly intervals 6-9 and 18 – 21 months after commencing grazing, there was an increase in plant density (%plants.m^{-2}) of some cultivars under continuous grazing. Reasons for this variations may again be attributed to the fact that the counts were not made in the exact same spot and also the influence of the dry summer of 1998. With the exception of cultivar CUF 101, all lucerne cultivars and lines showed a higher plant density (%plants.m^{-2}) than SA Standard. CUF 101 is highly winter active which means that the cultivar's root crown is carried much higher that the other winter dormant types, which is why CUF 101 is much more sensitive to grazing, especially during the winter. That is the reason why CUF 101 is exclusively used for the production of hay.

Figure 7 (the combination of figures 4 and 6) shows that the plant density of lucerne cultivars and lines declines more rapidly under continuous grazing (after about 12 months) in comparison to rotational grazing (after about 18 months). Furthermore, during the experimental period the plant density (%plants.m^{-2}) of all the cultivars and lines was higher under rotational than continuous grazing.

Results

Under the same stocking rate (sheep/ha/year) the following results were achieved:

- There were cultivar differences between continuous and rotational grazing

- The seasonal DM-production (kg DM.ha^{-1})of lucerne cultivars and lines appeared visually more abundant under rotational than under continuous grazing .

- Continuous grazing caused the plant density to recline much quicker than rotational grazing.
- At any stage of the experiment (3 to 21 months after grazing commenced) lucerne cultivars and lines had a lower plant density under continuous compared to rotational grazing.

Compared to rotational grazing, continuous grazing under the same stocking rate had a negative influence on the longevity of dry land lucerne pastures in the Southern Cape.

Aspects to be given attention to for further grazing tolerance trials in the Southern Cape

The determination of relative production potential (kg $DM.ha^{-1}$) of lucerne cultivars and lines under continuous grazing did not take into account the aspect of winter dormancy (see discussion of results).

Lucerne pastures in the Southern Cape under continuous grazing usually get a resting period the moment additional camps become available in the form of crop residues used for grazing. In this experiment this aspect was not taken into consideration.

In case this trial should be repeated, these aspects should be considered. Stocking rate is also an important factor that should be included. Contact should be made with pasture- and other researchers, extension officers, as well as producers from the specific area so that reference to all factors influencing the longevity of the pastures can be taken into consideration in the shortest possible time.

Plant density is a guideline for the grazing tolerance of lucerne cultivars. It is also important to consider the production potential of the cultivars under grazing so that management can incorporate any limitations of the pasture or crop into the system. There is no sense in advising cultivars that survive under high stocking rate but cannot produce sufficient fodder for sustainable, economically viable animal production.

ROTATIONAL GRAZING

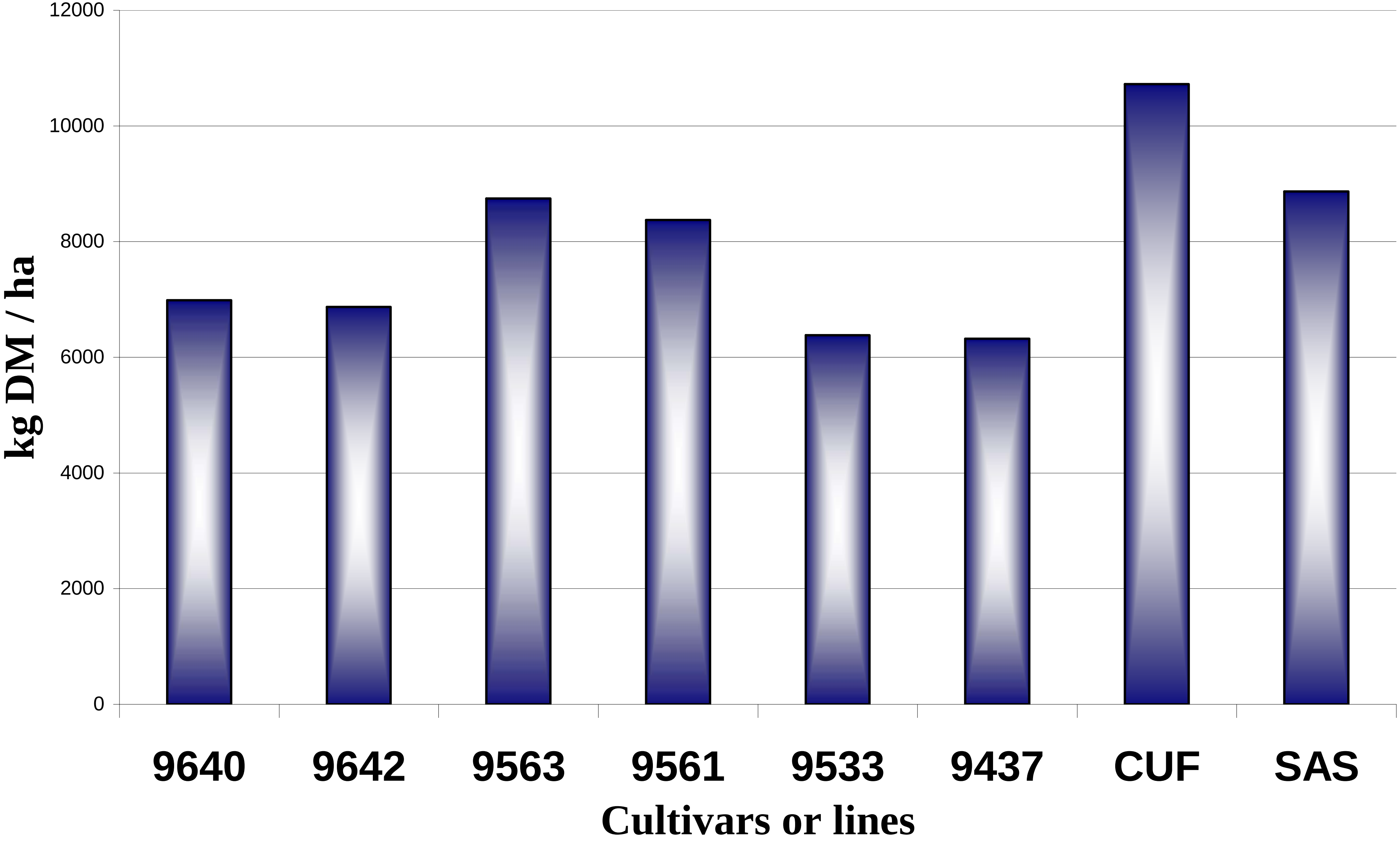


Figure 1 : The effect of rotational grazing on the total dry matter yield (kg DM / ha) of various lucern cultivars and /or lines (April 1998-Mei 2000).

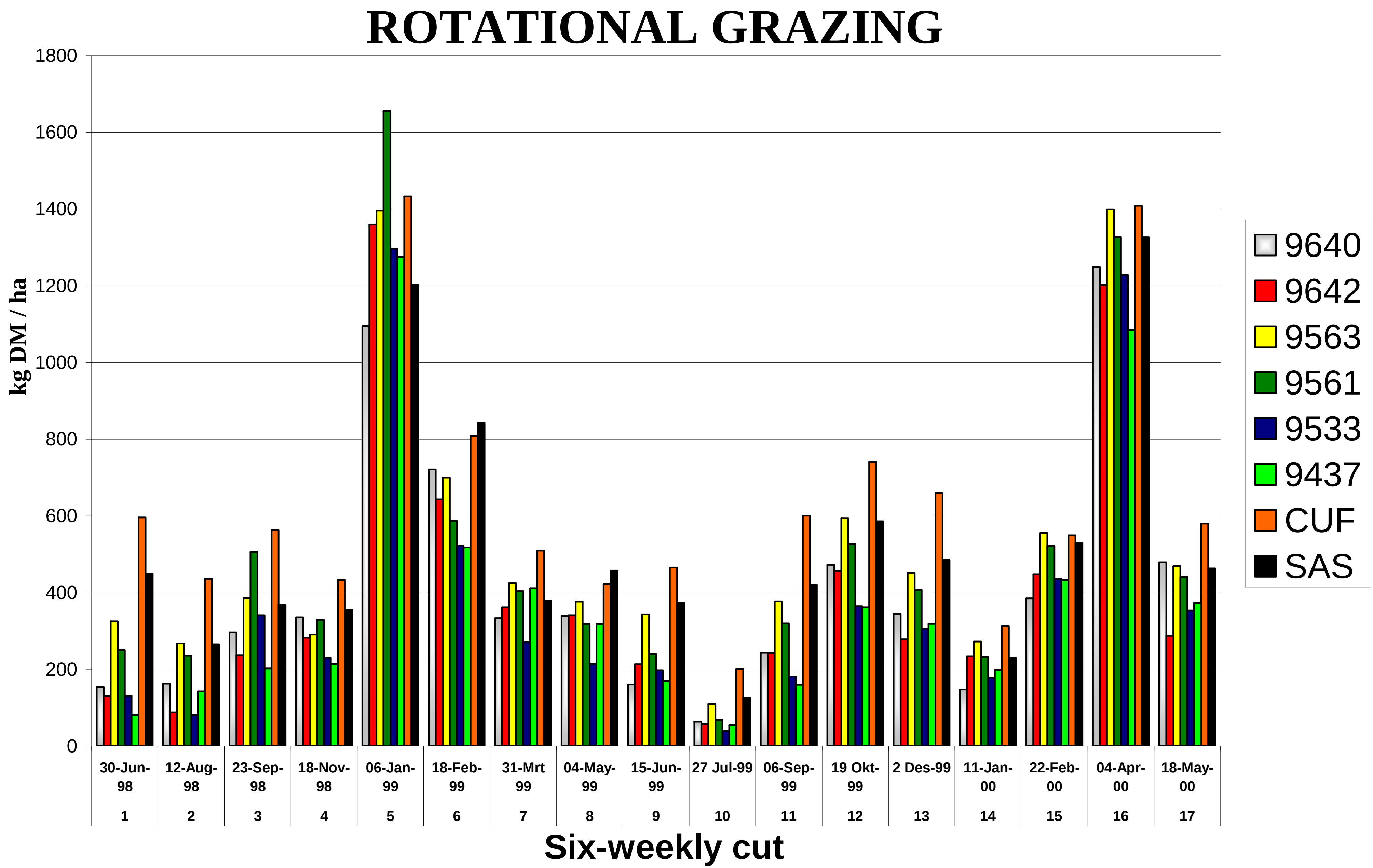
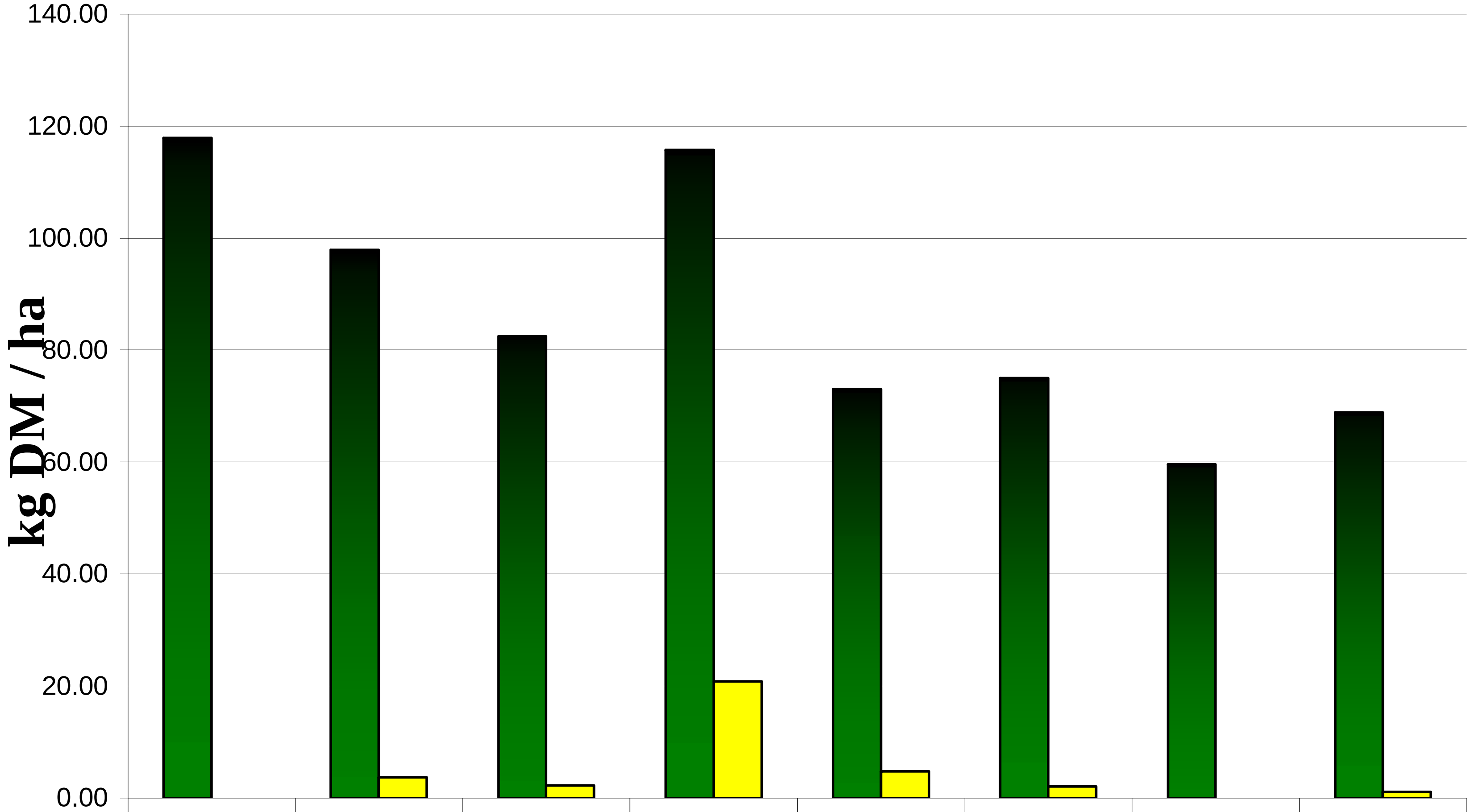


Figure 2 : The influence of rotational grazing on the seasonal drymatterproduction (kg DM / ha) of different lucern cultivars and lines (April 1998-May 2000).

CONTINUOUS GRAZING



	9640	9642	9563	9561	9533	9437	CUF	SAS
Measurement 1 (23 Sept 1998)	117.91	97.88	82.50	115.75	73.00	75.01	59.63	68.88
Measurement 2 (22 July 1999)	0.00	3.66	2.25	20.81	4.78	2.05	0.00	1.00

Cultivars of Lines

Figure 3 : The influence of continuous grazing on the relativedrymatterproduction (kg DM / ha) of different lucern cultivars and lines(23 Sept. 1998 and 22 July 1999).

CONTINUOUS vs ROTATIONAL GRAZING

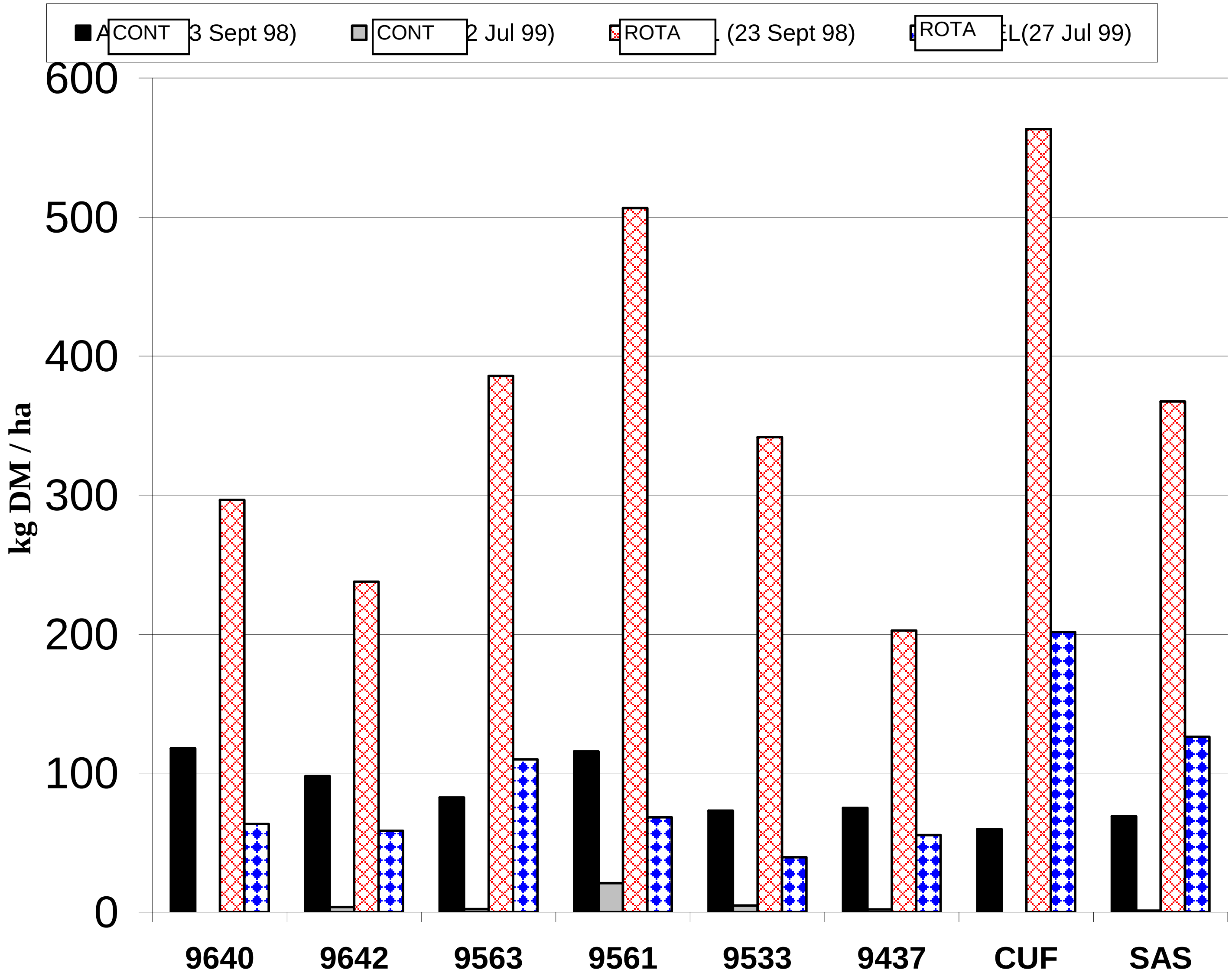


Figure 4 : The influence of continuous and rotational grazing on the relative drymatterproduction (kg DM / ha) of different lucern cultivars and lines.

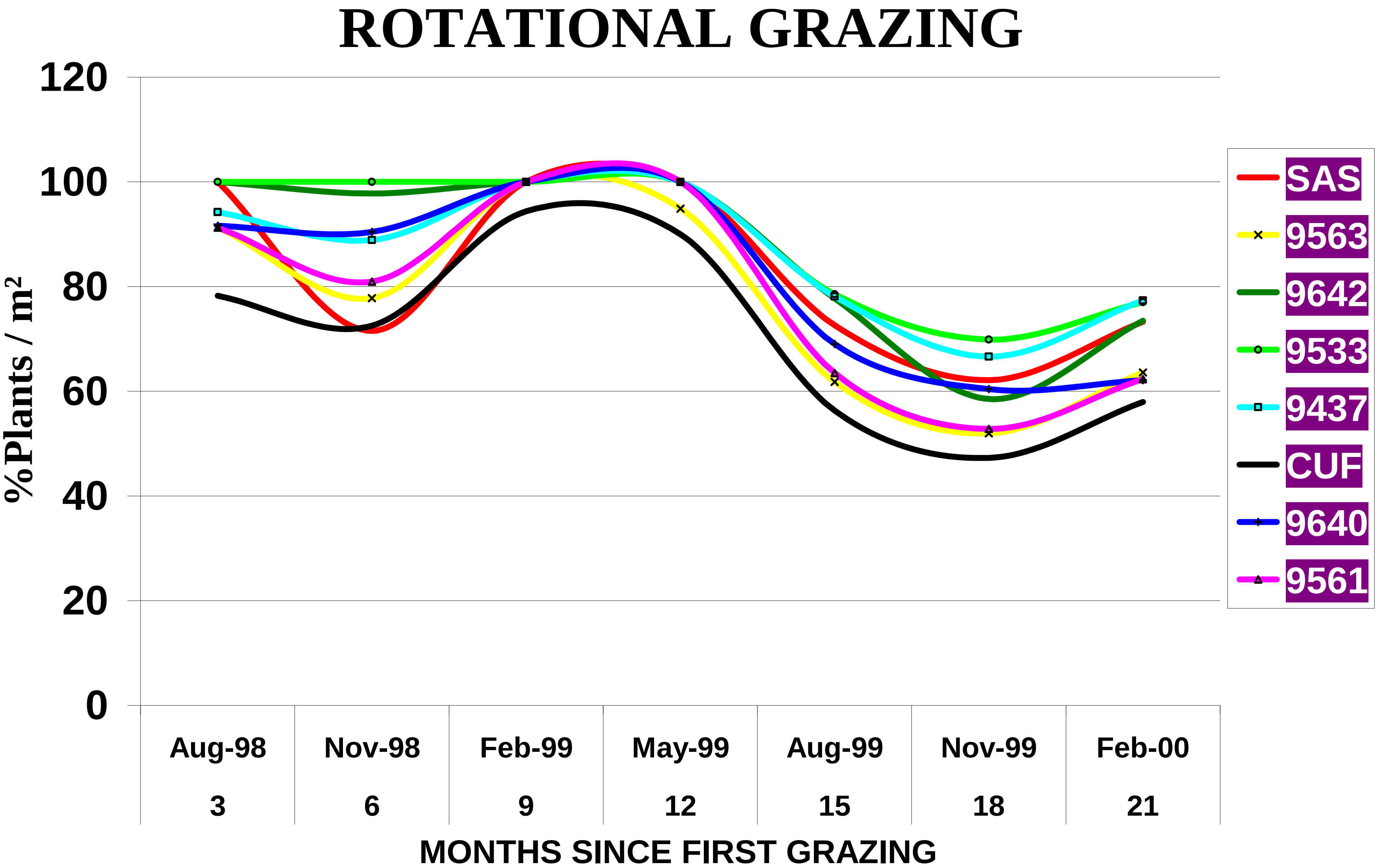


Figure 5 : The influence of rotational grazing on plantdensity (%Plante per sqm) of different lucern cultivars and lines.

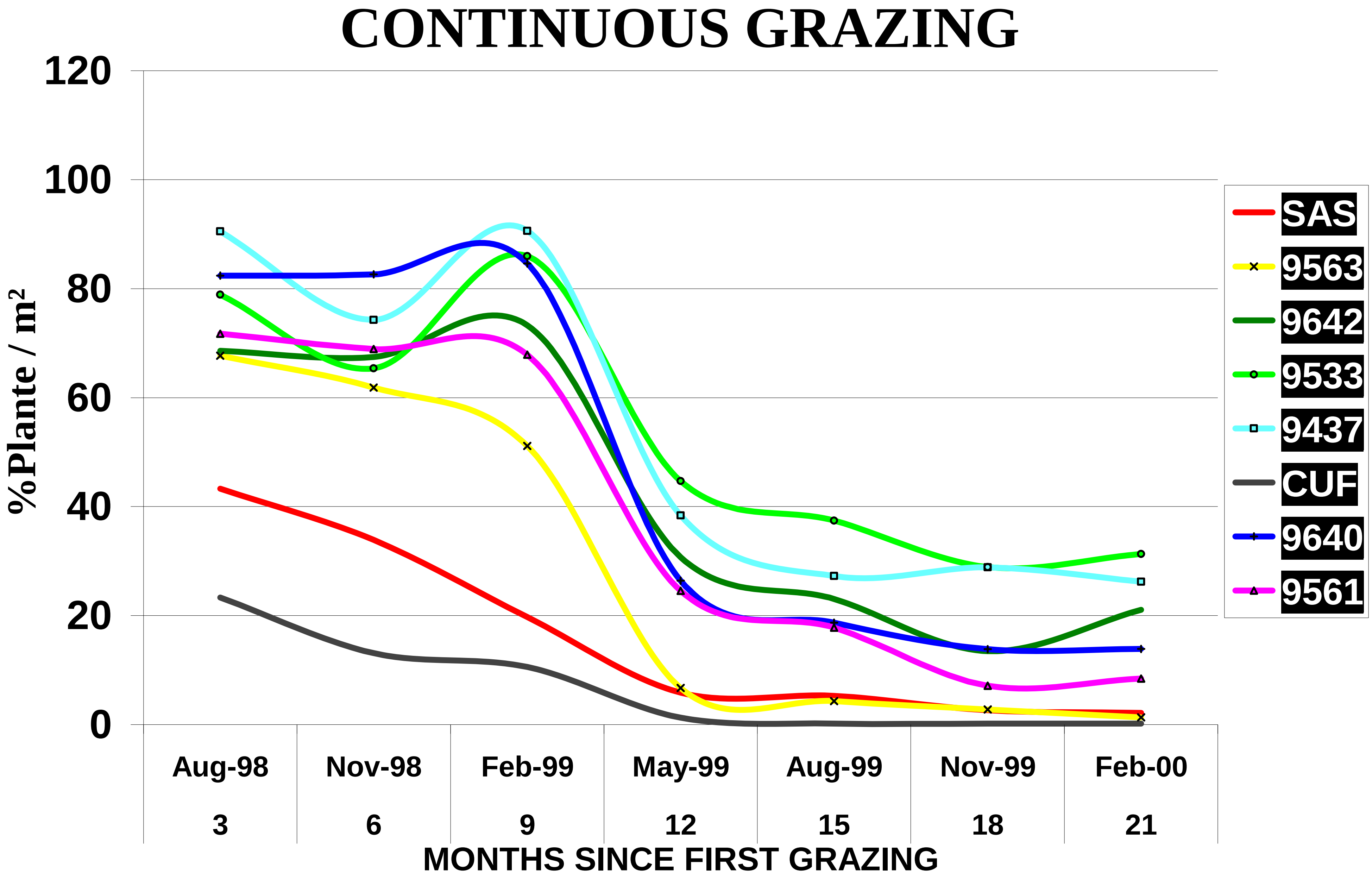


Figure 6 : The influence of continuous grazing on plantdensity (%Plante per sqm) of different lucern cultivars and lines.

ROTATIONAL VS CONTINUOUS GRAZING

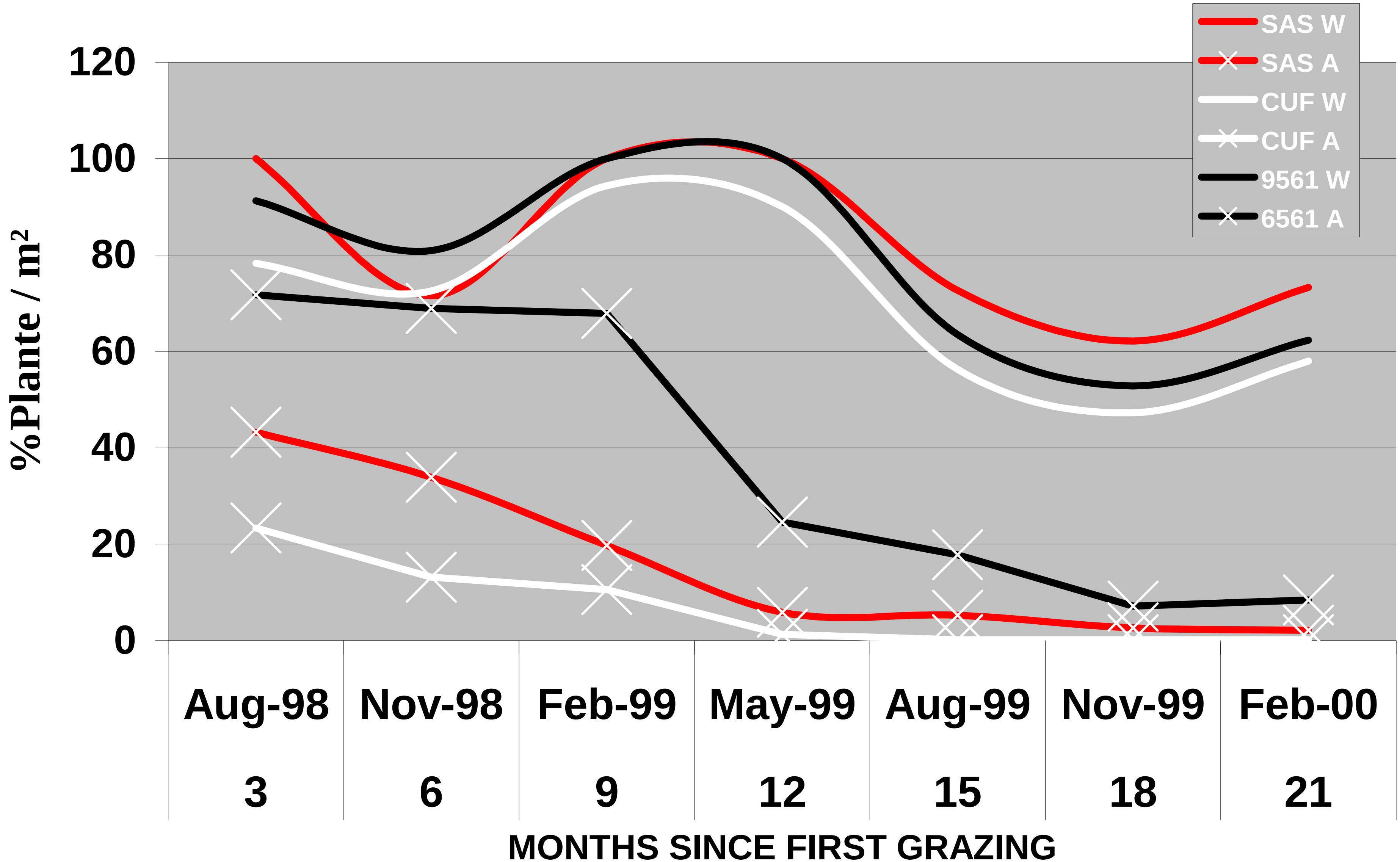


Figure 7 : The influence of rotational grazing on plantdensity (%Plante per sqm) of different lucern cultivars and lines.

The restoration of bare patches in the Karoo: an evaluation of various techniques.

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Introduction

The Great Karoo is an arid to semi-arid region of the inland, central and western parts of South Africa with an average annual rainfall of 100-600 mm increasing from the west to the east. Bare patches cover large areas of the Great Karoo. The surface soil of these bare patches is severely compacted, limiting moisture penetration. Perennial plants are rarely found in these areas (Louw 1992).

The development of large bare patches is usually the result of degradation processes, mainly severe overgrazing and patch selection (Kellner & Bosch 1992). Severe drought may also initiate the formation of such bare patches. The degradation of semi-arid regions may be rapid, but the recovery is slow due to low and variable rainfall, physical limitations to increasing soil moisture and depleted soil seed banks (Van der Merwe & Kellner 1999; Wiegand, Milton & Wissel 1995; Call & Roundy 1991; Yeaton & Esler 1990).

The objective of this study was to identify and evaluate suitable methods for the revegetation of bare patches in the Karoo.

Study site

A bare patch, covering an area of approximately 100 ha, on the farm Hillmore near Beaufort West, was chosen as the study site. Hillmore is situated south east of Beaufort West and receives an average annual rainfall of 190 mm. The annual rainfall during the study period was 364 mm. The soils are clayey loam, with a very low organic carbon content of 0.2 %. However soil nutrient status is high, with sodium 60 mg/kg, phosphorous at 159 mg/kg and potassium 430 mg/kg.

Methods

Six different treatments were applied during November 1999. A randomised block design was followed in this study. The treatments were:

1) No treatment (Control) (C)
2) Oversowing (S)
3) Oversowing and covering with branches (SB)
4) Tilled to a depth of 100 mm (T)
5) Tilled and seed (TS)
6) Tilled, seed and branches (TSB)

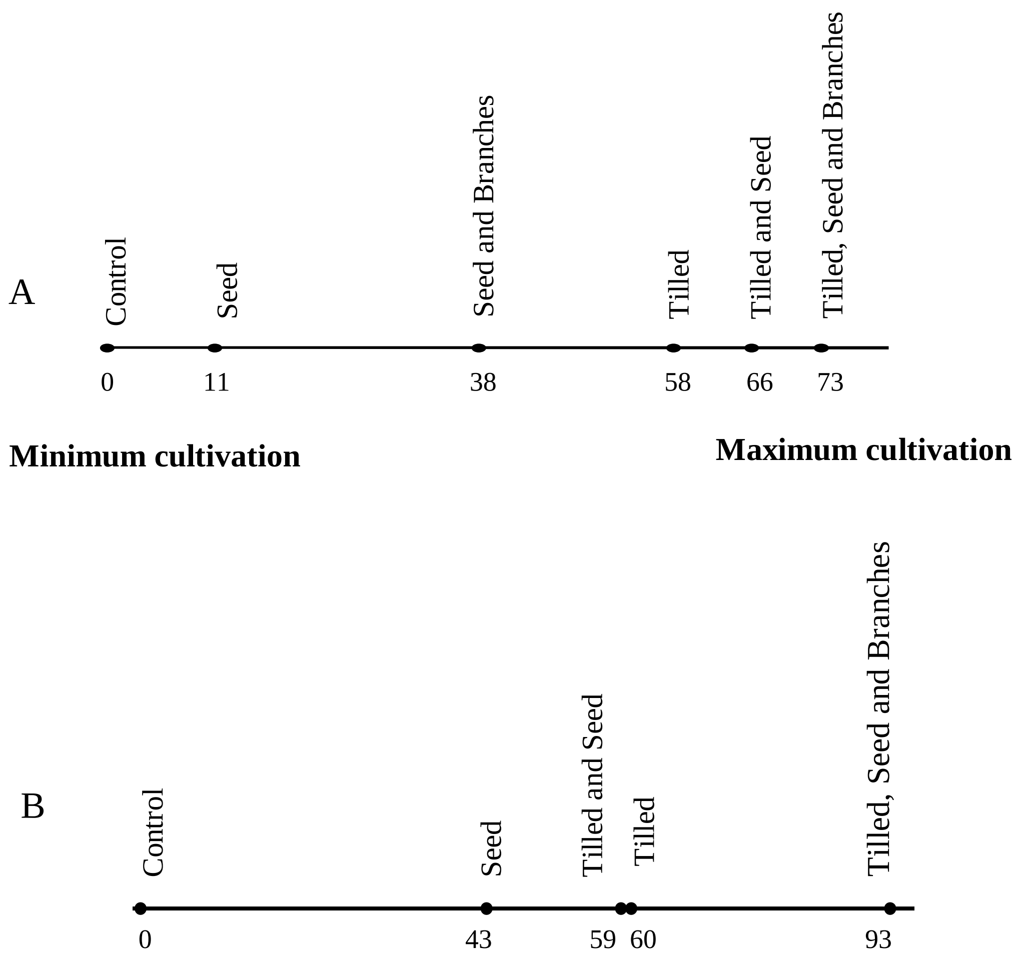
Each of these treatments was applied in 20x20 m plots with 5 replications. Branches of nearby *Acacia karroo* trees were used for covering the necessary plots. A total of 15 kg seed/ha was broadcast onto the soil surface, after the tillage treatment had been applied, using a seed mixture comprising *Atriplex semibaccata*, *Cenchrus ciliaris*, *Chaetobromus dregeanus, Pteronia membranacea* and *Tripteris sinuatum*. All these seeds were obtained from the Worcester Veld Reserve.

Botanical composition (frequency data) was determined for each treatment plot during surveys conducted in July and November 2000. Ten quadrants of 1x2 m were placed in each plot and all the plants were counted and distinguished between reproductive and vegetative plants and seedlings on species level.

The data was statistically analysed using Two-way ANOVA, student-t tests and polar ordination.

Results and Discussion

Polar ordination of the data set (Figure 1) shows that the control and the TSB treatments had the smallest similarity in species composition following both the July and November botanical surveys. The greater the disturbance applied the greater the similarity in species composition among treatments. The SB-treatment of



November was not included because it is an outlier.

Figure 1: Polar ordination of the species composition of the different treatments in (A) July and (B) November 2000.

The most common species in July and November include *Pentzia incana* and *Chaetobromus dregeanus, Lepidium africanum, Salsola calluna, Othonna sedifolia, Tagetes minuta, Atriplex lindleyi, Tripteris sinuata, Salsola kali, Sonchus oleraceus*. There were 49 different species present in July in the different plots and 30 different species in November. The soil seed bank consists of mainly annual weeds of which *Gnaphalium pensylvanicum,* was the most common (Table 1).

Table 1: Species present in the soil seed bank on Hillmore

Species	**Hillmore**
Lepidium bonariense	*
Hypochoeris radicata	*
Salvia sp.	**
Gnaphalium pensylvanicum	***
Gazania sp.	*
Oxalis sp	*
Creeping plant (maroon)	**
Species 1	*
Species 2	***
Species 3	*

*** Many individuals

** Few individuals

* Very few individuals

The oversown species that show the best germination were *Chaetobromus dregeanus* and *Tripteris sinuatum*, although their numbers declined from July to November 2000. The best germination results were found in the TS and TSB treatments (Figure 2).

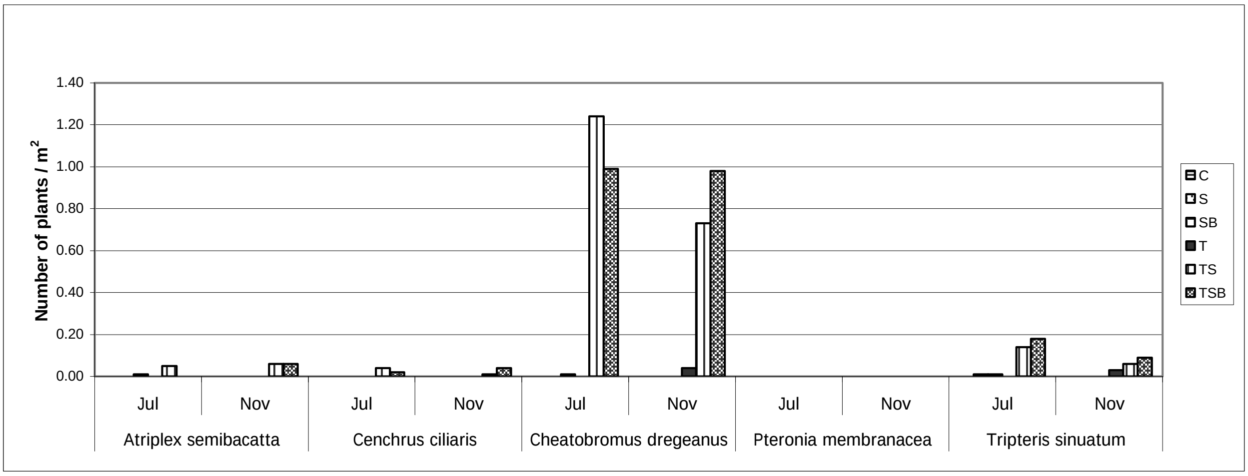


Figure 2: The density of the oversown species in the different treatments in July and November 2000.

The Tilled-Seed-and-Branches treatment was the most successful, but also the most expensive (Esler & Kellner 2001). Tilled-and-Seed treatment was almost as successful, but will be much cheaper to apply, since it is not so labour intensive.

Conclusion

From the treatments applied in this study bare patches in the Karoo can be successfully revegetated. Success depends on ensuring either

1) severe mechanical disturbance of the soil (cultivation of furrows to a depth of at least 100 mm) to increase water infiltration; or
2) the provision of physical barriers (such as tree branches) to
    * slow water movement across the soil surface,
    * limit the effects of raindrops impact,
    * reduce soil temperature, and
    * act as a “catch” for wind-blown seed and organic matter or both.
3) In addition viable seed of desirable species must be introduced where seed banks have been depleted.

Seeds of pioneer species such as *P. incana, Aridaria* spp. and *Galenia* spp. can also be oversown to provide a soil cover and a microhabitat for sub-climax and climax species, like *C. dregeanus* and *T. sinuatum* to establish in.

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