# 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.

<u>Procedures:</u>

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 | 39.0 | 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.

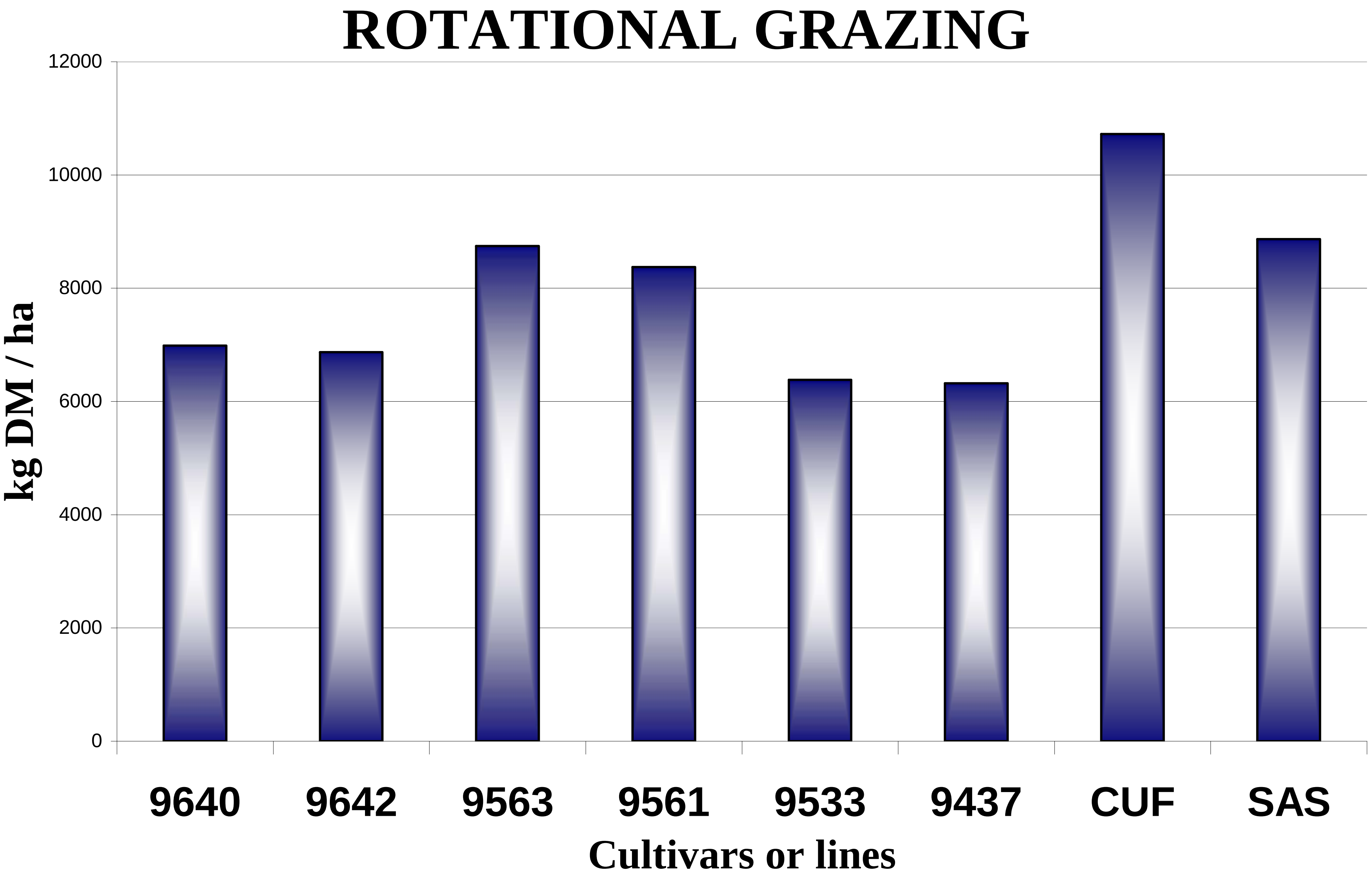



**Figure 1 :  The effect of rotational grazing on the total dry matter yield (kg DM / ha) of various lucern cultivars and /or lines (April 1998-Mei 2000).**

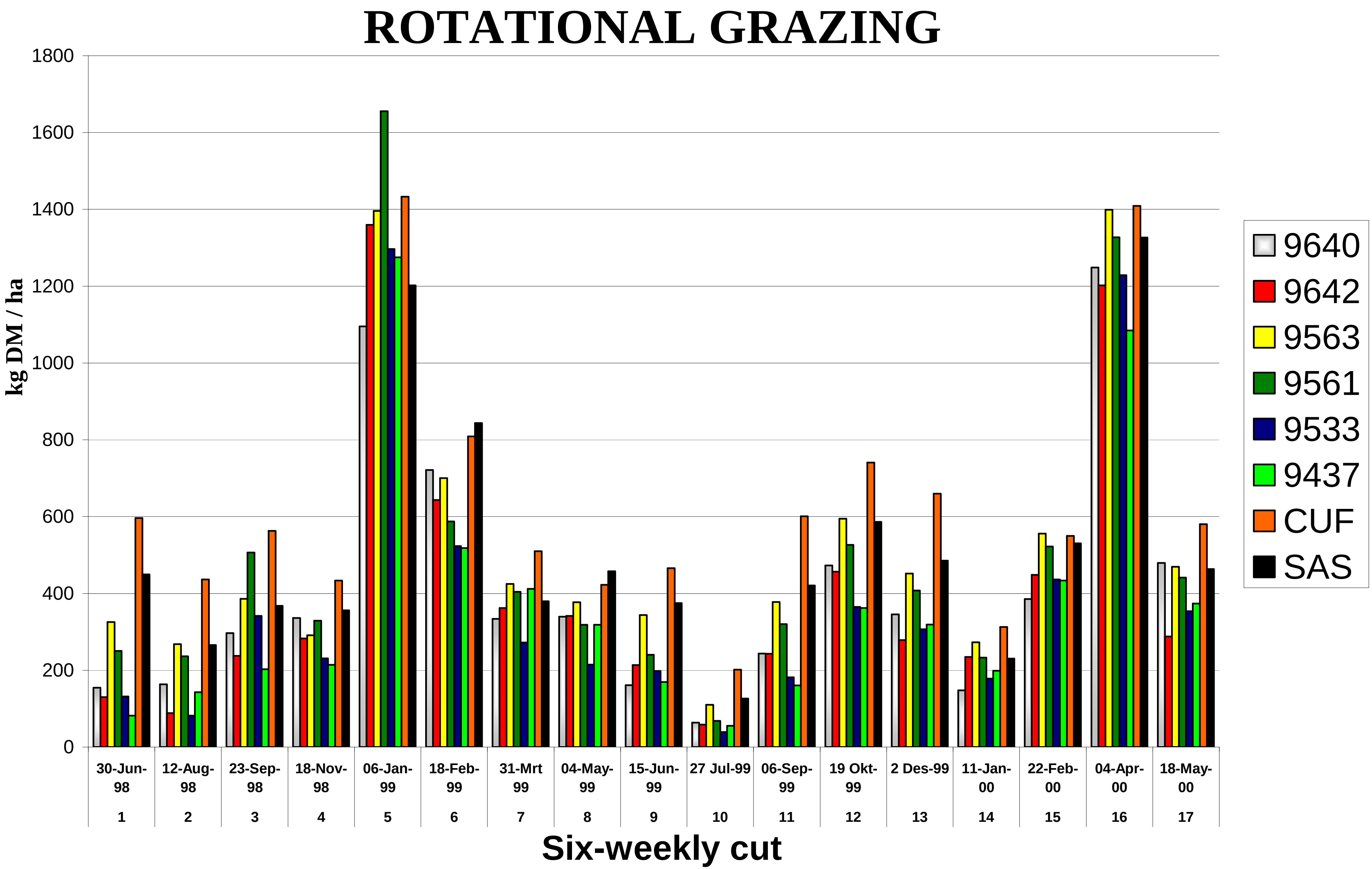
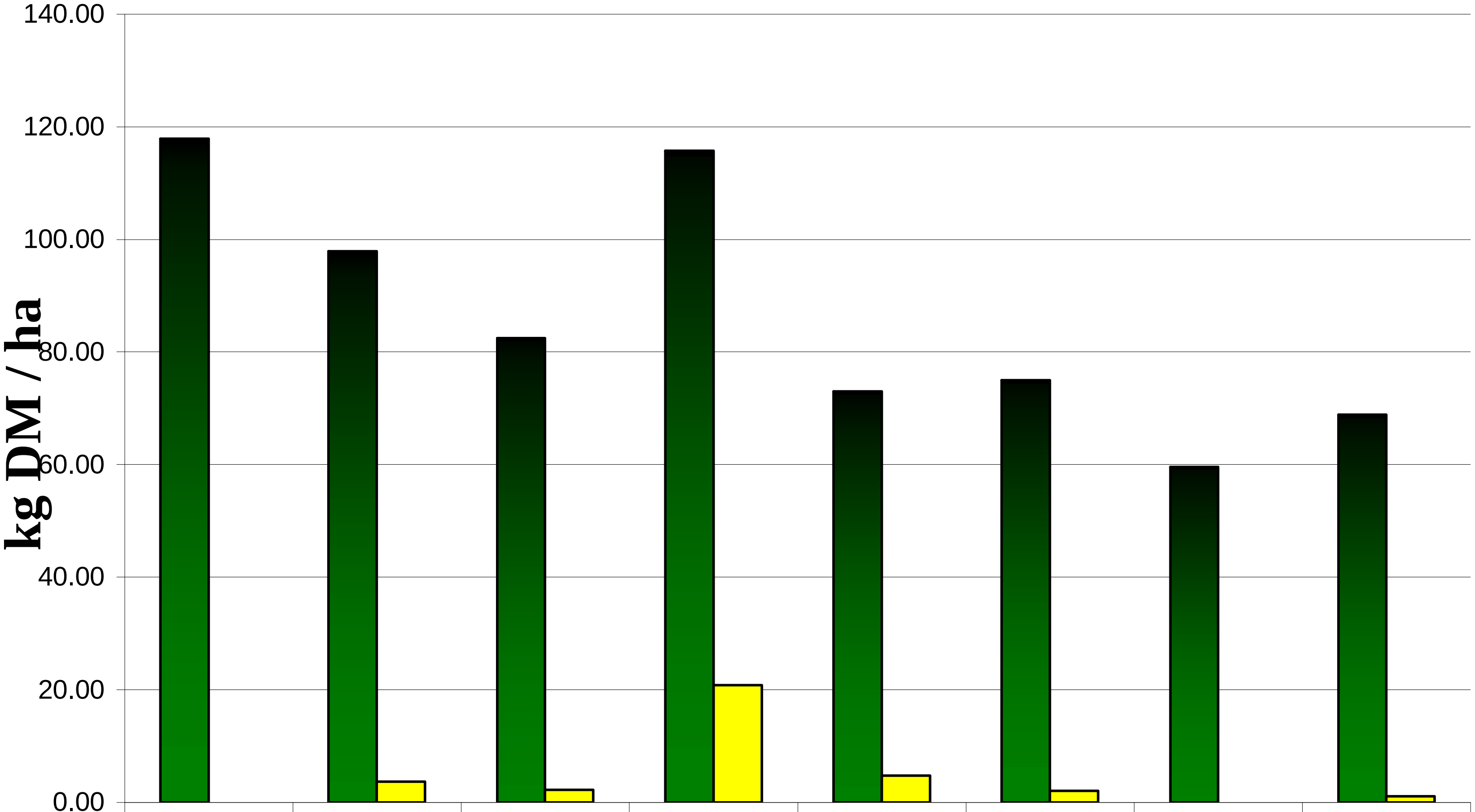



**Figure 2 : The influence of rotational grazing on the seasonal drymatterproduction (kg DM / ha) of different lucern cultivars and lines (April 1998-May 2000).**

# 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

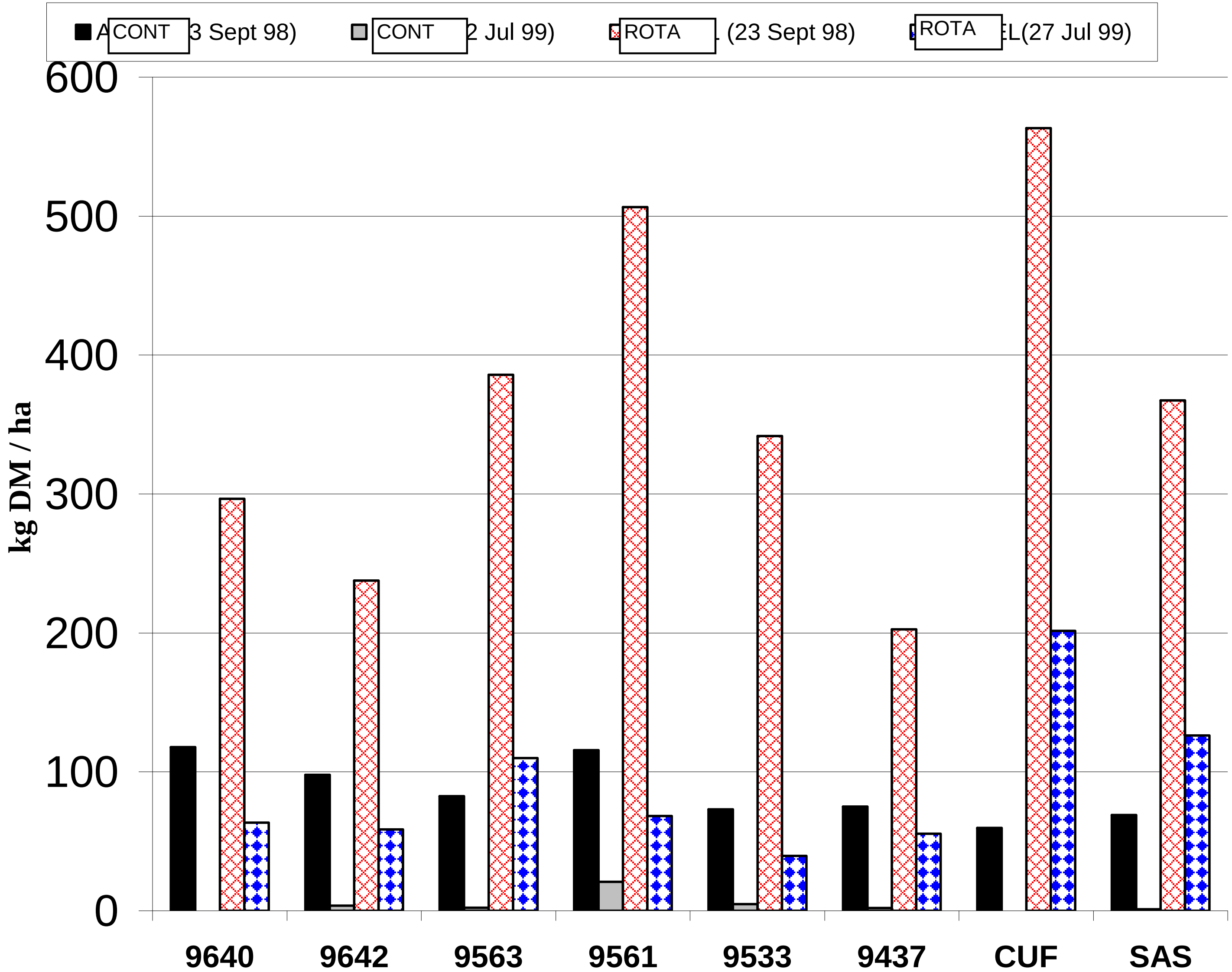



**Figure 4 : The influence of continuous and rotational grazing on the relative drymatterproduction (kg DM / ha) of different lucern cultivars and lines.**

# ROTATIONAL GRAZING

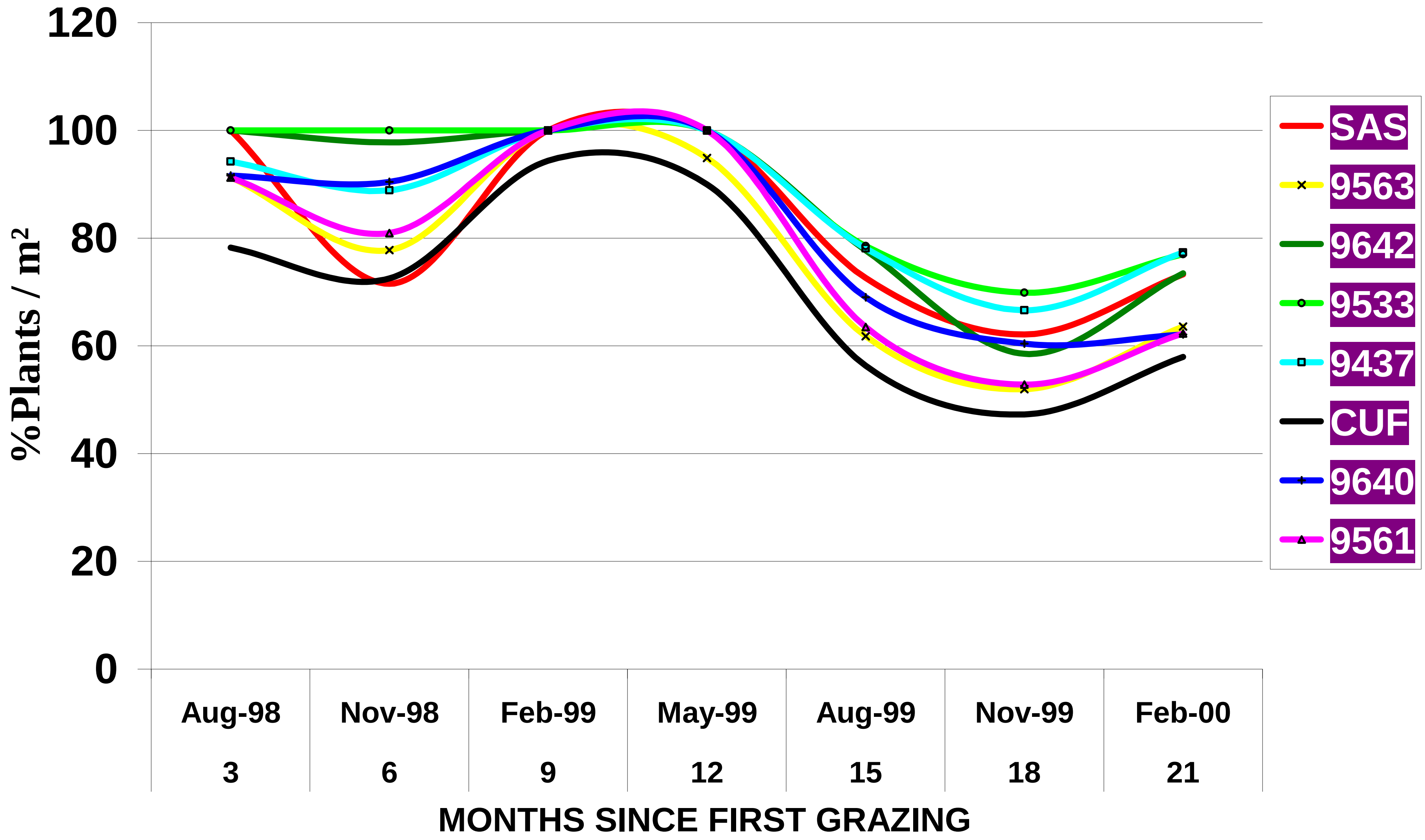



**Figure 5 : The influence of rotational grazing on plantdensity (%Plante per sqm) of different lucern cultivars and lines.**

# CONTINUOUS GRAZING

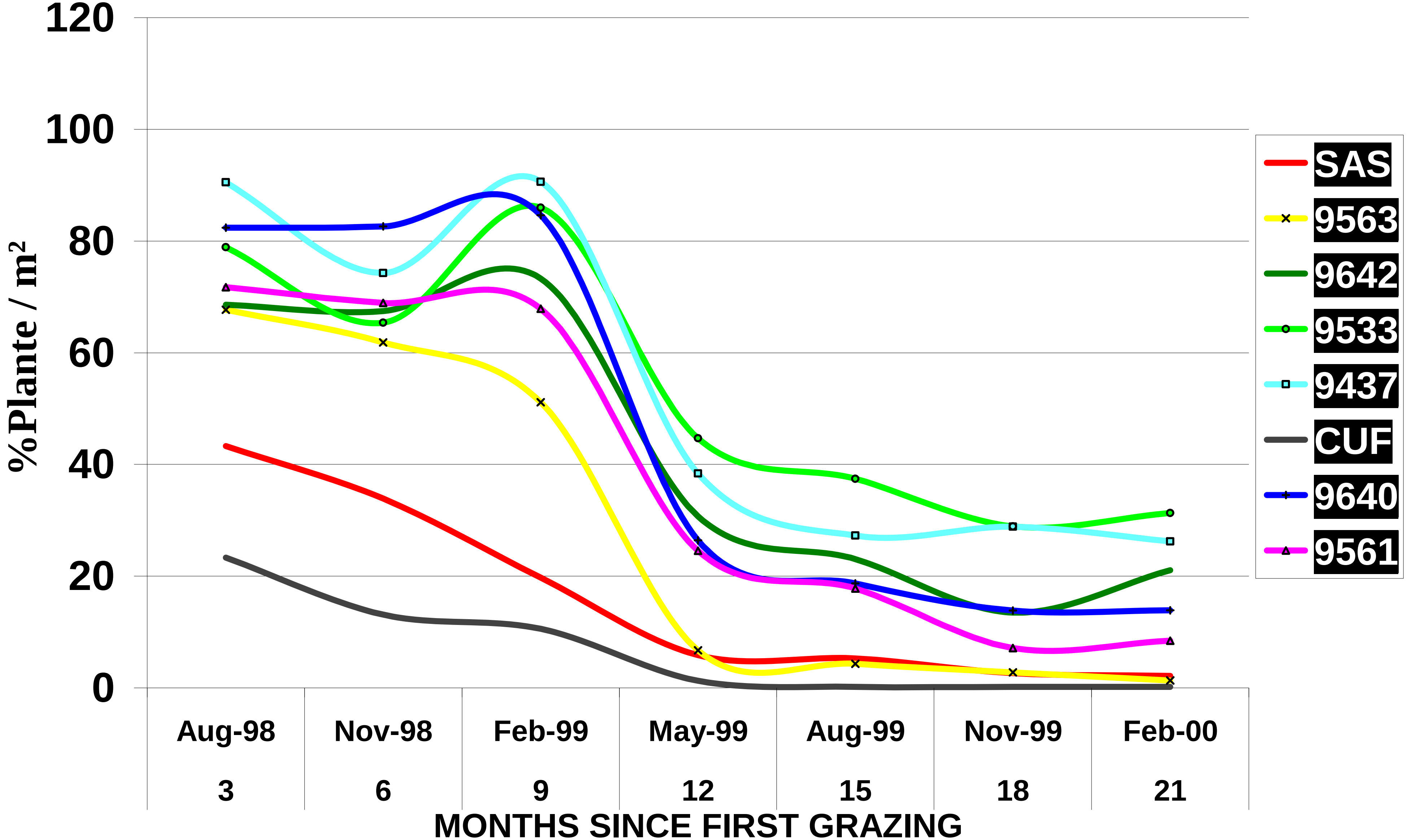



Figure 6 : The influence of continuous grazing on plantdensity (%Plante per sqm) of different lucern cultivars and lines.

# ROTATIONAL VS CONTINUOUS GRAZING

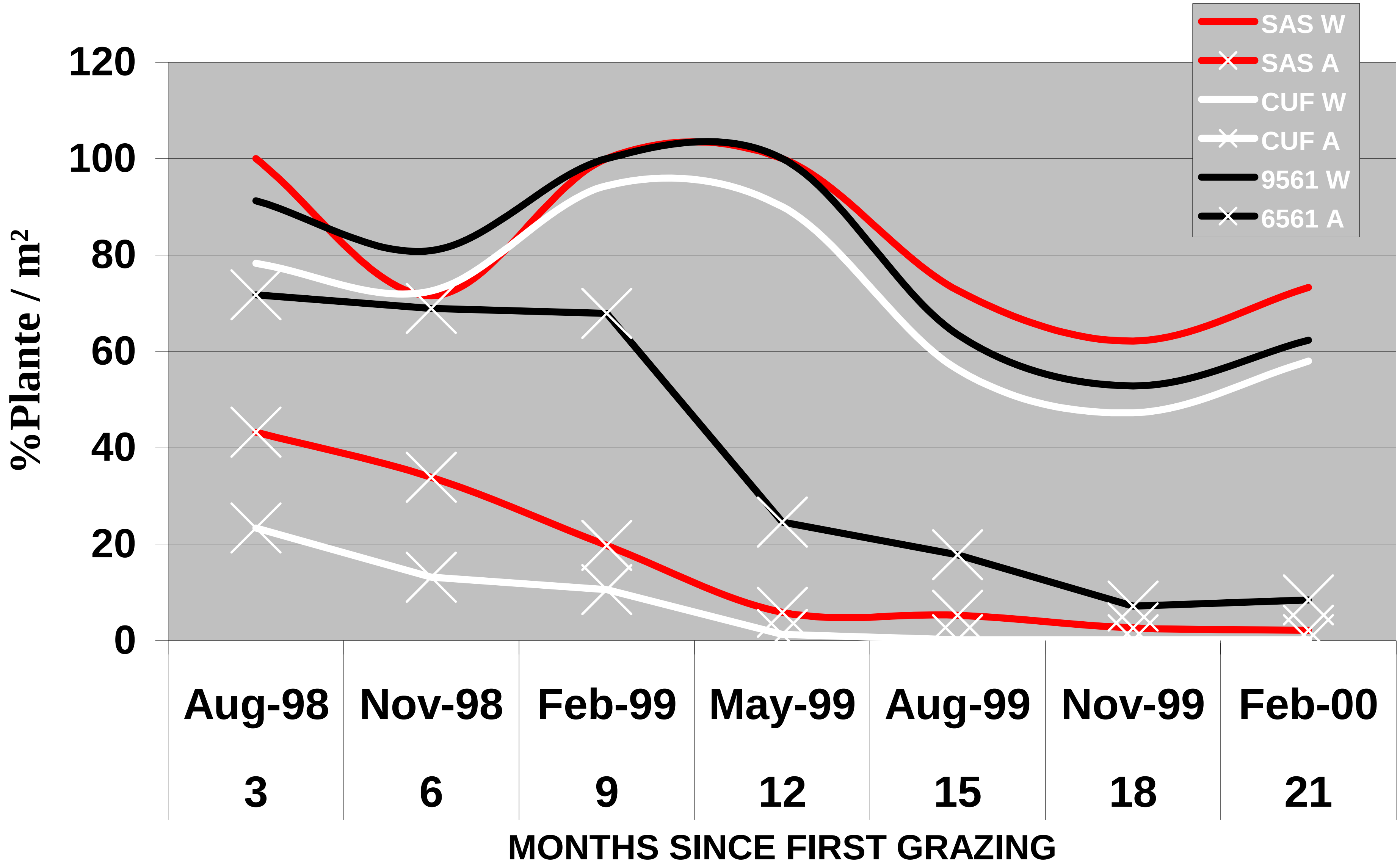



Figure 7 : The influence of rotational grazing on plantdensity (%Plante per sqm) of different lucern cultivars and lines.