第 21 卷第 7 期
2001 年 7 月

生 态 学 报
ACTA ECOLOGICA SINICA

Vol. 21, No. 7
Jul., 2001

亚热带山地草地退化系列上种群更新研究

苏德毕力格[1],萨 仁[2],周 禾[1],王 培[1]

(1. 中国农业大学草地研究所,北京 100094;2. 中国科学院植物研究所标本馆,北京 100093)

摘要:从种子库、幼苗和种子雨等方面对亚热带山地草地退化系列上 5 种植物的种群更新进行了研究。结果表明:(1)引入种多年生黑麦草(*Lolium perenne*)和白三叶(*Trifolium repens*)种群在轻度和中度退化条件下能够正常更新,但不能忍受草地进一步的退化;(2)本地种对草地退化的胁迫表现出较强的承受能力。簇生卷耳(*Cerastium caespitosum*)、箭叶蓼(*Polygonum sagittatum*)和华蒲公英(*Taraxacum sinicum*)的种群更新分别在中度、重度和极度退化草地上处于最佳状态;(3)若要防治草地退化,就应当在引入种的种群更新受到抑制时采取有效措施。

关键词:亚热带;草地退化;种群更新.

Study on regeneration of species in a subtropical pasture undergoing retrogression process

H. Sudebilige[1], Saren[2], ZHOU He[1], WANG Pei[1] (1. *Grassland Research Institute of China Agricultural University, Beijng* 100094; 2. *Herbarium, Institute of Botany, Chinese Academy of Sciences, Beijing* 100093, *China*)

Abstract: Seed bank, seedling recruitment and seed production of five prevalent species were studied along a degradation series on a subtropical mountain pasture. Results showed that (1). exotic species *Trifolium repens* and *Lolium perenne* regenerated themselves successfully at light and moderate degradation sites, but could not tolerate further deterioration of the pasture. (2). native species showed a great resistance to the stress of pasture deterioration. *Cerastium caespitosum* were predominant in seed bank, seedlings and seed production at moderate and heavy deterioration sites, while *Poligonum sagittatum* and *Taraxacum sinicum* were at heavy and extreme deterioration sites, respectively. (3). to control pasture deterioration and retain high level of pasture productivity, proper and effective measures should be implemented as soon as a reduction is detected in regeneration ability of the introduced species.

Key words: subtropical; pasture; regeneration

文章编号:1000-0933(2001)07-1104-05 **中图分类号**:Q948 **文献标识码**:A

1 Introduction

Study on regeneration process of species is important for understanding of vegetation dynamic[1~5]. Information about seed rain, seed bank and seedling recruitment of key species is vital to reveal succession mechanism of a community. Subtropical sown pastures that were established in the late 1970s at Nanshan Farm of Hu′nan Province are now undergoing retrogression[6,7]. Increasing spread of weed species and diminishing productivity and cover of the pasture have posed a big threat to natural environment and livelihood of local people. Several causes may account for the phenomenon, among them the role of population regeneration is one of the most important but less studied aspect of the issue. In this paper, variation in seed rain, seed bank and seedling recruitment of five key species of the region were studied across the pastures with deferent level of deterioration, and the dauses and effects of the variation in regeneration ability

基金项目:农业部科技基金项目

收稿日期:1999-04-09;**修订日期**:2000-03-10

作者简介:苏德毕力格(1972~),男,蒙,内蒙古赤峰人,博士,副研究员。主要从事植物生态学研究。

of species were also discussed.

2 Materials and Methods

2.1 Study Site

Research area lays at northwest edge of the Nan Ling mountain ridge, 25°48′～25°58′N110°26′～110°40′E, elevation 1278～1946m. Mean monthly temperature varies between −1.9℃ and 23.5℃ with an average of 11.9℃; annual precipitation is around 1648mm. In topography, the region is a hilly land with gentle undulation, and angles of the slopes seldom exceed 30°. The soil at the site is predominantly yellow.

Natural vegetation is mountain grassland that is composed mainly of Gramineae species. The grazing animal of the region is cow. In the late 1970s, some exotic herbs, such as clover and ryegrass etc., were introduced into the region to increase productivity of the grassland, and the species have been well adapted to the area. However, due to improper management and the extensive use of grassland resources aroused by growing number of population and livestock, the established pastures have been deteriorated rapidly in recent years. Four plots with different levels of deterioration were selected with respect to vegetation cover and composition, and named light, moderate, heavy and extreme deterioration sites respectively. The plots were about 1 km away from one another, and have similar slope direction and angle. Abbreviations LD, MD, HD and ED will be used in the following text to represent the light, moderate, heavy and extreme deterioration sites, respectively.

2.2 Seed bank

Sixteen soil cores, 25cm^2 and 5cm deep, were taken randomly at each of the four sites in Sept. 10th, 1997(after the seed rain). Being devoid of root and stem remnant using a sieve with mesh size of 5mm, soil samples were stored in paper bags and transported to laboratory.

2.3 Germination test

After being stored at low temperature for a period, the soil samples were spread thinly in separate glass trays and placed in a Artificial Climate Chamber where soil moisture, air temperature and light can be regulated to simulate the natural condition of the study site. Two months later, each soil sample was moved into a plastic tray which contains sterilized sand base of 5cm thick, to make sure the seedlings grow large enough to be identified.

2.4 Seedling recruitment

Thirty two bare land patches created by livestock trampling were randomly selected on each sites and a quadrate of 12.5×12.5cm^2 was located on each patch in April 10th, 1998. The seedlings emerged from the quadrates were recorded one month later.

2.5 Seed production

Just before the beginning of the seed rain of a species, 16 quadrates of 25×25cm^2 were located on each sites to collect and calculate seeds of the species.

2.6 Statistical analysis

Differences in seed bank, seedlings and seed production among the four sites were analyzed using ANOVA. Effects of soil properties on the pasture begradation were analyzed by canonical correspondence analysis(CCA).

3 Results

3.1 Seed bank

Seed bank of introduced species *Trifolium repens* and *Lolium perenne* were largest at moderate deterioration site, and then decreased significantly with increasing degradation of the pasture. Seed bank of native species *Cerastium caespitosum*, *Polygonum sagittatum* and *Taraxacum sinicum* were largest at moderate,

heavy and extreme deterioration sites, respectively (Fig. 1). Seed bank sizes of the five species vary significantly across the four sites ($p<0.01$).

3.2 Seedling recruitment

The densities of seedlings were highest at moderate site for *T. repens* and *L. perenne*, while the highest seedling densities for *C. caespitosum*, *P. sagittatum* and *T. sinicum* were observed at moerate, heavy and extreme deterioration sites, respectively. The variation trend of each species in seedling density was similar to that of its seed bank, and the difference in seedling density of each species was also significant among the four sites ($p<0.01$).

3.3 Seed production

Seed productions of *L. perenne* were 23.56 sample^{-1} and 24.81 sample^{-1} at LD and MD sites, respectively; however, the quantity of the seed production fell sharply with further deterioration of the pasture. As for *T. repens*, highest seed production was detected at havy deterioration site (56.75 sample^{-1}), but very small seed production was observed at extreme deterioration site (Fig. 1).

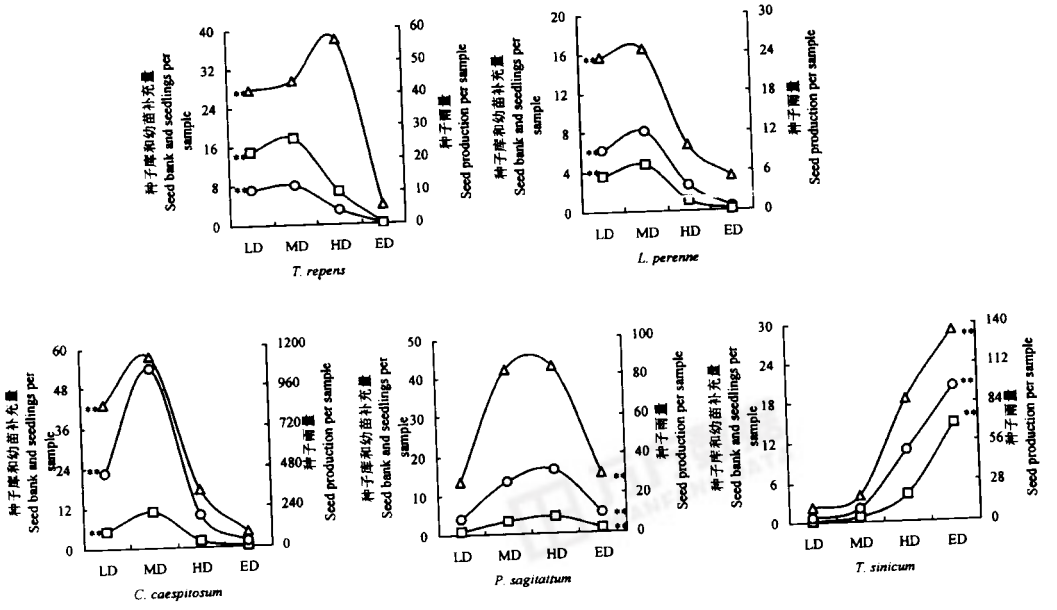

Fig. 1 Variation in seed bank, seedlings and seed production of the five species across the four sites. * * means the variation was very significant ($p<0.01$)

—□—Seedlings —○—Seed bank —△—Seed production

Native species *C. caespitosum* produced much large quantity of seeds compared with other species. From light deterioration site to moderate deterioration site, seed production of *C. caespitosum* increased from 860 sample^{-1} to 1141.7 sample^{-1}, but decreased significantly with further deterioration (Fig. 1). Seed production of *P. sagittatum* showed a variation style similar to that of *C. caespitosum*, but highest seed production occurred at HD site instead of MD site. Seed production of *T. sinicum* increased monotonously from LD site to ED site.

3.4 Effect of soil nutrient

CCA ordination showed that the lose of soil nutrient, such as soil available N and P, was one of the factors that were closely related to the pasture deterioration.

4 Discussion

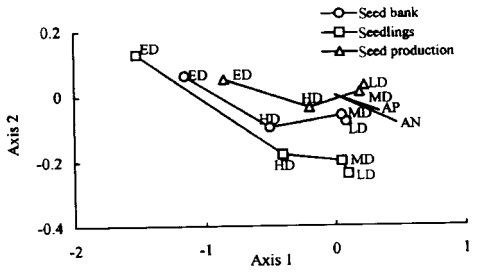

Fig. 2　CCA ordination of the study sites. AN and AP represent soil available nitrogen and soil available phosphorus

Seed bank, seedlings and seed production of two introduced species were increased from LD site to MD site, which means that the species could adapt to adverse circumstance through enhancing their regeneration ability. But decrease of the seed bank, seedlings and seed production of the two species at HD and ED sites indicated that the adaptation strategies of the two species was much restricted, i. e. there threshold existed. The two species can not regenerate themselves regularly once the environmental changes exceed the threshold, and the two species would disappear from the community sooner or later.

Several factors may account for the increment and decrement in seed bank, seedlings and seed rain of the species: (1)grazing activity; (2)variation in soil nutrient contents; and (3)competition from the native species. The authors found there was an apparent increase in grazing intensity from LD to ED site. Many studies[8,9,3,10,11,12] showed that light or moderate grazing could promote regeneration of some species in following ways: i). stimulate seed ste per plant through defoliation; ii). increase number of seedlings by reducing dry matter accumulation; and iii). make seeds easy to germinate. Therefor, seed bank, seedlings and seed production of the two species gained an increase from LD to MD site. But heavy or extreme grazing would hinder or even terminate regeneration process, since few or no seeds will enter the soil under over-defoliation and few or no seedling will recruit because of over-trampling etc. Soil nutrient also plays an important role in regeneration process of vegetation, since nutrient deficiency directly influence growth and reproduction of a plant individual[13]. Soil available N and P increased a little from LD to MD site and then decreased significantly with further pasture deterioration[7]. The quantities of seed bank, seedlings and seed production of the two species also fluctuate in the same way, means that the two species are sensitive to soil available N and P. CCA ordination of the plots also confirmed this point. From MD to ED site, increasing number of native species seedlings make already deficient soil nutrient even less available to the seed germination and seedlings recruitment of the two introduced species.

From LD to MD, seedling, seed production and especially seed bank of native species *C. caespitosum* increased dramatically to its highest point while few *P. sagittatum* and *T. sinicum* was present in seed bank, seedlings and seed production. This showed that *C. caespitosum* is a vanguard species of the invasion process throughout the pasture deterioration. Increment was also detected for *P. sagittatum* and *T. sinicum* in seed bank, seedlings and seed rain from LD to MD site, but at a small extent compared with that of *C. caespitosum*. This means that *T. sinicum* and *P. sagittatum* were not as strong competitor to the sown species as *C. caespitosum* at MD site. From MD to HD site, regeneration ability of *C. caespitosum* was reduced much significantly by increased grazing impact and soil nutrient deficiency. However, native species *P. sagittatum* and *T. sinicum* seem to be much more adapted to the worse condition, since the seed bank, seed production and seedlings of *P. sagittatum* and *T. sinicum* still got a gain from MD to HD site. The quantities of seed bank, seedlings and seed production of *P. sagittatum* were highest among the three native species at HD site, showed that *P. sagittatum* was predominant species at HD stage of the pasture deterioration. *T. sinicum* was the best adapter under the worst pasture condition, since a large number of *T. sinicum* was recorded at HD for its seed bank, seedlings and seed production, while other species were represent in a much small amounts. This means that *T. sinicum* developed a stress tolerant strategy by adapting to worse

and worse pasture condition such as overgrazing impact and soil nutrient deficiency etc.

If the four sites are considered to be four consecutive stages of the pasture deterioration pocess, it is wise to take measure to control pasture deterioration problem at MD stage. Otherwise, once the pasture gone to HD stage or even to ED stage, introduced herbs could not reproduce themselves effectively and therefor will lost advantage against competition from native species. If the pasture already at HD or ED stage, seeds of the introduced species should be re-sown and soil fertilization measures also be taken to rehabilitate the pasture to its high productivity stage. Removal of grazing alone is time-consuming or even impossible to restore the deteriorated pasture back into its original state because of limited propagule source, deficient soil nutrient and competition from native species.

References

[1] Aguiar M R and Sala O E. Seed distribution constrain the dynamics of the Patagonian steppe. *Ecology*, 1997. **78**: 93～100.

[2] Espigares T and Peco B. Mediterranean pasture dynamics: the role of germination. *Journal of Vegetation Science* 1993, **4**: 189～194.

[3] Harper J L. *Population biology of plants*. Academic Press, London, UK. 1977.

[4] Milberg P. Soil seed bank after eighteen years of succession from grassland to forest. *Oikos*, 1995. **72**: 3～13.

[5] Morgan J W. Patterns of invasion of an urban remnant of a species-rich grassland in southeastern Australia by non-native plant species. *Journal of Vegetation Science*, 1998, **9**: 181～190.

[6] Hu T. Studies on degenerative succession in mixed sward of perennial rygrass/white clover. Ph. D. dissertation. China Agricultural University, Beijing. 1996.

[7] Sudebilige, Zhou H, Wang P, *et al*. Variation in reproductive characters of white clover on a degradation series of Artificial Grassland. *Chinese Journal of Grassland*, 1998. **6**: 68～71.

[8] Bakker J P, Dijkstra M and Russchen P T. Dispersal, germination and early establishment of halophytes and glycophytes on a grazed and abandoned salt marsh gradient. *New Phytology*. , 1985, **101**: 491～496.

[9] Collins W J. The effect of defoliation on inflorescence production, seed yield and hard seededness in sward of subterranean clover. *Australian Journal of Agricultural Research*, 1978, **29**: 789～801.

[10] Jones R M, Noguchi M and Bunch G A. Levels of germinable seed in topsoil and cattle faeces in legume-grass and mitrogen-fertilized pastures in South-East Queensland. *Australian Journal of Agricultural Research*, 1991, **42**: 953～968.

[11] Jutila H. Seed banks of grazed and ungrazed Baltic seashore meadows. *Journal of Vegetation Science*, 1998. **9**: 395～408.

[12] Russi L Cocks P. S. and Roberts E. H. Seed bank dynamics in a Mediterranean grassland. *Journal of Applied Ecology*, 1992, **29**: 763～771.

[13] Franco-Pizana J G, Fulbright T E, Gardiner D T, *et al*. Shrub emergence and seedling growth in microenvironments created by *Prosopis glandulosa*. *Jounal of Vegetation Science*, 1996. **7**: 257～264.