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Summary

Regeneration of orchardgrass pasture by the natural reseeding method was studied under different deferred grazing system with or without trimming. The main results obtained were summarized as follows:

1. Relative yields of orchardgrass at the plots treated by natural reseeding were higher than those at the controlled plot.
2. The best establishment of seedlings was observed with spring grazing system, although seed yield was small. It was considered that the grazing in early spring had little negative influence on the amount and quality of seed for natural reseeding; and therefore the system should be recommended.
3. The great seed loss and poor establishment of seedlings were caused when the resting of grazing was too short in duration. Consequently, the relative yield of self-sown seedlings was the lowest in the deferment system.
4. In the no-trimming system, seed germination and seedling establishment were inhibited by the accumulation of litter. It was suggested that the residual stand should be trimmed away after resting.

Introduction

Regeneration by the method of natural reseeding with deferred grazing has been practiced in natural grassland. Some merits of this method had been indicated by Sampson (1). In recent years, it is recognized that this method is also valuable for regenerating the vegetation of sown pasture, and particularly is applicable on large, rugged or stony pastures and on steep slope pasture of hill country.

Kitahara *et al.* (2) reported on a successful regeneration of pasture by natural reseeding with deferred grazing. Yang *et al.* (3) investigated the regeneration of orchardgrass (*Dactylis glomerata*) by seed in conventionally and lightly grazed

pastures. These studies offered an outline for the possibility of regenerating the vegetation by the natural reseeding method in sown pasture. However, the published reports were limited on practice with this method in sown pasture.

The purpose of this study is to clarify the effects of the resting duration on the seed production and the trimming after resting on seedling establishment in the regeneration of vegetation by the natural reseeding method in sown pasture of orchardgrass.

Methods

The experiment was conducted at Obihiro, Hokkaido, from 1983 to 1984. The experimental field was orchardgrass predominant pasture which was established in 1960 and was treated in 1983 as follows:

1. Normal deferred grazing system (A): resting was continued until August 27, followed by trimming.
2. No trimming system (B): similar to (A) except for no trimming after resting.
3. Spring grazing system (C): grazing was added in early June, followed by resting from June 5 to August 27, and trimming was conducted after resting.
4. Short resting system (D): resting period was shorter than that in (A), only until July 28, and trimming was conducted after resting.
5. Control: grazing was allowed frequently throughout the season.

Each treatment plot was 36 m^2. The plots were separated by net fence and stocked with 2-3 sheeps per plot for five days at each grazing time in 1983. In the following year, the partition net fence was removed and the grazing was performed together at the same level of stocking. Treatment methods and preceding vegetation are shown in Table 1.

Fertilizers were applied by N: 5, P: 10, K: 10 g per m^2 in May 1983, and by N: 3, P: 5.5, K: 5.5 g per m^2 on May and August 1984, respectively.

Numbers of ears of adult orchardgrass were examined. Yields of seed, seed

TABLE 1. *Treatment ethods and preceding vegatation*

	Treatment		Coverage of predominant pasture plants (%)			
	Resting periods	Trimming	OG*	WC*	KBG*	Total
A	Spring to Aug. 27	+	50	7	—	73
B	Spring to Aug. 27	−	33	7	—	53
C	June 3 to Aug. 27	+	33	7	—	53
D	Spring to July 28	+	47	—	4	66
Control	Continuous grazing	+	35	6	3	56

*OG: orchardgrass WC: white clover KBG: kentucky bluegrass

weights per ear, numbers and weights of shed seeds, germinating energy, percentage of seed germinating until the 7th day from initiation of germination test, and germinating percentage, percentage until the 21st day, were measured in 50 ears which were picked before the end of resting. Densities of seedlings from self-sown seeds were surveyed from the time of the appearance of the seedlings to autumn of the following year. Yields of orchardgrass seedlings, adult orchardgrass and other species were measured on August 11, 1984.

Results

Seed production

The details of seed production of adult orchardgrass are shown in Table 2. Ear production was depressed slightly in the spring grazing system (Treatment C) as compared with that in the normal deferred grazing system (treatment A). The lowest ear production in the short resting system (treatment D) was incomprehensible. Seed weight per ear was lower in the spring grazing system than in others. Seed yields ranged from 33.6 to 58.3 g per m^2 by A>B>D>C, and showed a similar tendency in depression by spring grazing to ear production.

Germinating energy and germinating percentage of seeds were very similar among treatments A, B and C, but in treatment D, they both showed a very low value. The results indicated that most of the seeds in treatment D did not complete their after-ripening before July 28.

Seedling appearance and establishment :

The processes of the appearance and the establishment of the seedlings for each treatment are shown in Fig. 1. The maximum numbers of emerged seedlings differed greatly among the treatments, ranging from 4,424 to 12,976 plants per m^2, by A>C>B>D. Emerged seedlings were fewer in the no-trimming system (treatment B) than in the trimming one (treatment A), although seed productions were nearly equal between the two treatments.

Densities of seedlings decreased rapidly in all treatments, and the numbers of surviving seedlings ranged from 1,423 to 7,232 plants per m^2, by C>A>B>D at the end of the season, late October of 1983. The highest mortality of seedlings

TABLE 2. *Seed production*

	Number of ears per m^2	Weight of seeds per ear (g)	Yield of seed per m^2 (g)	Germinating energy (%)	Germinating percentage (%)
A	197	0.296	58.3	45.3	70.0
B	187	0.296	55.3	45.3	70.0
C	178	0.189	33.6	48.7	67.0
D	151	0.249	37.6	7.3	56.7

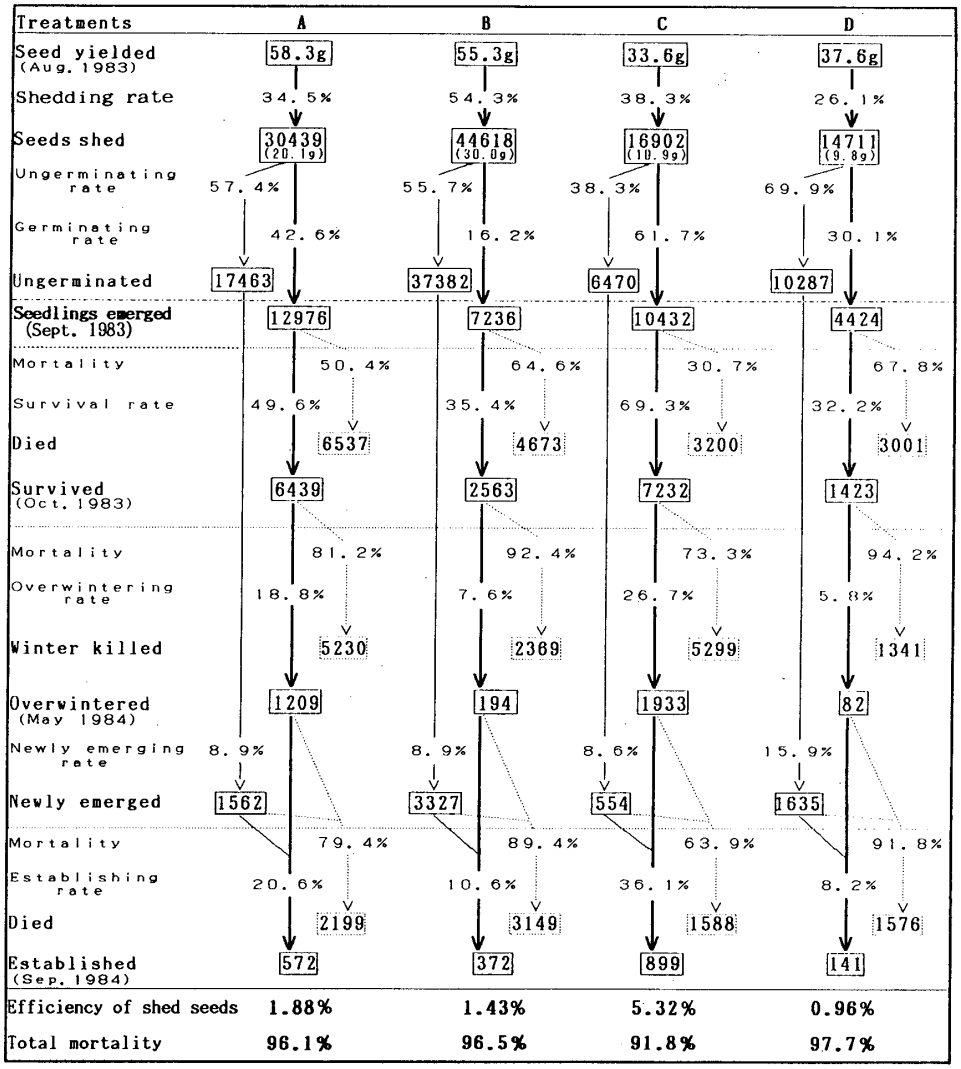

FIG. 1. Processes of appearance and establishment of self-sown seedlings. The data in [ ] are counted for one square meter (m^2).

occured in the short resting system (treatment D) and the lowest in the spring grazing system (treatment C).

Extremely high winter mortalities of seedlings, ranging from 73.2 to 94.2% by D>B>A>C, were observed in all treatments. Significant negative correlation was noticed between the number of seedlings immediately before winter and the winter mortality. This could be called "positive density-dependent overwintering". Therefore, it was considered that the population of high density is favorable to overwintering in the field.

The orders of C>A>B>D in density and D>B>A>C in mortality of seedlings were maintained until the end of the experiment. The mortalities throughout the second year ranged from 63.9 to 91.8%, and the eventual numbers of established seedlings were 572, 372, 899 and 141 plants per m^2 for treatments A,

TABLE 3. *Yield (DM g/m²) and relative yield (R-yd, %) (Aug., 1986)*

	Orchardgrass					Others		Total
	Adult (A)		Seedling (B)		(A)+(B)	Yield	R-yd	Yield
	Yield	R-yd	Yield	R-yd	R-yd			
A	94	43	117	48	91	19	9	218
B	117	45	113	45	90	20	8	250
C	55	26	143	66	92	18	8	216
D	126	50	28	11	61	99	39	253
Control	53	26	—	—	26	154	74	207

B, C and D, respectively.

There was a new emergence of many seedlings after overwintering. The numbers of the new seedlings correlated negatively with the subsequent mortalities, although the relationship was not significant.

Throughout the experimental period, the efficiencies of shed seeds (number of established seedlings/number of shed seed, %) were 1.88, 1.43, 5.32 and 0.96% for treatment A, B, C and D, respectively. A great seed loss and mortality of seedlings were noted in all treatments, especially in the short resting system (treatment D).

Herbage yield

Yields of adults and self-sown seedlings of orchardgrass and those of other species were determined on August 11 of 1984 before the 4th grazing was carried out (Table 3). The differences among treatments were not notable on total yields. However, considerable differences were observed on botanical compositions. Low relative yields of adult orchardgrass in the spring grazing system (treatment C) and continuous grazing system (control plot) were attributed to the low coverage of orchardgrass in preceding vegetation (Table 1). In the plots except the short resting system (treatment D) and the control plot, relative yields of total orchardgrass, adults and self-sown seedlings, were maintained at the level of more than 90% because of the high yield of self-sown seedlings. On the other hand, those were 61% in treatment D and 26% in the control. The highest relative yield of self-sown seedlings was recorded in the spring grazing system and the lowest in the control plot. This result obviously coincided with the tendency of seedling establishment. In the control, a very high relative yield of other species, mainly Kentucky bluegrass (*Poa pratensis L.*), was observed.

Discussion

In the short resting system, the vegetation of orchardgrass did not improve

well because of the poor ability of seed germination, despite the fact that the seed yield was adequate. From our previous work which showed that a resting should be continued for 70 days after the first heading time in order to ensure the seed production of orchardgrass, the delay of germination in this system indicated that the resting length was not sufficient for after-ripening of seeds. So a great number of seeds were lost while completing their after-ripening on the surface of the ground, and the appearance of seedlings deteriorated.

As compared with the short resting system, the spring grazing system maintained a high level of ear number and germination ability, but depressed seed weight per ear and seed yield. Similar results were reported by Evans (5), Green and Evans (6), Lambert (7) and Knight (8), with regard to orchardgrass cultured for the purpose of seed production. According to our previous work (4), the ear formation of orchardgrass was not depressed by cutting until the 10th day before the first heading time, but injury of ear increased steeply by cutting on the 4th day before the first heading time. In this experiment, the fact that the highest values of yield and relative yield of self-sown seedlings were shown in the spring grazing system suggested the possibility of shortening the resting period by spring grazing, in order to use efficiently the herbage produced in spring when regeneration of pasture was planned by the natural reseeding method.

The effect of trimming was identified by comparing the normal deferred grazing system (treatment A) with the no-trimming system (treatment B). In the no-trimming system, the number of emerged seedlings was seriously depressed. It was considered that the steep change of moisture and temperature on the surface layer of litter which was formed in the field by not trimming would kill the germinating seeds and the emerged seedlings. Similar inhibitions of seed germination was reported by Hughes *et al.* (9) and Warboys (10) on surface sowing.

The higher mortalities of seedlings before winter and during winter in the no-trimming system (treatment B) suggested that the vigor of seedlings would be depressed by residual stand. Although the relative yield of self-sown seedling was high in both the no-trimming system and normal deferred grazing system (treatment A) in August, 1984, most seedlings of the no-trimming system were newly emerged ones after winter and the population would be unstable, compared with the overwintered ones. In fact, the mortality of seedlings after August, 1984 was higher in the no-trimming system than in the trimming one, although the residual stand had little depression. Therefore it is recommended to trim the resitual stand after resting.

As mentioned above, it was obvious that the vegetation of pasture could be improved markedly by natural reseeding, when the duration of resting was sufficient for seed production and the residual stand was treated with trimming.

Farther studies about the factors affecting seedling establishment, such as competition between adult plants and seedlings and interactions among seedlings,

are needed when the natural reseeding method is introduced into a conventional management system in order to maintain the vegetation of sown pasture.

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