DEVELOPMENTAL CHARACTERISTICS AND RENOVATING PATTERN OF REED CANARYGRASS SHOOTS IN A SWARD

M. Ito[1], S. Mizuno[1], T. Otani [2] and S. Kobayashi [3]

[1] Faculty of Agriculture, Niigata University, 2-8050, Igarashi, Niigata 950-21, Japan

[2] Zootechnical Station, Tokyo University of Agriculture, 422, Fumoto, Fujinomiya 418-02, Japan

[3] Niigata Animal Husbandry Experiment Station, Tanahire, Shitada-mura 955-01, Niigata Prefecture, Japan

ABSTRACT

Developmental and renovating traits of shoots were investigated ecomorphologically in a reed canarygrass (*Phalaris arundinacea* L., cv. Palaton) sward harvested 3 times per year. Reed canarygrass shoots exhibited notably high growth rates both in the 1st and 2nd crops together with rapid leaf formation (around 7 days/leaf) and active internode elongation. Vigorously growing shoots, which regenerated soon after the 1st cutting and dominated in the 2nd crop canopy, mainly originated from the stubble formed with 3 to 4 phytomers that developed after the beginning of spring growth, thus resulting in higher shoot density than that of the 1st crop. In the 3rd crop, the same kind of regeneration pattern of dominant shoots arose soon after the 2nd cutting.

KEYWORDS

Dormant tiller bud, internode, leaf, phytomer, *Phalaris arundinacea* L., regrowth, rhizome, shoot.

INTRODUCTION

Reed canarygrass (*Phalaris arundinacea* L.) cultivars usually reveal excellent performance in forage productivity and sward longevity under various climatic and geographical conditions in Japan (Hoshino *et al*., 1971; Otani *et al*., 1994). However, details of specific developmental characteristics of the species are not clear, partly because of its low appraisal for herbage quality (Ito *et al*., 1990a), so that more eco-physiological information will be necessary to improve utilization techniques for this grass. With this view, we have made some morphological observations on growth and tillering habits of reed canarygrass plants under sward conditions (Ito *et al*., 1987, 1990a, 1990b, 1993). The purpose of the present study is to clarify the developmental courses of primary canopy and aftermath shoots and renovation patterns of dominant shoots at each harvest.

MATERIALS AND METHODS

In 1993, similar sized, vigorous shoots were collected in different developmental stages during the growth periods of 1st and 2nd crops of a reed canarygrass (cv. Palaton) sward (Niigata Animal Husbandry Experiment Station, Shitada-mura, Niigata Prefecture). The sward was fertilized with 15, 10 and 15 kg/m^2/year of N, P_2O_5 and K_2O, respectively, and harvested on June 5, July 28 and September 28 (cutting height was 5 cm above ground). Each length of successive leaf blade, leaf sheath, internode and tiller bud attached to each phytomer (the simplest unit structure of grass shoot) was measured in each of 8 shoots collected on different dates with ca. 10- and 14-day-intervals in 1st and 2nd crops, respectively. A supplemental measurement was also made 2 weeks after the 2nd cutting. Dormant tiller buds in lower nodes of shoots were excised and fixed in formalin-aceto-alcohol. They were sectioned longitudinally with a paraffin method and stained with safranin, orange G and tannic acid series, then, number and size of juvenile leaves were counted under a light microscope. Yields and shoot densities of 1st and 2nd crops were also measured.

RESULTS AND DISCUSSION

In RCG swards most existing shoots are deprived of their regrowing capacity at each harvesting of 1st and aftermath crops, as the shoot apices which exist on elongated internodes are removed (Ito *et al*., 1990a). Therefore, the majority of sward-dominating shoots are replaced with newly emerged shoots at each harvesting (Ito *et al*., 1993). In this study, the principal shoots of the 1st crop made very active extension growth forming ca. 9 phytomers with full foliage leaves and 5 to 6 elongated internodes before heading, so that initial 3 to 4 internodes stayed unelongated or with very short elongation. These basal internodes lasted in stubbles as main components for regrowth after 1st cutting, with tiller buds attaching to them (Table 1). The close resemblance in internode elongation in upper phytomers and several condensed internodes in lower phytomers was observed in the second crop, with dormant buds being capable of regeneration.

The interval of successive leaf appearance on shoots, which was estimated by the difference of expanded leaf number in different developmental stages, was rather stable around 7 days both in the 1st and 2nd crops. The dormant buds attached to the lower nodes of 1st crop shoots usually developed 8 to 10 juvenile leaves enclosed with swollen scaly leaves of 2 to 6 mm in length. Although a few dormant tiller buds began to elongate during 1st and 2nd crop growth, most of them stayed dormant before the cutting.

Then, most of the existent tiller buds in the stubbles, especially those of upper 3 or 4 nodes, sprouted and elongated quickly, reaching nearly 30 cm in height with a slight internode elongation in 2-week-regrowth (Figure 1, Table 1). The highest ratio of bud sprout was observed at St-2, 2 phytomers below the uppermost node (St) on the stubbles, while the growth activity of buds originated from St were rather inferior to that of lower buds and many of them tended to decay during the regrowth. The regeneration shoots often began to grow with short rhizomatous creeping, forming nearly 5 or more cataphylls before expansion of foliage leaves.

Thus reed canarygrass swards instantly recovered higher shoot density of over 1200 shoots/m^2 just after the 1st cut, when most of around 800 shoots/m^2 in primary canopy lost their growth activity. Higher productivity in aftermaths of reed canarygrass swards (Hoshino *et al*., 1971; Ito *et al*., 1990a; 0tani *et al*., 1994) seems to be partly derived from these abundant regenerated shoots occurring soon after cuttings, though active internode growth both in reproductive and vegetative stages (Ito *et al*., 1990a, 1990b; Otani *et al*., 1994) surely must be of advantage in dry matter accumulation.

REFERENCES

Hoshino, S., T. Sakai and T. Imai. 1971. On the improvable application of reed canarygrass. J. Jap. Soc. Grassld. Sci. **17:** 141-144*.

Ito, M., S. Nakayama and Y. Tsubota. 1987. Morphological studies on tillering habits in temperate herbage grasses. V. Patterns of tillering and tiller bud development of some grasses under contrasting light regimes. J. Jap. Soc. Grassld. Sci. **33:** 163-174.

Ito, M., S. Kobayashi, H. Tokushige, N. Muraki and F. Tokutake. 1990a. Population dynamics of tillers formed in reed canarygrass

(*Phalaris arundinacea* L.) swards. J. Jap. Soc. Grassld. Sci. **35:** 279-285*.

Ito, M., E. Sato, H. Goto and Y. Hattori. 1990b. Growth morphology of reed canarygrass (*Phalaris arundinacea* L.) tillers under sward conditions. J. Jap. Soc. Grassld. Sci. **36:** 254-262*.

Ito, M., H. Kuwakino and K. Yamashina. 1993. Relationships between the development of dormant tiller buds and the successive leaf and internode formation of mother shoots in reed canarygrass (*Phalaris arundinacea* L.) grown under a sward condition. J. Jap. Soc. Grassld. Sci. **38:** 469-477*.

Otani, T., M. Ito and Y. Maeda. 1994. A comparison of productivity in some reed canarygrass (*Phalaris arundinacea* L.) cultivars. J. Agric. Sci., Tokyo Nogyo Daigaku. **39:** 27-32*.

* in Japanese with English summary.

Table 1
Shoot and sward growth in primary canopy and aftermath of reed canarygrass

Crop Number	Date of Observation	Shoot Length (mm)	Internode length [c] (mm)	Expanded leaf no. [d]	No. of elongated internode	Dry matter yield (g/m²)	Shoot density (no./m²)	Culm/ foliage ratio
	Apr. 15	197	3	3.3	0	-	-	-
	Apr. 26	276	17	4.9	0.5	-	-	-
1	May 6	459	9	5.8	2.1	-	-	-
	May 18	733	334	8.1	4.0	-	-	-
	May 28 [a]	1253	890 + 110 [e]	9.3	6.3	533	823	2.0
	June 5 [b]	1660	1219+286 [e]	9.5	6.5	768	871	2.8
	June 22	237	20	3.2	1.0	-	-	-
2	July 6	643	278	5.5	3.5	-	-	-
	July 21	968	615	7.5	5.4	-	-	-
	July 28	988	648	8.7	6.6	437	1229	1.3
3	Aug. 11	251	14	3.2	0.4	-	-	-

[a] ear emergence, [b] full heading, [c] summing up of foliage internodes, [d] successive leaf number was counted acropetally from initially elongating (in 1st crop) or 1st foliage (in 2nd and 3rd crops) leaf, [e] length of inflorescence internode.

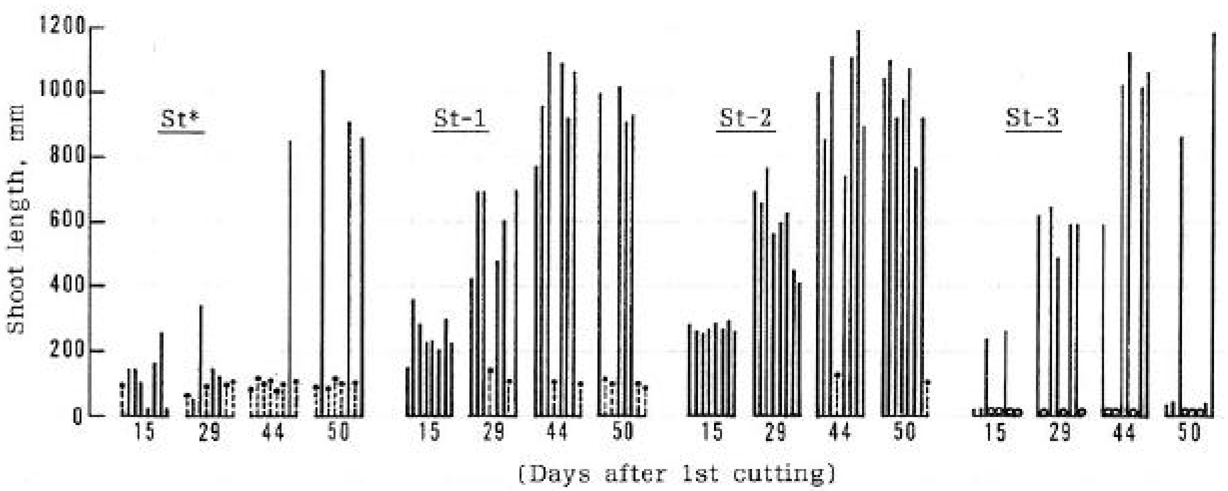

Figure 1
Various patterns of development of shoots and buds remained on the stubble of primary canopy during the course of second crop growth. Each of actively elongating, resting in dormant state and deteriorated shoots is arranged in each rank in different dates of observation and successive nodal positions of insertion (8 stubbles were examined in every sampling date). * ' St' in the figure indicates the highest node in the stubble, remaining higher nodes are numbered basipetally, as St-1, St-2, … .
_____: total length of elongating shoot, •-- : shoot decay and not measurable, ° : dormant bud below 10mm in length.