Seasonal Change in the Standing-Crop of *Imperata cylindrica* var. *koenigii* Grassland in the Kii-Ohshima Island of Japan

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Introduction

Knowledge of the seasonal change in the dry-matter production of weeds is important for establishing a rational weed control program, and there have few studies on the standing-crop of *Imperata cylindrica* (L.) BEAUV. var. *koenigii* (RETZ.) DURAND *et* SCHINZ ("Chigaya" in Japanese).

In the southwestern part of Japan, this species grows vigorously and sprouts young shoots from spring to autumn. It heads in mid-May, and one panicle can set more than five hundred seeds. Its seeds have no dormancy⁵⁾. It reproduces vegetatively and vigorously by rhizome. The tip of the rhizome elongates as a shoot naturally, and a bud on one of the nodes quickly elongates as a shoots if a rhizome is separated from the mother plant.

In this paper, the seasonal change of a standing-crop of *I. cylindrica* var. *koenigii* grassland and the horizontal and vertical distribution of its rhizomes in an abandoned field are described.

Materials and Methods

The field investigated

Seasonal change in a standing-crop of *I. cylindrica* var. *koenigii* grassland was investi-

gated in a 30×20 m² abandoned field (33°28'N, 135°50'E, 50m above sea level) on Kii-Ohshima Island located at the southern extremity of the Kii Peninsula. This field was abandoned after sweet potato cultivation in the 1940's. *I. cylindrica* var. *koenigii* grows densely and covers it almost entirely (Fig. 1). Uncyclic mowing is conducted several times a year and this grass weed is used as mulching material. The last mowing was done in late April, 1980, just before this investigation began.

Measurements of the standing-crop

The standing-crop in three 50×50 cm² quadrats was measured at intervals of about one month from June 14, 1980, to May 18, 1981.

Fig. 1. View of the field investigated, May 14, 1981.

A part of this work was reported at the 22nd Annual Meeting of the Weed Science Society of Japan in 1983.

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Plant height, number of individuals and coverage of each species were investigated. The coverage was assessed according to PENFOUND and HOWARD⁹⁾. Aerial parts were cut into 10 cm strata above soil level by the stratified clip technique of MONSI and SAEKI⁷⁾. After sampling, the aerial parts of each stratum were divided into leaf-blades, leaf-sheaths, petioles, culms, stems, panicles, and flowers. They were dried at 80°C for 48 hours, and then the dry-matter weight of each organ in each stratum was measured. The rhizomes of *I. cylindrica* var. *koenigii* were sampled in each 5 cm of soil layer below the ground surface, and rhizome dry-matter weight of each layer was measured.

The horizontal distribution and the branching pattern of the rhizome were recorded in a $2 \times 2\text{ m}^2$ quadrat.

Results and Discussion

Figure 2 shows the horizontal distribution of 19 species found in one $50 \times 50\text{ cm}^2$ quadrat at the beginning of the investigation, on June 14, 1980. Plants of *Imperata cylindrica* var. *koenigii* were densely and irregularly distributed, and *Lonicera japonica* THUNB. was occasionally found. *Miscanthus sinensis* ANDERSS. and *Ophiopogon japonicus* (L. fil.) KER-GAWL. with very short rhizomes grew in clusters.

Thirty-two species were found in all three quadrats of the field between June 14, 1980 and May 18, 1981 (Fig.3). *I. cylindrica* var. *koenigii* covered nearly the whole area of the quadrat and was dominant throughout the year. *Miscanthus sinensis* occupied less than 10% area of the area, *Rumex acetosa* L., *Cassia nomame* (SIEB.) HONDA., *Geranium thumbergii* SIEB. et ZUCC., and *Paederia scandens* (LOUR.) MERRILL var. *mairei* (LÉVEILLÉ) HARA less than 5%, and the coverage of the other 26 species was extremely small. No seedlings of *I. cylindrica* var. *koenigii* were found.

As shown in Fig. 4, *I. cylindrica* var.

koenigii grew very swiftly. The plant was 89.7 cm in height and a part of the lower leaves had died back on June 14, 1980. The canopy of the three quadrats consisted of aerial parts of *I. cylindrica* var. *koenigii*, *Miscanthus sinensis*, and three voluble species, *Paederia scandens* var. *mairei*, *Lonicera japonica*, and *Stephania japonica* (THUNB.) MIERS. The standing crop of the other 27 species was very small, less than 5% of the total. By February 16, 1981, the aerial parts of *I. cylindrica* var. *koenigii* had largely died, but the dead leaves had not yet been shed.

The aboveground standing-crop in this field reached a peak in January of 883 g/m^2 in dry weight, with *I. cylindrica* var. *koenigii* accounting for 87.4%. The species had thus produced prolifically. The peak of the aboveground standing-crop of this field was greater than those (376 to 793 g/m^2) of the *Miscanthus sinensis* community^{2,4)} which is the typical grassland vegetation in Japan.

Fig. 2. Horizontal distribution of individual species in a $50 \times 50\text{ cm}$ quadrat on June 14, 1980.

- : *Imperata cylindrica* var. *koenigii*;
- : *Miscanthus sinensis*; △ : *Rumex acetosa*;
- ▼ : *Cassia nomame*; △ : *Ophiopogon japonicus*;
- : *Lonicera japonica*; * : the other species.

Species	Coverage*												
	1980.						1981.						
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	
<i>Imperata cylindrica</i> var. <i>koenigii</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Miscanthus sinensis</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Rumex acetosa</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Cassia nomame</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Geranium thunbergii</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Paederia scandens</i> var. <i>mairei</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Lactuca indica</i> var. <i>laciniata</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Pteridium aquilinum</i> var. <i>latiusculum</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Lophatherum gracile</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Arundinella hirta</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Arthraxon hispidus</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Cyperus cyperoides</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>C. rotundus</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Carex</i> sp.	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Scilla scilloides</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Ophiopogon japonicus</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Dioscorea japonica</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Stephania japonica</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Corydalis heterocarpa</i> var. <i>japonica</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Potentilla freyniana</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Kummerovia striata</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Vicia sepium</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Oxalis corniculata</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Viola mandshurica</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Hydrocotyle sibthorpioides</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Lysimachia clethroides</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Justicia procumbens</i> var. <i>leucantha</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Lonicera japonica</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Patrinia scabiosaeifolia</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Solidago virga-aurea</i> var. <i>asiatica</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Artemisia princeps</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	
<i>Ixeris dentata</i>	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	—————	

Fig. 3. Fluctuation of coverage in the field investigated.

*——: Coverage, 76 to 100%; ———: 6 to 25%; ———: 1 to 5%; ----: less than 1%.

Fig. 4. Seasonal change of productive structure of the *Imperata cylindrica* var. *Koenigii* community.

Dry weights of photosynthetic parts are shown to the left of the vertical line and non-photosynthetic part to the right, □: *I. cylindrica* var. *koenigii*; ▨: dead leaf-blade of *I. cylindrica* var. *koenigii*; ■: other species.

The rhizome is the main reproductive organ of *I. cylindrica* var. *koenigii*, therefore an understanding of its standing-crop and distribution in soil is important for the control of this grass weed. Total rhizome dry-weight of *I. cylindrica* var. *koenigii*, increased notably from September to November, accompanied by the occurrence of a large standing-crop of living leaf-blade in September and October. The dry-matter weights of dead leaf-blade and leaf-sheath had maximum value in January, 353 and 382g/m², respectively, and that of rhizome reached 653g/m² in February (Fig. 5). Thus, maximum value of dry-matter weight in rhizome was found one month later than the peak of dry-matter weight in the aerial portions. This is attributable to the translocation of photosynthetic products from the aerial parts to the rhizomes. Total dry weight of rhizomes decreased on and after March, when

Fig. 5. Seasonal change in the standing-crop of each organ of *Imperata cylindrica* var. *koenigii*.

▲ : living leaf-blade; △ : dead leaf-blade; ● : rhizome; ■ : leaf-sheath, culm, and panicle; ○ : total aerial parts.

the new shoots sprouted. A similar decrease in total dry weight of rhizome was seen in *Miscanthus sacchariflorus* (MAXIM.) BENTH.⁸⁾ and *Solidago altissima* L.³⁾

Soil texture in the 50 × 50 cm² quadrat investigated was : the 0 to 14cm deep layer was composed of black loam, the 14 to 17 cm layer black loam contained red clay, the 17 to 21cm layer red clay, and the 21 to 40cm layer red clay contained conglomerates. The greater parts of the rhizomes of *I. cylindrica* var. *koenigii* were distributed over soil depths of 0 to 30cm, sprawling particularly densely in the 5 to 10cm layer (Fig. 4). The rhizomes of this weed knitted together complexly and densely in the field (Fig. 6). Rhizome internode length was from 2.0 to 2.5cm, and proximal internodes were very short, 0.1 to 0.3cm.

Since a plant with a large quantity of reserve substances has greater advantage in competing with other species^{1,6,8)}, the large rhizome biomass of *I. cylindrica* var. *koenigii* has assured the weed's rapid regrowth and vigorous vegetative reproduction in spite of the several mowings a year. The dominant occurrence of this weed in the field observed is due to the large amount of reserve-substances in rhizomes. The penetrating ability of this weed through its vigorous rhizome-reproduction in various directions in the soil may make control difficult.

Fig. 6. Horizontal distribution of rhizomes in *Imperata cylindrica* var. *koenigii* on March 1, 1981.

Summary

Seasonal change in the dry-matter production of *Imperata cylindrica* var. *koenigii* grassland was investigated in an abandoned field (135°50'E, 33°28'N, about 50 m above sea level) on Kii-Ohshima Island. This weed grows densely and covers nearly the entire field. The standing-crop in three quadrats (50×50cm²) was investigated by the stratified clip technique at intervals of about one month from June 14, 1980 to May 18, 1981.

I. cylindrica var. *koenigii* was dominant in every season. The maximum standing-crop of 883g/m² was obtained in January, and *I. cylindrica* var. *koenigii* accounted for 772g/m² of that. The other 31 species, *Miscanthus sinensis*, *Rumex acetosa*, and *Pteridium aquilinum* var. *latiusculum* etc., covered only a small area. The rhizome is the main reproductive organ of *I. cylindrica* var. *koenigii* and were distributed densely and complicatedly in soil depths of 0 to 30 cm. Rhizomes occupied 40 to 50% of the total dry-matter weight.

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(Received June 23, 1989)

紀伊大島におけるチガヤ草地の現存量の季節変化

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摘 要

チガヤ (*Imperata cylindrica* var. *koenigii*) は、防除が極めて困難な、世界の熱帯から温帯に広く分布するイネ科の多年生雑草である。チガヤが密生している草地の現存量の季節変化を調査し、あわせてチガヤの主な繁殖器官である根茎の水平および垂直分布を調査した。

1980年6月14日から1981年5月18日に和歌山県西牟婁郡串本町紀伊大島にみられるほぼ全域をチガヤに被われた放棄畑(北緯33°28', 東経135°50', 標高約50m)において(Fig. 1) 調査を行った。50×50cm²のコドラート3個を調査地に設け、ほぼ1か月ごとに出現種および被度を調査した後、地上部を地上から10cmごとに層別に刈り取り、器官別に乾物重を測定した。地上部を刈り取った後、チガヤの根茎の水平および垂直分布を調査した。

調査地ではチガヤが密に分布していたが、分布様式は一様でなかった(Fig. 2)。チガヤの他にススキ、スイバ、ワラビなど31種の生育が確認された。チガヤの被度は1年を通じて76%以上であったが、その他の種の被度は10%以下であり(Fig. 3)、個体数も少なかった。チガヤは速やかに生長し、調査開始時には既に草丈が89.7cmに達し、草冠を被っていた(Fig. 4)。チガヤ、ススキ、ヘクソカズラ、スイカズラおよびハスノハカズラ以外の種は下層に位置していた。2月にはチガヤの地上部はほとんど枯死したが、枯死葉は、脱落せず、枯死した状態で残存していた。調査地の地上部最大現存量は1月に883g/m²を示し、チガヤはそのうちの87.4%を占めた。チガヤの主な繁殖器官である根茎は複雑に分枝していた(Fig. 6)。根茎は、深さ10cmまでに全量の約80%が分布し、深いものでは30cmに達していた(Fig. 4)。根茎の現存量は年間を通じ全器官の40~50%を占め、その最大値は地上部の現存量が最大となる時期から約1か月遅れた2月に653g/m²を示した(Fig. 5)。

複雑に分枝した根茎が地中深くまで分布し、多量の同化産物を蓄積していることがチガヤの防除を困難にしている要因であると推定された。

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