JARQ 31, 35-40 (1997)

Disappearance of Nezasa Dwarf Bamboo (*Pleioblastus variegatus* Makino) after Flowering in Grazing Grassland of Aso

Nobuaki KOYAMA and Yasuo OGAWA*

Department of Grasslands, Kyushu National Agricultural Experiment Station
(Nishigoshi, Kumamoto, 861-11 Japan)

Abstract
Nezasa bamboo (*Pleioblastus variegatus* Makino) is an important native plant for grazing of beef cows in the grasslands of Aso area. In 1992 nezasa bamboo flowered over 2,150 ha of grassland in the northern somma of Aso volcano. The current studies were carried out to investigate the effects of flowering on yearly changes in the above- and underground parts of nezasa bamboo. In the flowering year (1992) the amount of aboveground parts (44.0 g DM m^{-2} in June 1992) decreased to 19% of the value recorded (227.1 g DM m^{-2} in June 1991) in the previous year (1991). In the year after flowering (1993), the aboveground parts were scarce (only 1.3 g DM m^{-2} in June 1993). Dry matter weight of underground plant parts in the year of flowering decreased from spring to autumn, and the plants died after the summer. In the next year of flowering the dry matter weight continued to decrease. In 1994, the recovery of nezasa bamboo in grasslands of the northern somma of Mt. Aso was investigated. The rate of recovery was low and it was considered that 10 or more years would be required for the recovery of nezasa bamboo.

Discipline: Grassland
Additional key words: aboveground parts, *Arundinella hirta, Miscanthus sinensis*, under ground parts

Introduction

Nezasa bamboo is an important plant for feed of grazing beef cows in the grassland area of Aso in Kumamoto Prefecture, Japan and about 7,000 head of beef cows are grazed in the area. It is considered that nezasa bamboo flowers once in several decades, and that all the aboveground and underground parts of nezasa bamboo die. Therefore after flowering of nezasa bamboo, the pasture potential in the grassland is reduced and the grazing capacity decreases. The flowering of nezasa bamboo may thus adversely affect the grazing of beef cow.

There have been several reports on the flowering of bamboo in Japan. Muroi[2] reported on the flowering of sasa bamboo from 1817 to 1967. Muroi & Fujimoto[3] reported on the flowering of nezasa bamboo in the western part of Honshu, Shikoku and Kyushu in 1970. Matumura et al.[1] reported on the germination and growth of seedlings of nezasa bamboo. Yano & Takahashi[5] observed the seed production and recovery of vegetation after flowering of nezasa bamboo in Mt. Otafuku in 1970. Although there are some reports on the flowering and recovery of the vegetation of grasslands after flowering, yearly changes in the above- and underground parts after flowering are poorly documented. In 1992 nezasa bamboo flowered over 2,150 ha of the grassland area of Aso volcano[4]. Yearly changes in the above- and underground parts of nezasa bamboo were investigated in 1991 when flowering did not occur, in 1992 when flowering occurred and in 1993, 1 year after flowering. In 1994 the degree of recovery of nezasa bamboo after flowering was determined over the grassland in the northern

*Present address:
Department of Forage Crop Breeding and Grassland, Hokkaido National Agricultural Experiment Station (Hitsujigaoka, Toyohira, Sapporo, 062 Japan)

somma of Mt. Aso.

The present study was carried out to investigate the effect of flowering of nezasa bamboo on the yearly changes in the above- and underground parts by comparing the data collected during the 3-year period and the state of recovery of nezasa bamboo after flowering.

Materials and methods

1) Yearly changes of aboveground and underground parts

Investigations were conducted over a 3-year period (1991 – 1993) in the grassland of Nishiyunoura in the northern somma of Aso volcano in Kumamoto Prefecture. Altitude of the grassland is 920 m, annual mean temperature was 11.3°C and annual mean rainfall was 3,047 mm. Dominant species in the grassland were nezasa bamboo, *Arundinella hirta* (Thunb.) C. Tanaka and *Miscanthus sinensis* Anderss. Flowering of nezasa bamboo occurred in 1992.

Grazing cows consisted of Japanese Brown and crossbreed (Japanese Brown × Holstein). Yearly total number of grazed cows per ha was 96.5, 43.4 and 44.2 in 1991, 1992 and 1993, respectively. The herbage was cut off every month as well as before and after grazing by drawing a quadrate (0.5 × 0.5 m) at the ground level. The cut herbage was separated into nezasa bamboo, *A. hirta, M. sinensis* and other plants. Underground plant parts of herbage (0.25 × 0.25 m and 0.25 m deep) were taken from the grassland in April, August and November, washed to remove soil, and separated into nezasa bamboo and other plants. These samples were dried for 48 h at 70°C, and the dry matter (DM) weight of the samples was measured.

2) Recovery of nezasa bamboo

In 1994, the second year after flowering, the recovery of nezasa bamboo was investigated in 16 locations in grasslands in the northern somma of Mt. Aso. The line method was used to measure the degree of recovery. A 40 m ruler was put on the grassland, and the number of nezasa bamboos was counted at 10 cm intervals along the ruler. The degree of recovery (DR) was expressed by the equation;

$$DR = \text{number of nezasa bamboos}/400. \quad .... (1)$$

When nezasa bamboos were not detected, DR was 0. When nezasa bamboos completely recovered, DR value was 1. As a result, DR increased from 0 to 1.

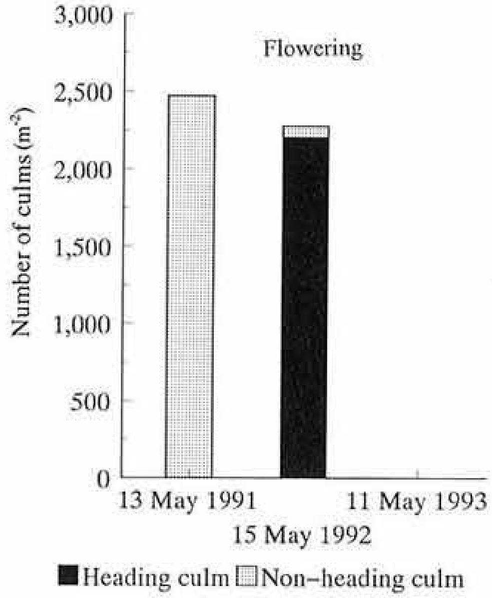

Fig. 1. Yearly changes in number of heading and non-heading culms of nezasa bamoo from 1991 to 1993

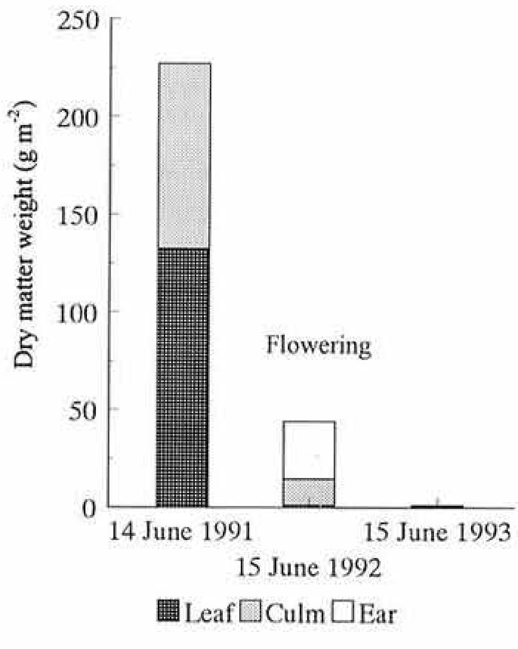

Fig. 2. Yearly changes in dry matter weight of leaf, culm and ear of nezasa bamboo from 1991 to 1993

Results

1) Yearly changes of aboveground and underground parts

In winter all the leaves and culms of nezasa bamboo in the Aso area die due to the cold temperature. In spring new leaves and culms emerging from rhizomes grow in summer, and in late autumn all the leaves and culms die again due to the cold temperature. However, the rhizomes do not die in winter.

There were differences in the growth of the above- and underground parts of nezasa bamboo before and after flowering. Yearly changes in the number of heading and non-heading culms are shown in Fig. 1. In 1991, the year without flowering, the number of heading culms was 0 m^{-2} and of non-heading culms 2,473 m^{-2}. In 1992, the year of flowering, a large number of heading culms and a small number of non-heading culms emerged directly from the rhizomes in spring. Number of heading culms was 2,204 m^{-2} and of non-heading culms 74 m^{-2}. In 1993, 1 year after flowering, there were few heading and non-heading culms. Number of heading culms was 2 m^{-2} and of non-heading one 0 m^{-2}.

Yearly changes in the dry matter weight of the aboveground parts (total weight of leaves, culms and ears) are shown in Fig. 2. In June 1991 the value was 227.1 g DM m^{-2}. However, in June 1992, year of flowering, the dry matter decreased, with a value of only 44.0 g DM m^{-2}. The dry matter weight of the aboveground parts in the year of flowering decreased by 19% of that in the previous year. In. June 1993, the dry matter weight was lower, only 3.1 g DM m^{-2}.

The weight of leaves (Fig. 2) was 132.4 g DM m^{-2} in June 1991, but 1.0 g DM m^{-2} in 1992. The leaf weight in 1992 was only 1% of that in 1991. In 1993 the weight was low.

Yearly changes in the underground parts are depicted in Fig. 3. Dry matter weight of underground parts was 1,609 g DM m^{-2} in November 1991, but in 1992, the dry matter weight decreased from spring to autumn, and most of the underground parts died after summer. Therefore live dry matter weight in November was 24 g DM m^{-2} in contrast to dead dry matter weight 950 g DM m^{-2}. In 1993 the live parts died and since the dry matter weight of the underground parts decreased, dead dry matter weight in November was 540 g DM m^{-2} and live parts were not found.

The dry matter weight of other dominant plants, i.e. *M. sinensis* and *A. hirta,* increased in the years of flowering and after flowering of nezasa bamboo (Fig. 4). However, the total dry matter weight increase of these 2 plants did not compensate for the decrease of that of nezasa bamboo.

Plates 1 and 2 show the condition of the grassland in 1991 and 1993, respectively. In June 1991 there was a large amount of nezasa bamboos and grazing started. In June 1993 nezasa bamboos were not found and since the herbage mass was also small, grazing started 1 month later from July. However, in August the steep slope was eroded by the trampling of cows and consequently grazing could not continue.

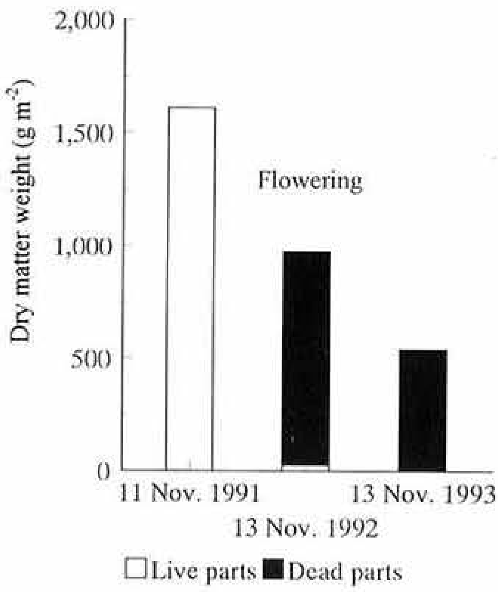

Fig. 3. Yearly changes in dry matter weight of underground parts of nezasa bamboo from 1991 to 1993

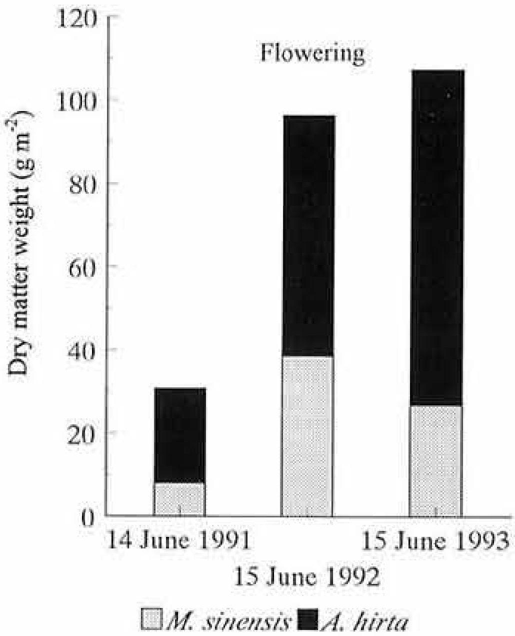

Fig. 4. Yearly changes in dry matter weight of aboveground parts of *Miscanthus sinensis* and *Arundinella hirta* from 1991 to 1993

Plate 1.
Condition of the grassland in the year before flowering of nezasa bamboo (June 1991)

Plate 2.
Condition of the grassland in the year after flowering of nezasa bamboo (June 1993)

2) Recovery of nezasa bamboo

In 1994 the degree of recovery (DR) of nezasa bamboo over the grassland of the northern somma of Mt. Aso was determined. Small nezasa bamboos, which may grow from seed, were observed. The degree of recovery is depicted in Fig. 5. The highest DR value was 0.41. However, in 12 of the observed 16 locations, the DR value was less than 0.1. Furthermore nezasa bamboos were not found in 2 locations. These observations indicate that the rate of recovery was low.

Discussion

Many theories have been put forward to explain the cause of flowering of nezasa bamboo, including weather conditions (i.e. low temperature or drought), poor nutrition, decrease of nitrogen content, increase of carbon content and increase of C/N ratio in nezasa bamboo. Another theory is that flowering occurs in cycles.

In March 1990 nezasa bamboos were transferred from the Aso area to Nishigoshi town with a warm climate (80 m above sea level and mean annual temperature of 15.5°C, mean annual rainfall of 2,004 mm). The transplanted nezasa bamboos also flowered in 1992. Since drought did not occur in the Aso area and Nishigoshi town from 1990 to 1992, low temperature and drought were not the cause of flowering. To investigate the role of nutrition, decrease of nitrogen content and increase of C/N ratio, the nitrogen content of nezasa bamboos grown in 1990 and 1991 was analyzed. Nitrogen contents of leaves, culms and underground parts in 1991 were

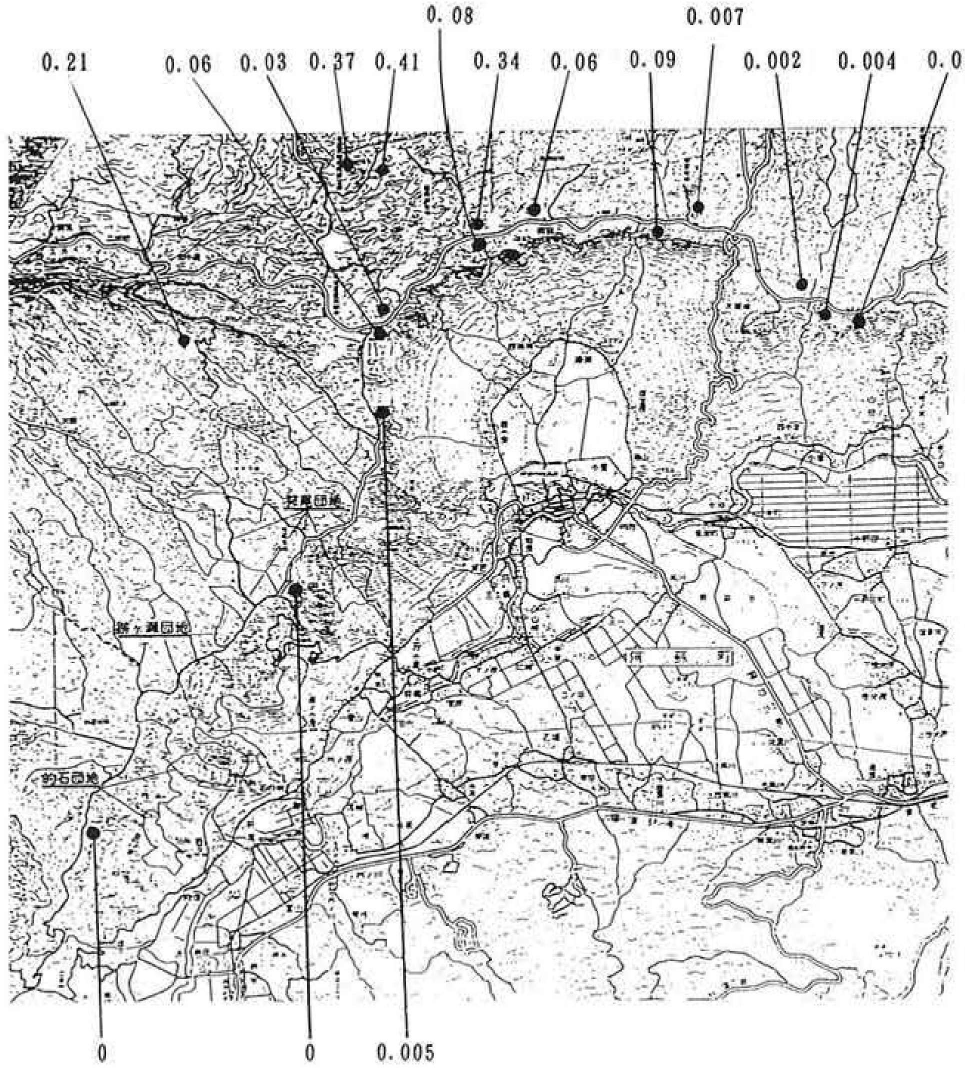

Fig. 5. Degree of recovery (DR) of nezasa bamboo over grassland of northern somma of Aso in 1994
When nezasa bamboo was not found, DR value was 0. When nezasa bamboo completely recovered, DR value was 1.

higher than in 1990. Therefore, it was considered that nutrition factors, decrease of nitrogen content and increase of C/N ratio associated with the decrease of the nitrogen content, were not involved in the promotion of flowering. Since the carbon content in nezasa bamboo was not analyzed in this study, it could not be confirmed whether the increase of the C/N ratio due to the increase of the carbon content caused flowering. As for the cycle theory, since there are no detailed records of flowering in the Aso area, the theory could not be verified.

In the year before flowering, grazing started in June, because there was a large amount of herbage (Fig. 1, Plate 1). However, in the years of flowering and after flowering, grazing could not start in June due to the small amount of herbage (Fig. 2, Plate 2). Therefore, grazing started 1 month later, from July. In the summer of the year of flowering the steep slope was eroded by the trampling of cows, which may be due to the death of underground parts of nezasa bamboo and beef cows could not be grazed after the summer. As a result, in the years of flowering and after flowering, the grazing period became shorter and the grazing capacity was reduced.

Nezasa bamboo produced a large number of seeds in 1992. Otaki & Nasu[4] counted the number of seeds and determined the germination percentage. The number of seeds was 1,037 m^{-2} and the germination percentage was 76%. Matumura et al.[1] reported that seeds germinated on thickly accumulated litter, but that many of them died at a very young stage of growth due to the failure of radicle penetration and further development of the root system. In the Aso area many nezasa bamboo seeds germinated[4], but in 1994 there were few nezasa bamboos. This small number may result from the death of seedlings due to the failure of radicle penetration into the ground and development of the root system. Yano & Takahashi[5] studied the recovery of nezasa bamboo after flowering in Mt. Otafuku. They reported that the community of nezasa bamboo recovered in the 7th year after flowering. In the Aso area the recovery rate of nezasa bamboo was low in the second year (1994) after flowering. This low recovery rate suggests that 10 or more years may be required to obtain a sound nezasa type grassland.

References

1) Matumura, M., Iwata, E. & Saijoh, Y. (1974): Fundamental studies on artificial propagation by seedling of useful wild grasses in Japan. IV. Notes on the reproduction by seeds in nezasa plant, *Arundinaria pygmea* var. *glabra*, in central Japan. *Res. Bull. Fac. Gifu Univ.*, **36**, 389-404 [In Japanese with English summary].

2) Muroi, H. (1966): Cause of bamboo flowering and evil effect of rat on farm produce. *Rep. Fuji Bamboo Garden*, **11**, 7-38 [In Japanese].

3) Muroi, H. & Fujimoto, Y. (1970): Flowering of *Pleioblastus* Sect. Nezasa. *Rep. Fuji Bamboo Garden*, **15**, 96-110 [In Japanese].

4) Otaki, N. & Nasu, R. (1993): Flowering of nezasa dwarf bamboo in grassland in northern somma of volcano Aso. *Botany*, **43**, 19-28 [In Japanese].

5) Yano, G. & Takahashi, Y. (1979): Seed production of flowering nezasa bamboo community and recovery rate of the community. *In* Abstr. 26th annual meeting of the ecology society of Japan, 162 [In Japanese].

(Received for publication, January 9, 1996)