

スズタケの生態に関する研究(IV) : 個体生長と光合成

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Ecological Studies of Suzutake (*Sasa borealis*) (IV) Individual Growth and Photosynthesis

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Abstract

The growth of new culms and the seasonal changes of photosynthetic ability were investigated.

1) The new culm of Suzutake begins to sprout when the daily mean soil temperature at the depth of 10 cm go up to about 10°C and finishes its elongation within two months.

2) After the completion of culm-elongation, the new leaf begins to unfold and finish it completely by ten days or more. The unfolding of all leaves have been completed within 30~50 days following the first-leaf appearance.

3) The photosynthetic ability of new leaves is higher than in any old leaf.

4) As the optimum condition in photosynthesis, temperature should be about 20°C and light intensity, 30 klux and more.

5) Although the photosynthetic ability of a new leaf continued to increase until late in the first growing season, it decreases rapidly at a temperature below 0°C. The decreased photosynthetic ability hardly recovers.

6) It became evident that the photosynthetic ability of shade leaf is higher than that of a sun leaf in low light intensity and Suzutake was found to be a shade-enduring plant.

Introduction

Among *Sasa* species appeared characteristically in the temperate forests of Japan, Suzutake (*Sasa borealis*) is distributed widely from Hokkaido to Kyushu. However, its distribution is limited to high mountainous regions in Shikoku and Kyushu. In general, Suzutake grows close to the forest floor, thus preventing other plants from taking root. Also, the rhizomes of Suzutake are very well developed and tightly binds the surface soil, effectively ensuring their continuous presence. Many research papers are available on the ecology of *Sasa* species (AGATA *et al.*, 1976) (AGATA *et al.*, 1978) (AGATA *et al.*, 1979) (KAWAHARA *et al.*, 1977a) (KAWAHARA *et al.*, 1977b) (KAWAHARA *et al.*, 1978) (OHSHIMA, 1961a) (OHSHIMA, 1961b) (OHSHIMA, 1961c) (SAKURAI, 1983a) (SAKURAI, 1983b) (UEDA *et al.*, 1958) (USUI, 1961) (YOSHIDA, 1950) etc, but few deal with Suzutake.

The present authors have investigated the development of a natural Suzutake

community for twelve years and reported the stratum structure and age structure of the community (YURUKI *et al.*, 1977) (YURUKI *et al.*, 1984). In the present paper, the growth of new culms and seasonal changes in photosynthetic ability are studied.

Materials and Methods

The Suzutake used in this investigation were transplanted to pots in Kyushu University Forest Nursery in Kasuya (70 m in altitude) from Kyushu University Forest in Miyazaki (1000 m in altitude) in December, 1983, and grown in the open and under 20% full-light.

The growth of new culms and leaves was measured periodically, and the soil temperature at a depth of 10 cm and air temperature at a height of 150 cm were measured using a thermocouple. The photosynthesis of a leaf fixed to an assimilation box without excision was measured with an infra-red gas analyser. Furthermore, measurements were carried out using the same leaf throughout the period of study. Assimilation temperature was measured with a thermocouple placed in contact with the reverse side of the leaf.

Results and Discussion

1. A relationship between growth of new culms and temperatures

As shown in Fig. 1, new culms began to sprout in late March when the daily mean air temperature (in the open) went up by about 10°C. The shoots of Suzutake are assumed to start being active with rise in soil temperature rather than air temperature. The daily mean soil temperature (Y) at a depth of 10 cm is related to the daily mean

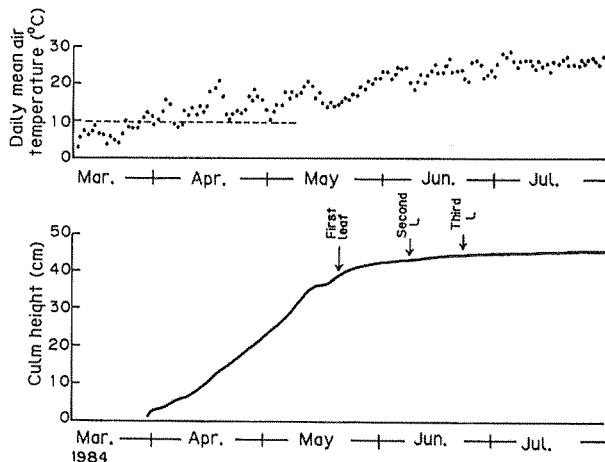


Fig. 1 Growth of new culm

air temperature (X) at a height of 150 cm as follows :

$$Y = 0.2934 + 1.0157X \quad r = 0.9878$$

Daily mean temperature : (daily maximum temperature + daily minimum temperature) / 2

From this linear function, the daily mean soil temperature is about 10°C when the daily mean air temperature is 10°C. As previously reported (YURUKI *et al.*, 1977), we found new culms to appear when the daily mean air temperature rose to 12~13°C in a natural community. A natural Suzutake community is covered by an upper crown, being unlike the potted Suzutake, and thus the relation between air temperature and soil temperature in a community may differ from that in a pot. It was anticipated that the daily mean soil temperature would eventually rise to about 10°C with a daily mean air temperature of 12°C in a natural Suzutake community.

Several reports indicate a correlation between culm growth of *Sasa* species and temperatures. YOSHIDA (1950) found Kumaizasa (*Sasa paniculata*) to become physiologically active at a soil temperatures above 10°C. According to UEDA *et al.* (1958), the shoots of Kenezasa (*Pleioblastus pubescens*) began to emerge from the soil surface at a mean air temperature of about 17°C. Tokugawazasa (*Sasa tokugawana*) began to sprout in early May when the air temperature was about 12°C (SAKURAI, 1983b). The sprouting temperature of Suzutake is considered to be essentially the same as that of Kumaizasa and Tokugawazasa.

A new culm completes its elongation within two months following its appearance and it corresponds to the period of daily mean air temperature from 10°C to 25°C. New leaves begin to unfold after the completion of culm elongation. This phenomenon suggest that the leaf unfolding has a close relation to the culm development. During the initial stage, a leaf has a rolled letter-form and its development complete by ten days or more. A new culm has 3~4 attached leaves under normal conditions. The

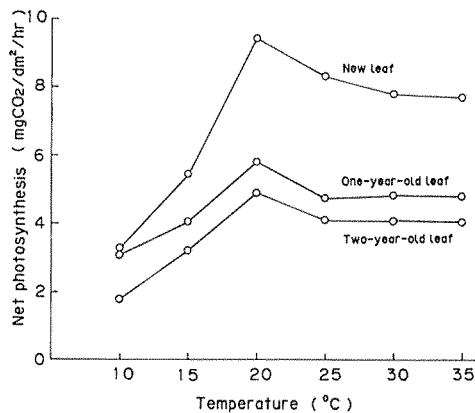


Fig. 2 The relationships between net photosynthesis and temperature

unfolding of all leaves was noted to be complete in the present study within 30~50 days following the first-leaf appearance. In regard to the unfolding season, no difference between the leaf of a new culm and that of an old culm was noted.

2. Photosynthetic ability

The relations of photosynthetic ability to temperature and light intensity were investigated on the Suzutake grown in the open.

Fig. 2 shows the relation between temperature and photosynthesis. The maximum photosynthetic rate appeared at 20°C, irrespective of leaf age, and accordingly, the optimum temperature for the photosynthesis of Suzutake was noted to be at about 20°C. The optimum temperature of Suzutake is nearly equal to that of an upper tree (*Fagus crenata*) (HAN *et al.*, 1978).

The relation between photosynthesis and light intensity is shown in Fig. 3. Photosynthesis was saturated at about 30 klux and more. Also, the light saturation point changed with growth. The photosynthetic ability of a new leaf rose rapidly within a short time following unfolding and in September it was higher than that in July. As shown in Fig. 2 and 3, a new leaf had higher photosynthetic ability than an old leaf. Also, photosynthetic ability decreased with leaf age. The photosynthetic ability of Suzutake was nearly equal to that of *S. kurilensis* (OHSHIMA, 1961c).

Fig. 4 shows seasonal changes in the photosynthetic ability of a new leaf. This ability increased rapidly after the unfolding and became higher than that of old leaves within a short time. This characteristic tendency was noted particularly in the leaf unfolded in 1986. Furthermore, the high photosynthetic ability continued until the beginning of December, followed by a rapid decrease. WAKASUGI (1985) also founded this ability in Mosochiku (*Phyllostachys heterocycla* var. *pubescens*) to decrease rapidly after reaching its highest value in December. Judging from changes in daily minimum

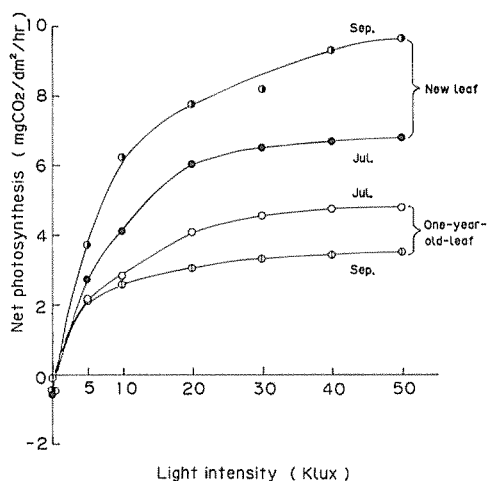


Fig. 3 The relationships between net photosynthesis and light intensity

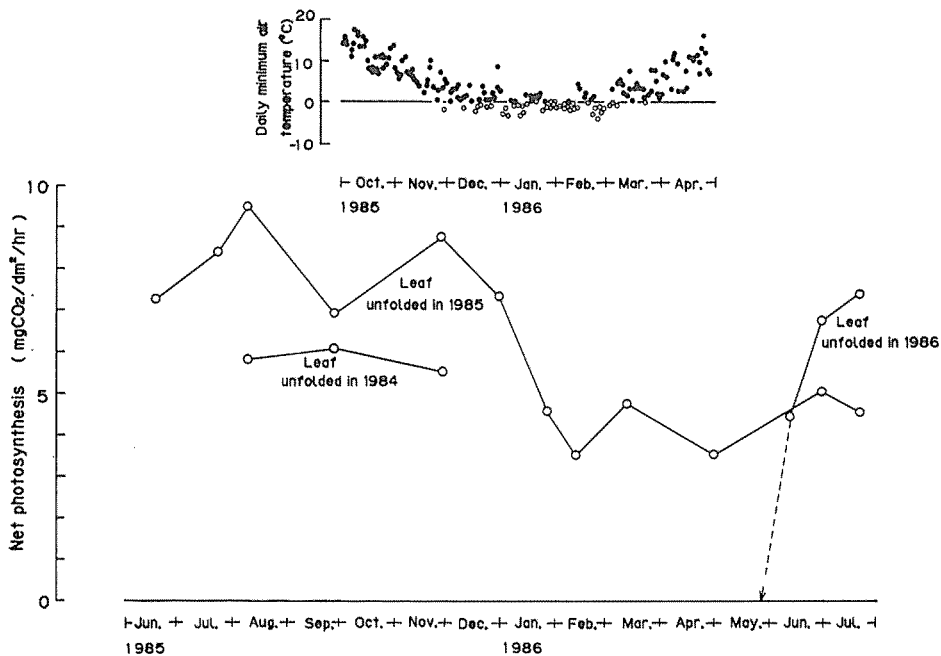


Fig. 4 Seasonal changes of photosynthetic ability

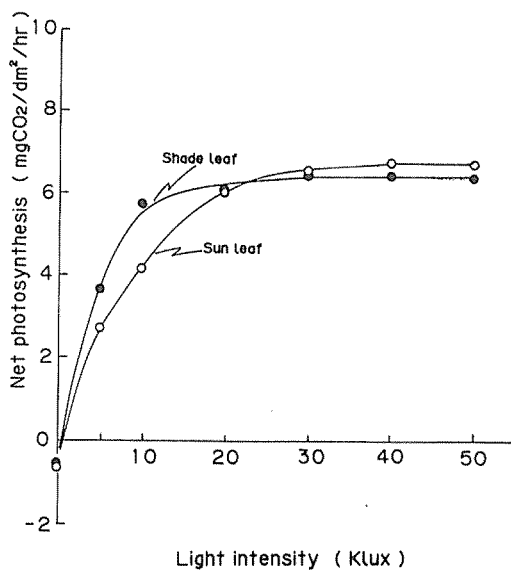


Fig. 5 Comparison between shade leaf and sun leaf

temperature, it is obvious that photosynthetic ability decrease rapidly when the daily minimum temperature falls below 0°C. Even with a rise in temperatures again in the spring, the decreased photosynthetic ability hardly recovers. Thus, the decline in photosynthetic ability in a new leaf appears to be related to a cold wave. It is generally known that when *Sasa* leaves are exposed to a dry, chilly wind, their peripheral parts wither and become in white. The new leaves which had been completely green at an early growth stage, fade slightly white during the first winter season. Possibly, such damage give influence on physiological activity of leaves.

Suzutake is a main constituent species of the undergrowth of Japanese beech (*Fagus crenata*) forests and usually grows in a fairly poorly lighted environment. Thus, Suzutake may be a shade-enduring plant. AGATA (1976) found Suzutake to photosynthesize efficiently under conditions of poor light. In the present study, Suzutake was raised under 20% full-light and the photosynthetic ability of a shade leaf was compared with that of a sun leaf. As shown in Fig. 5, at high light intensities, the photosynthetic ability of a shade leaf was essentially the same as that of a sun leaf. However, the photosynthetic ability of a shade leaf was noted to be higher than that of a sun leaf at low light intensities. This is also an evidence that Suzutake is a shade-enduring plant.

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スズタケの生態に関する研究 (IV) 個体生長と光合成

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要 旨

スズタケの稈の発生と葉の光合成能を鉢植えのスズタケでしらべた。新稈は土壤温度(深さ 10 cm)が 10°C 以上になると伸び始め 2 カ月以内にその伸長を終了した。新葉は稈の伸びが終ってから展開を始め 10 日前後で完全に開いた。すべての葉の展開は 30~50 日間で終わった。スズタケの光合成は新葉がもっとも高く年齢の高いほど低くなった。光合成の最適条件は温度 20°C, 照度 30 klux 以上であった。新葉の光合成能は最初の生長期の終わりまで高い水準を維持し, 0°C 以下の低温に遭遇すると急速に低下した。この低下した光合成能の再上昇は殆どみられなかった。弱い光の下では陰葉の光合成能は陽葉に比べ比較的高く, 耐陰性の高い植物であると推定された。