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Effect of Soil Covering on Growth and Blanching of *Allium victorialis* L. ssp. *platyphyllum* Hult.

Toshinari KANAZAWA*, Hideaki SUZUKI, Hajime ARAKI**,
Takashi HARADA and Toshiro YAKUWA
(Department of Horticulture, Faculty of Agriculture, Hokkaido University, Sapporo 060, Japan)
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Introduction

Allium victorialis L. ssp. *platyphyllum* Hult., belonging to *Allium* species, is a perennial wild plant which distributes widely in northern Japan, especially in Hokkaido and Tohoku district, and grows in forests of mountainous areas[1-3]. Because its harvested leaves have a strong garlic-like flavor, *A. victorialis* is valued as an edible plant, and recently the demand of the plant is gradually increasing. When they begin to grow in early spring, large amounts of these plants, which are wholly harvested by cutting at the basal portion of a leaf sheath, are available consumption. Thus, its long leaf sheaths and leaf blades make it a popular vegetable. In Japanese bunching onion (*Allium fistulosum*), soil covering or ridging is generally known as a suitable method for blanching, because this method has been proved to make white parts of leaf sheaths long and to result in a high yield[4-6]. However, the blanching of *A. victorialis* is also in great demand because of its noticeable appearance like the Japanese bunching onion. Therefore, there is a very great need for a blanching method. This study was carried out mainly to develop a suitable method of blanching of *A. victorialis*.

Materials and Methods

1. Effect of soil covering thickness on leaf growth

Adult plants of *A. victorialis* that were grown on the Experimental Farm of Hokkaido University were used as plant materials. On 10 April, 1991, when no plant started to grow, the soil surface was completely covered with soil. Effects of soil covering were tested using 4 different soil thicknesses (2 replications for each thickness) : 0 (control), 5, 10 and 15 cm thick. A unit of planting plots was 2 m^2 (2 m × 1 m), and the space for each thickness treatment was surrounded with wooden boards (forming walls about 30 cm in height) (Fig. 1).

After 2 weeks of treatment, using 15 plants harvested, plant height, diameter of leaf sheaths, diameter of basal leaf sheaths, and fresh weight of leaves (a sprout leaf and a foliage leaf) were

Present address
*Faculty of Education, Iwate University, Morioka 020
**University Farm, Niigata University, Muramatsu, Niigata 959-17

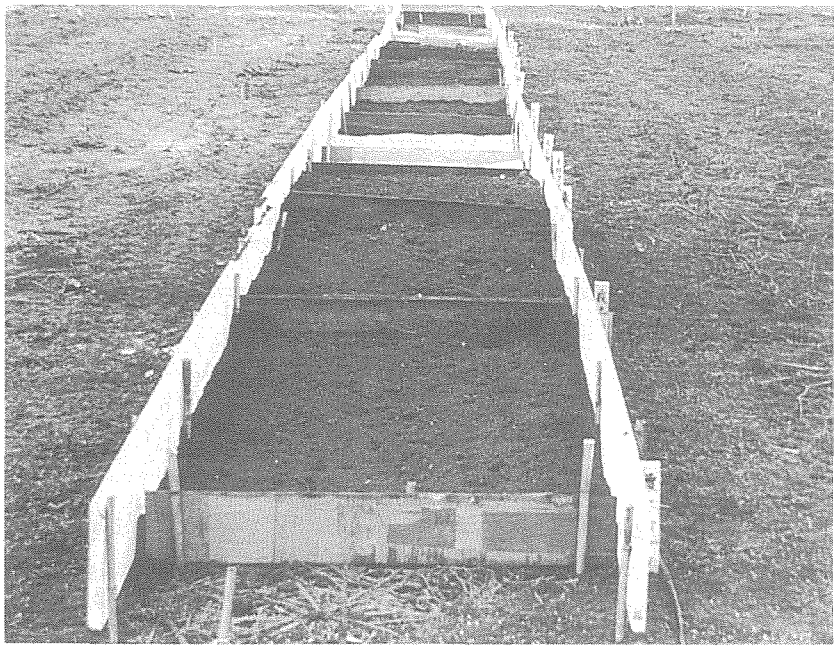

Fig. 1. A view of soil covering.
Each planting plot was surrounded with wooden boards (forming walls about 30 cm in height).

recorded. The sprout leaf was divided into 2 parts, a violet (upper) and white part (lower), and the length of each part was measured. Additionally, after 3 months of treatment, when plants completely finished expanding their foliage, both the plant height and the length of leaf sheaths of the 1st leaf were also measured.

2. Effect of soil covering thickness on cortical cell size

After 3 weeks of treatment, 15 plants were harvested in 2 treatments (control and 10-cm thickness of covering soil). The leaf sheaths of a whole plant were uniformly divided into 3 parts (upper, middle and lower). The cortical cell layers [about 1 cm^2 (1 cm×1 cm)] were carefully excised from the external cell layer on the outside surface of each part, and fixed in Carnoy's fluid (ethanol : acetic acid ; 3 : 1 in volume) for 24 hours. Ten samples were separately put on a slide glass and covered with a cover glass, and then both the length and width of cells were measured with a micrometer under the microscope.

Results

1. Effect of soil covering thickness on leaf growth

After 2 weeks of treatment, at both 5-cm and 10-cm thickness of covering soil, the tips of sprout leaves emerged above the ground, and the foliage leaves subsequently appeared throughout. The length of sprout leaves increased in both the treatments, particularly at 10-cm thickness of covering soil, reaching 13.7 cm (Fig. 2). On the contrary, the length of foliage leaves decreased as the

Fig. 2. Blanching effect of soil covering. Photos of 2 different plants sampled in noncovering (control, left) and covering (right) treatments after 3 weeks of treatment. Bar indicates 10 cm.

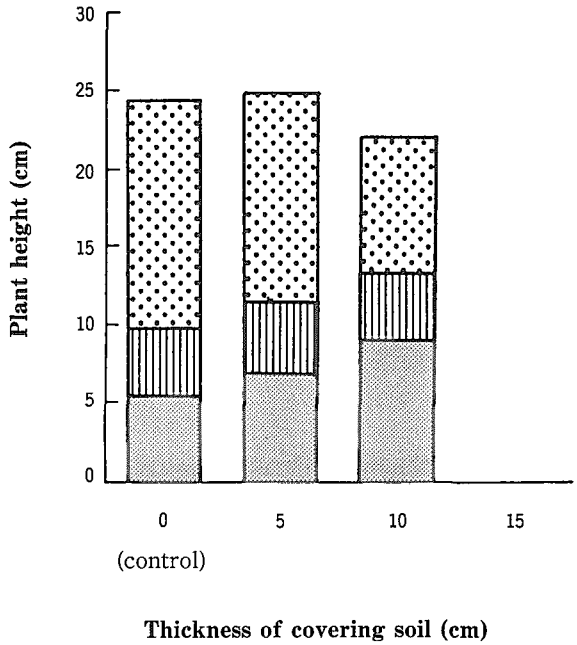

Fig. 3. Effect of thickness of covering soil on plant height.
Data were obtained following 2 weeks of treatment. ⊡, foliage leaf ; ▥, sprout leaf (violet part) ; ▩, sprout leaf (white part).

Table 1. Effects of thickness of covering soil on growth of leaf sheaths and leaves[z].

Thickness of covering soil[y] (cm)	Diameter of leaf sheath (mm)	Diameter of basal part of leaf sheath (mm)	Fresh weight of leaves (g)
0 (control)	7.2	10.0	9.0
5	8.1	10.9	10.4
10	7.9	10.9	10.4
15	–	–	–

[z]After 2 weeks of treatment.
[y]No plant emerged above ground in the 15-cm-thick soil covering.

covering soil thickened, and merely because 8.7 cm. However, with 15-cm thick covering soil, no plant ever emerged above ground. After a few days of treatment, sprout leaves in control started to elongate, and thereafter foliage leaves developed throughout the sprout leaves. In the control, the average diameter of leaf sheaths reached a comparatively small value of 7.2 cm, and little difference in the length of basal leaf sheaths was observed among the 3 treatments (Table 1). Concerning sprout leaf, although the length of a violet part (upper part, pigmented by anthocyanin) showed little difference among the 3 treatments, the white part (middle and lower) pushed up through the soil covering (Fig. 3). Fresh weights of leaves in both 5- and 10-cm thick covering soil

Table 2. Effects of thickness of covering soil on plant height and length of leaf sheath of the 1st leaf[z].

Thickness of covering soil (cm)	Plant height (cm)	Length of leaf sheath of the 1st leaf (cm)
0 (control)	41.1	7.7
5	50.5	11.5
10	52.5	12.9
15	54.2	13.2

[z]After 3 months of soil covering.

were 10.4 g, showing a slight difference compared with that in control.

After 3 months of treatment, the soil covering promoted plant growth, and the plant height ranged from 50.5 to 54.2 cm (Table 2). Leaf sheaths of the 1st leaf in the covering treatments consequently became long, and the expanded foliage leaves grew higher in terms of the thickness of covering soil (Fig. 4). The basal portions of foliage leaves in 15 cm-thickness-covering treatment partially turned yellowish green because the leaves continued to expand through the soil.

Fig. 4. Appearance of leaf sheath.
Photos of 2 different plants sampled in noncovering (control, left) and covering (right) treatments after 3 months of treatment. Expanding foliage leaves were high in soil covering treatment.

2. Effect of soil covering thickness on cortical cell size

The cortical cell size was remarkably different among the 3 parts of a leaf sheath (Table 3, Fig. 5). In each part of a whole plant in both covering and noncovering treatments, the cells were small and dense in the upper part, but evidently longer in the middle and lower parts. In control, the cells of leaf sheaths were relatively small (357.1 μm-505.5 μm in length) and crowded together. The blanched leaf sheath in soil-covering treatment was vertically composed of long cells (407.4 μm-639.8 μm in length), as different from that in the control. Little difference in width of cortical cells was recognized between covering and noncovering treatments : 67.0-74.4 μm in the covering and 64.5-67.8 μm in the noncovering.

Table 3. Effects of thickness of covering soil on length and width of cortical cell of sprout leaf[z].

Thickness of covering soil (cm)	Part of sprout leaf	Length of cortical cell (μm)	Width of cortical cell (μm)
0 (control)	Upper	357.1	74.4
	Middle	505.5	67.0
	Lower	463.7	71.9
10	Upper	407.4	64.5
	Middle	639.8	67.8
	Lower	568.8	66.6

[z]After 3 weeks of soil covering.

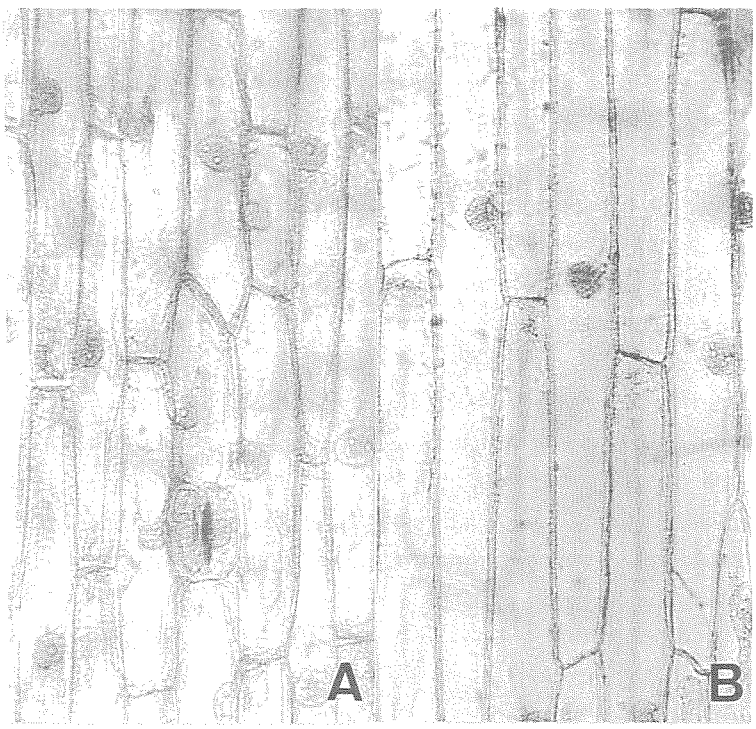

Fig. 5. Histological observation of sprout leaf cortical cells. Cortical cells of sprout leaves in noncovering (A) and covering (with 10-cm-thick soil) (B) treatments were sampled after 3 weeks of treatment.

Discussion

In treatments of both 5- and 10-cm thick soil covering, sprout leaves elongated vigorously in most of the plants, whereas in the 15-cm thick of covering soil, a small number of plants appeared above the ground, in some of which the foliage leaves elongated incompletely and were left in covering soil.

After 1 month of treatment, when the elongation was completed, most plants had appeared above ground and the foliage leaves emerged became gradually high depending on the thickness of covering soil. From the results, it was concluded that a suitable thickness of covering soil was essential for soil covering, because of the disadvantage of requiring a long period for sprout leaf elongation. Additionally, foliage leaf emergence above the ground was delayed.

Japanese bunching onion is known to have more foliage leaves than *A. victorialis*[3,5]. Accordingly, as the foliage leaves elongating throughout leaf sheaths decayed completely and lost chlorophyll by soil covering, the leaf sheaths blanched and appeared white.

On the other hand, in *A. victorialis,* only a limited number of sprout leaves and foliage leaves emerged within a year (1-3 sprout leaves and 1-4 foliage leaves), because of a small number of leaf primordia formed in the shoot apex[3]. *A. victorialis* had sprout leaves which appeared above the ground before expansion of foliage leaves, as in a garlic plant (*Allium sativum*). Because the elongating sprout leaf was covered with thick soil, the blanched sprout leaf appeared to be white. Thus, the blanching of *A. victorialis*, in which sprout leaves lost chlorophyll and their color turned white by soil covering, was found to be systematically different from that of Japanese bunching onion.

The cortical cells in treated plants, particularly at the middle part of a sprout leaf, were apparently long. In Japanese bunching onion, it is also reported that the cells in the blanched leaf sheaths were different between the upper and lower parts[4]. Accordingly, the cells were dense in the upper part, and rather loosely arranged in both the middle and lower parts. In *A. victorialis*, the difference among the 3 different parts was recognized and generally considered to be related closely to the elongation of cortical cells, as in the Japanese bunching onion.

These results indicate that a sprout leaf of *A. victorialis*, and its white part in particular, can be elongated by soil covering. The suitable soil thickness for elongation of sprout leaves was supposed to be between 5 and 10 cm. Consequently, it was clarified that the soil covering should be performed before sprouting last autumn, because the elongation of sprout leaves occurred as the temperature rose in early spring.

Summary

This study was mainly carried out to establish a suitable method for blanching plants of *Allium victorialis* L. ssp. *platyphyllum* Hult. Sprout leaves elongated vigorously in treatments of both 5- and 10-cm thick soil covering. In 15-cm thick covering soil, a small number of plants appeared above ground, and some foliage leaves elongated incompletely and were left in covering soil. The blanching of *A. victorialis* plants was found to be systematically different from that of the Japanese bunching onion. In addition, the blanching of *A. victorialis* plants was considered to be related closely to elongation of cortical cells as in Japanese bunching onion (*Allium fistulosum*). A covering soil thickness (5-10 cm) seemed suitable for elongation of sprout leaves.

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ギョウジャニンニクの生育に及ぼす萌芽前の培土の影響

金澤 俊成*・鈴木 秀明・荒木　肇**・原田　隆・八鍬 利郎

北海道大学農学部園芸学講座
*現在：岩手大学教育学部
**現在：新潟大学農学部附属農場
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摘　　要

ギョウジャニンニク（*Allium victorialis* L. ssp. *platyphyllum* Hult.）の生育に及ぼす萌芽前の培土の影響について実験を行った。

1．萌芽前に培土を行うことにより，萌芽葉の伸長を大きくすることが可能で，展葉完了後の草丈も大きくなった。
2．萌芽前に培土を行うことにより，葉鞘部を白く（軟白）することが可能であった。
3．培土の厚さは5～10 cm程度が適するものと考えられた。
4．培土を行うことにより伸長した萌芽葉では，中央部から基部の表皮細胞の伸長が観察された。