

Morphological characteristics of wasabi (*Wasabia japonica* Matsumura)

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Abstract : Morphological characteristics of wasabi were investigated. Wasabi, which is originated in temperate Asian area such as Japan, belongs to crucifer and is perennial. Leaf and lower stem are usually harvested. An edible portion of wasabi, which is commonly stated as a rhizome is suitable to name a shortened and swollen stem. Swollen stem is grown usually underground. Bottom part of petiole is also swollen. Some offshoots are arising from basal nodes of stem and are used for propagation. There are four petals, six stamen and a pistil in the flower.

(Accepted September 25, 2000)

Key words: Wasabi, Cruciferae, Morphology, Stem

Introduction

Wasabi, *Wasabia japonica* Matsumura, is a native plant of Japan and is distributed throughout from Hokkaido to Kyushu (Adachi, 1988). Wasabi belongs to the family Cruciferae. The other species of the genera wasabi is *Wasabia tenius* (Miq.) Matsum, which is commonly known as "yuri" wasabi and is not cultivated as a crop. The cultivated species *Wasabia japonica* is commonly known as "sawa" wasabi.

In habit wasabi is a glabrous perennial herb superficially resembling cousin species of the closely related genera *Cardamine*, *Cochlearia* and *Nasturtium* sharing a similar habitat preference (Hodge, 1974). Naturally wasabi grows in the mountains (200-1,000m elevation) on the wet banks of cool mountain streams and springs. Wasabi, a shade loving plant, is more or less evergreen and forms sizable clumps (Hodge, 1974).

The edible portion of wasabi is loosely described as stem (Palmer, 1990, Chadwick et al.,1993), rhizome (Yokogi & Ueno, 1971, Adachi, 1988), rootstalk (Hodge, 1974), and even sometimes root (Yokogi, 1952) by different authors in Japanese and English. This creates confusion among the readers. Side shoots developed from the axillary buds are also have not been described in proper biological term and has been described variously as side shoot (Palmer 1990), offshoot (Adachi, 1988; Chadwick et al.,1993), runner (Chadwick et al.,1993), suckers etc. In this report we are describing the morphological characters of wasabi organs in detail with proper botanical term.

Materials and Methods

Cultivar of Wasabi, 'Daruma - 3' which is growing in hydroponic condition at Faculty of Agriculture, Kagawa University, is used as a material. Ten plants were sampled one month interval from March 1, 1999 to August 30, 1999. After sampling wasabi plants were divided into parts and were observed morphologically.

Results and Discussion

Leaf: Figure 1 shows the dorsal (top side) and ventral side (reverse side) of a mature wasabi leaf. Wasabi

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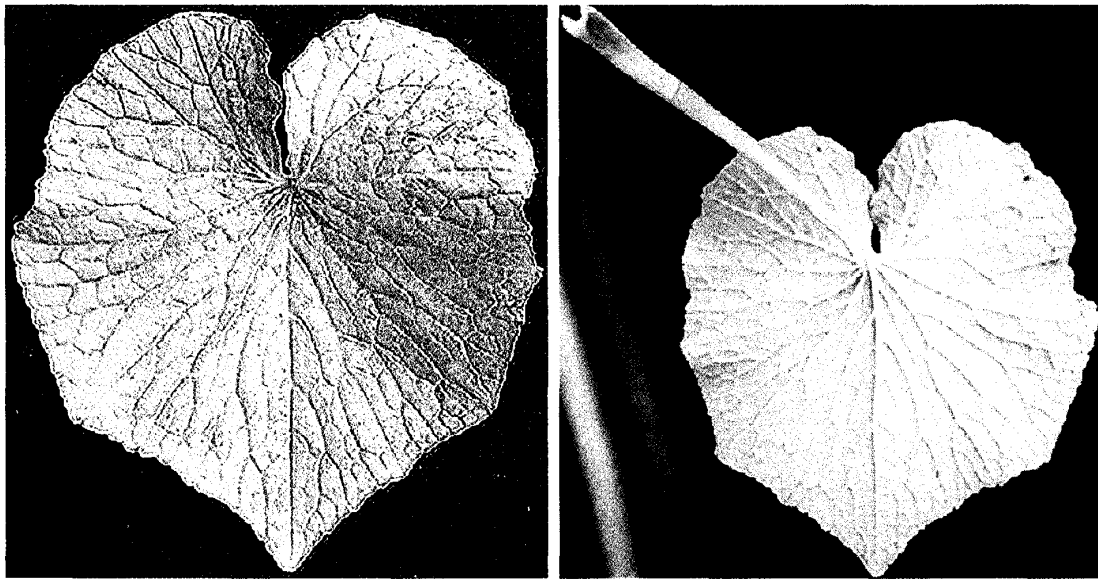


Fig. 1. Dorsal (top side) and ventral side (reverse side) of a matured wasabi leaf.

leaves are petiolate simple, cordate or heart shaped with narrow sinuses (depression), green in color having no hair on the surface (glabrous). Lamina is glossy on the dorsal surface. Leaf margin is undulated and serrate (toothed) and apex is slightly rounded. Leaf veins are palmate, radiating from the leaf petiole and protruding on the ventral side. The leaves have a purple appearance when emerging and turns into green as they expand. Leaf size is up to 25 cm in diameter. Leaf petioles is up to 50cm long (Adachi, 1988). Petioles which have flattened base partly surrounding the stem, are both cauline (arising from the upper part of the stem) and radical (forming a basis or foundation) from the stem (Ohwi, 1984). Surfaces is smooth and light green in color sometimes having purple tint due to the presence of anthocyanin pigment, particularly at the base. The cross section of the petiole at the base is crescent shaped which becomes elliptical at the laminar end. Mature petioles are vertical or oblique.

Stem: Figure 2 shows the sketch and photo of a young stem of wasabi. Wasabi stems are simple, leafy and usually without branching. The stem is cylindrical and pointed at the terminal bud. The radical leaves are spirally arranged on the stem base. In the cultivated species the stem can be up to 40 cm long and 5 cm in diameter (Cahdwick et al., 1993). At young stage the stem has very few scars left by the dead leaves and rather smooth (Fig. 2). The diameter of the stem grows larger with the age, giving the matured stem a conical shape (Fig. 3). In some cases the earlier part of the stem is lost due to wasting disease leaving a black scar at the lower end (Fig. 4). At the young stage it is easily distinguishable as a stem rather than a rhizome or rootstalk. The presence of nodes and buds clearly nullifies the possibility of it being termed as a root. As the stems become matured, the scars left by the dead leaves become more crowded giving the stem a very rough appearance (Fig. 3).

The tap root system of wasabi never grows strongly but is degenerated shortly afterwards. Numerous adventitious roots originated from the nodes of the bottom stem part replace the tap root which are not so strong to support the plant vertically (Figs. 2, 4). But, it is the stem that has to support the plant by being partly buried in the sand or by leaning against the surface. In fact the stems are not necessarily subterranean, neither they do grow horizontal. Naturally they grow erect on the gravel of the wet bank of the streams. Sometimes due to erosion the supporting sand is lost which causes the plant to take a horizontal posture. For this reason in many cases the matured stems are curved. (Fig. 3). The stem grows upward as the leaves die out in contrast to the usual rhizomes, which grows horizontally as a rule. In some cases part of the stem gets buried under the sand carried by torrents. If not buried by the sand, they are usually green in color.

Axillary buds can be found any where (Fig. 5) in leaf remnant scars on the stem but more frequently close to the tip. Many of them may extend into sizable new plants. But some of them may remain quite dormant. The new shoots arising from the main stem vary in size having comparatively smaller stems of their own.

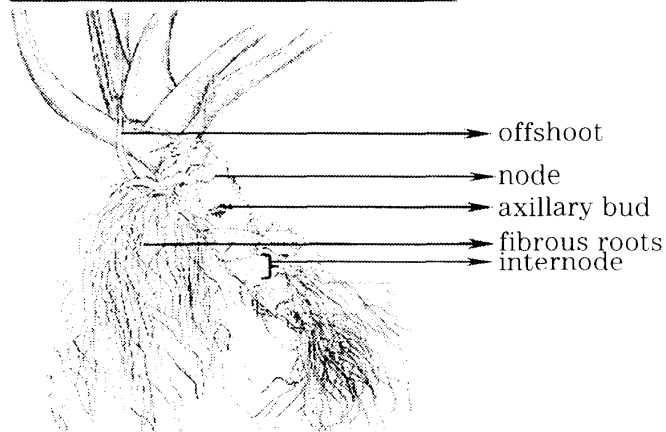
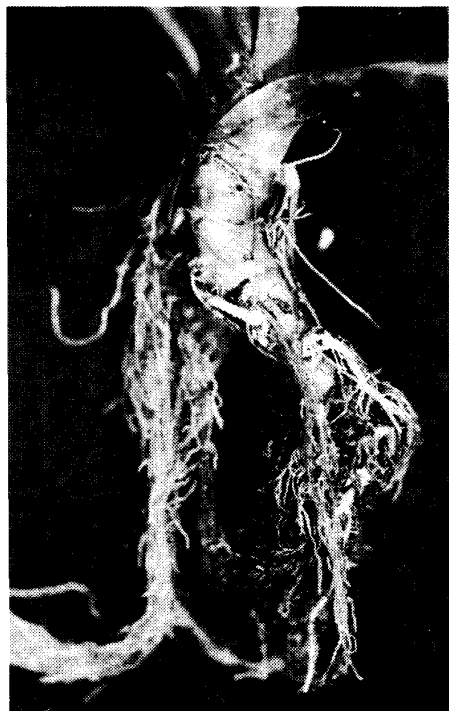


Fig. 2. Photo and sketch of a young wasabi stem.

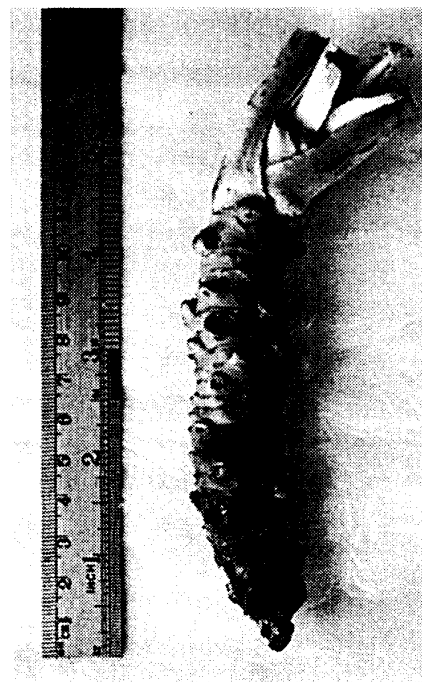


Fig. 3. A medium sized matured stem of wasabi.

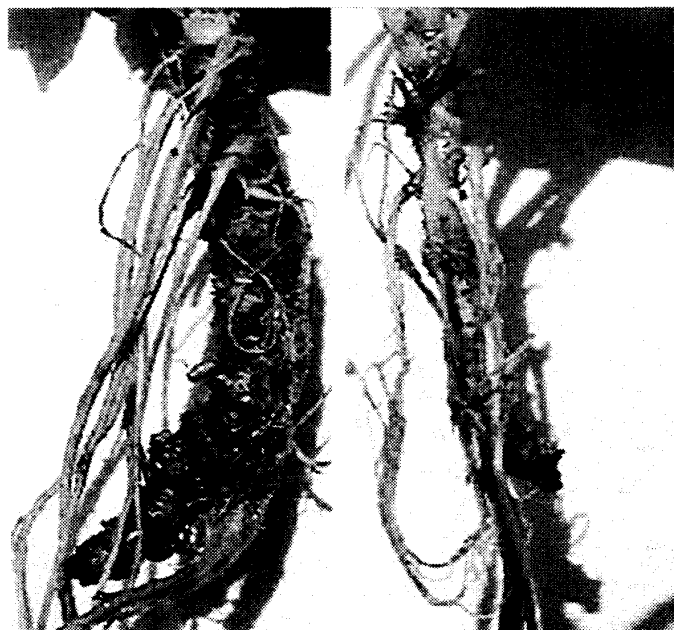


Fig. 4. Young stems of wasabi showing degeneration of early part of the stem leaving a black scar at the bottom and adventitious root development.

Considering the definitions given by Preece & Read (1993), the new shoots can best be defined as offshoots and not runners or suckers.

Root: The tap root system is replaced by numerous fibrous roots developing from the nodes (Figs. 2,4). Some of them become thick and long sometimes assuming green color and are distributed sporadically on the stem. Others are white and fibrous mostly originating from the ends of the stem. The white thin roots may be about 30 cm in length, while the thicker roots are even longer and also carry white fibrous roots at the end.

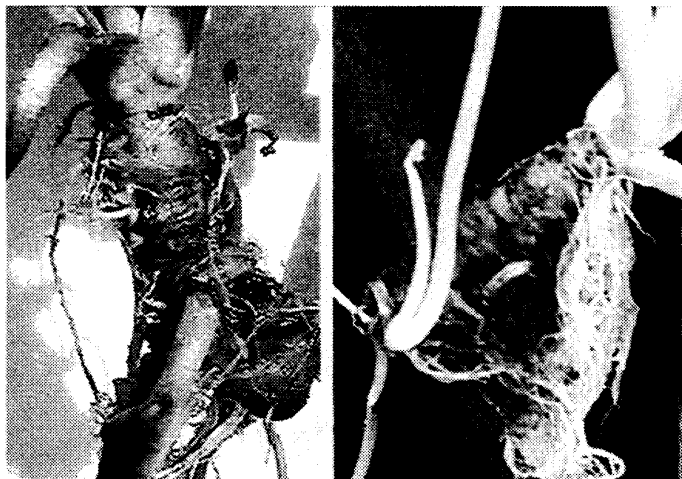


Fig. 5. Development of offshoots on the stem of wasabi.



Fig. 7. Flower of wasabi.

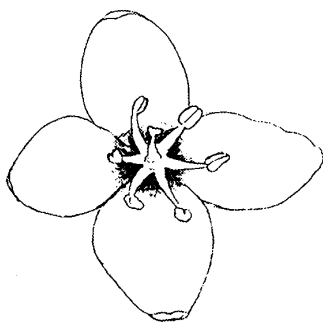


Fig. 6. Indeterminate peduncle of wasabi with terminal inflorescence.

The fibrous white roots may be well above 50 in number. They are more vigorous in flooded condition and do develop within few months of transplanting.

Flower: Several peduncles (up to 10 in number, Adachi, 1988) may emerge from the axillary buds depending on the growth of the plant in the late winter to early spring. The peduncle is leafy and indeterminate in nature (Fig. 6) having a terminal inflorescence, may occasionally have secondary inflorescence. The peduncle is up to 2 mm in length (Chadwick et al., 1993). The leaves on the peduncle are smaller and their shapes are quite different from the normal leaves often being deltoid or ovate having more pronounced undulation and a pointed or acute tip. Flowers are cruciform (Fig. 7), white, bracteate, arranged on racemes, ascending sepals, obovate petals, perfect septum, elongate styles and simple stigma. (Ohwi, 1984). Flowers away from the tip of the peduncle bloom first. White four petals are about 8-9 mm long and the style is about 2 mm long (Chadwick et al., 1993). The plants apparently being self-incompatible fertilization (Palmer, 1990) is primarily by cross pollination.

Pods and seeds: The pods are siliques and green in color, with a prominent midrib and pointed tip, about 2 cm long, linear, oblong, having the surface covered with rounded prominence, and cylindrical with membranous valves. The siliques mature along the length of the peduncle. Each contains up to 10 seeds. When matured the pod dehisces along the mid rib starting from the base.

Seeds are 2-3 mm long and about 1 mm wide, pointed at one end and flat on the other (Ohwi, 1984). The seed coat has a light green appearance when partially dried. A thin brown membrane under the seed coat covers the cotyledon and the radicle. Freshly harvested seeds show dormancy and needs vernalization by a period of low temperature.

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ワサビの形態的特徴

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摘要：ワサビ‘だるま-3号’について形態的観察を行った。ワサビは日本など温帯アジア原産植物で、アブラナ科に属し、宿根性である。通常葉と茎の基部が可食部として収穫される。可食部は通常根茎と呼ばれることが多いが、肥厚して短縮化した茎である。肥厚した茎は地中で成育することが多い。葉柄の基部も肥厚している。いくつかの子株が茎の基部から伸張して、繁殖に用いられる。花には4枚の白色の花弁、6本の雄ずいと1本の雌ずいがある。