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# Breeding and Production of Kurume Azaleas (*Rhododendron obtusum* Planch.)

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## ABSTRACT

"Kurume azalea" is a brand name for evergreen azalea cultivars bred in Kurume, Fukuoka, which is located in northern Kyushu, and belong to *Rhododendron obtusum* Planch. with small to medium sized flowers. It is generally accepted that their foundation stocks are hybrids between *R. kiusianum* Makino and *R. kaempferi* Planch., and *R. sataense* Nakai. However, it was recently clarified that some cultivars show characteristics of *R. macrosepalum* Maxim. and *R. ripense* Makino. Kurume azaleas were created about 170 years ago, in the end of Edo era and appreciated indoors as potted plants (*bonsai*). Originally, they had been grown as a hobby among plant lovers. In the 1900's, breeding improvement, production and marketing were greatly advanced by eager floricultural growers. The production of Kurume azaleas has outstandingly increased since the 1950's because of a great demand as a green plant for parks and other public spaces. Kurume azaleas were introduced to Europe and the United States in the 1870's. In Europe, they were loved as a pot culture, and were thus called Belgian florist azaleas. On the other hand, Kurume azaleas were to be loved in the United States because improvement of florist azaleas in Europe were for reduced height and cold hardiness. They are also used as parents to breed evergreen azaleas with increased cold hardiness and flower quality for gardens.

**Keywords:** epidermal cell, evergreen azalea, flower pigment, interspecific hybridization, isozyme, karyotype, stomata, *Sphaceloma* sp.
**Abbreviations: Aat-2**, aspartate aminotransferase-2; **AFLP**, amplified fragment length polymorphism

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## INTRODUCTION

"Kurume azalea" is a brand name for evergreen azalea cultivars bred in Kurume, Fukuoka, in northern Kyushu, and belonging to *Rhododendron obtusum* Planch. (**Fig. 1**). They are characterized by small to medium-small flowers with bright colors and numerous flowers covering the whole crown for the blooming period.

Originally, Kurume azaleas "Kurume tsutsuji (久留米躑躅)" were created by Motozo Sakamoto (1786-1854), who was a retainer of the Kurume feudal clan, and his friends of similar tastes about 170 years ago, in the end of Edo feudal era (Akashi 1905). They were appreciated indoors as potted plants (Bonsai, which is the art of dwarfing trees or plants by growing and training them in small containers. The art was introduced from China to Japan and refined) in this period. Therefore, many cultivars bred in those days had pinkish flowers that reflected brilliantly under weak light condition and exhibited a flower type, hose-in-hose, which retained flowers well because of sterility. In the late 1700's, more over 300 cultivar names were recorded in horticultural books. Azalea cultivars were often announced in the same style as a graded list of sumo that was most popular as a professional spectator sport in Japan in the Edo era (Akashi 1905). This appeals the great popularity of Kurume azaleas in those days.

Since the 1900's, the breed has been greatly improved by eager commercial floricultural growers and over 700 cultivar names have been introduced in seed and seedling catalogs. Hybridization between the Kurume azalea group and other azalea groups also contributed to many superior cultivars. The representative hybrids are Kuwano's intergroup azalea hybrids and 'Shakunan'. The former were bred by crossing the Kurume azalea group and the Satsuki group and bloom between the parents' blooming period. The latter was bred by crossing the Kurume azalea group, the Hirado azalea group (*R. scabrum* hybrid), and others and has beautiful medium to large flowers.

Recently, commercial growers have not been actively breeding and conserving Kurume azaleas because the greening industry in Japan has been depressed in the last long economic stagnation. Although many cultivars are gradually disappearing because of their low marketability, such as low propagative efficiency and a decline in demand, about 350 cultivars are extant. At present, two official organizations lead Kurume azalea breeding and conservation in Japan. One is the Kurume Branch, National Agricultural Research Institute of Vegetables, Ornamental Plants and Tea (currently called Kurume Research campus, National Agricultural Research Center for Kyushu Okinawa Region) located in Kurume. The other is the World Center of Azaleas founded by Kurume City and mainly conducts clonal conservation.

Received: 15 January, 2007. Accepted: 29 January, 2007.

Invited Mini-Review

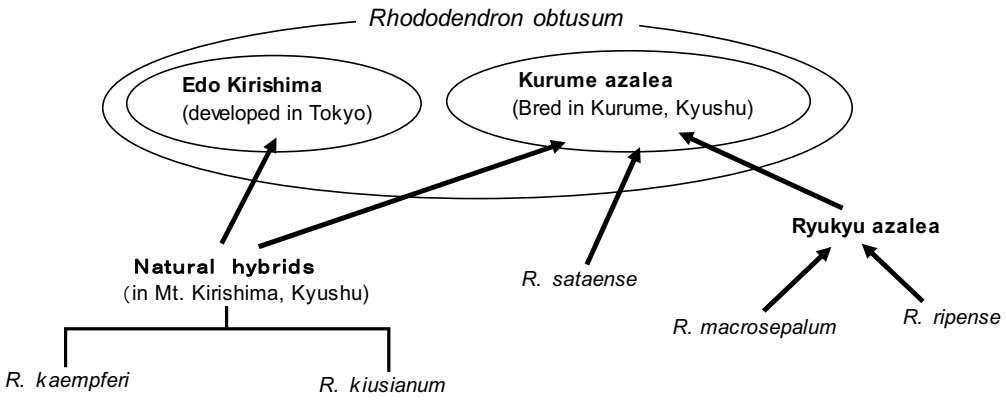


**Fig. 1 Correlation among Kurume azaleas and other evergreen azaleas.**

The former bred a new cultivar, 'Chikushibeni', in 1989. This cultivar is characterized by vigorous growth and bright red flowers (**Figs. 2, 3**). The latter introduced a new cultivar, 'Benikasuri', in 2000. 'Benikasuri' is distinguished by a unique splashed pattern of flowers.

**Fig. 2 Kurume azalea cv. 'Chikushibeni'.**

**Fig. 3 Kurume azalea (cv. 'Chikusibeni') cultivation in Tanushimaru (western Kurume).**

## ORIGINAL SPECIES OF KURUME AZALEA

It is generally accepted that Kurume azalea foundation stocks are natural hybrids between *R. kiusianum* Makino which are distributed in mountainous regions of Kyushu island and have purple flowers and *R. kaempferi* Planch. which are distributed around the base of a mountain in Kyushu island and have scarlet flowers, and *R. sataense* Nakai which grow in the wild in southern Kyushu (Ohsumi peninsula, Mt. Sakurajima and Mt. Kaimon) (Hatusima 1958; Kunishige and Kobayashi 1980; Miyazawa 1918). An early cultivar, 'Susogonoito', is a representative hybrid that exhibits features of a hybrid between *R. kiusianum* and *R. kaempferi*, such as small purple flowers, small leaves, and dwarf size (Miyazawa 1940). Cyanidin, peonidin and malvidin of anthocyanin pigments in the flower petals of Kurume azaleas are derived from *R. kaempferi* and *R. sataense*, *R. sataense*, and *R. kiusianum* and *R. sataense*, respectively (Kobayashi 1980). Miyajima *et al*. (1985) reported finding 5-methyl flavonol in cultivars derived from *R. kiusianum* with red-purple and purple flowers.

Recently, it was clarified that some cultivars possess characteristics of *R. macrosepalum* and *R. ripense*. This implies that foundation stocks of Kurume azaleas are more diverse than that had been thought. Okamoto and Nonaka (1999) classified 16 species of wild evergreen azaleas in Japan into eight groups based on dorsal leaf features (epidermal cells, cuticular topography and stomatal shape, and trichomes on veins) (**Table 1**). For example, stomatal shape is an important index distinguishable a group of *R. macrosepalum* and *R. ripense* from a group of *R. kaempferi*, *R. kiusianum* and *R. sataense* (Okamoto and Nonaka 1999).

One-third of Kurume azaleas investigated based on these properties were similar to *R. macrosepalum* and *R. ripense* (Okamoto *et al*. 2000a). Furthermore, some cultivars of Kurume azaleas carried the specific loci on the Aat-2 allele of aspartate aminotransferase in dormant flower buds, but these did not exist in *R. kaempferi*, *R. kiusianum* or *R. sataense* (Okamoto *et al*. 2000b). They were considered to derive from *R. macrosepalum* and *R. ripense* (Okamoto *et al*. 2001). Okamoto and Ikeda (2006) clarified two facts by C-banded karyotyping of the shoot chromosome. One was that *R. macrosepalum* and *R. ripense* carried a chromosome that did not exist in *R. kaempferi*, *R. kiusianum* or *R. sataense*. Another was that some cultivars of Kurume azalea also carried such chromosome. Ueno *et al*. (2005) used AFLP marker and suggested *Rhododendron* subsect. *macrosepala*, including *R. macrosepalum* and *R. ripense*, could be involved in establishing Kurume azaleas.

Okamoto and Suto (2006) crossed Kurume azaleas with *R. japonicum* (A. Gray) J. V. Suringar f. *flavum* Nakai, in order to breed evergreen azaleas with yellow flowers. Consequently, they found out some superior seed parents for breeding among cultivars with the dorsal leaf features similar to *R. macrosepalum* and *R. ripense*. Many seedlings of the hybrids exhibited high viability for two years after seeding, and the more vigorous of these carried a chromosome existent in *R. macrosepalum* and *R. ripense* but not existent in *R. kaempferi*, *R. kiusianum* or *R. sataense*. (Okamoto and Ikeda 2006).

## PRODUCTION OF KURUME AZALEAS IN JAPAN

Originally, Kurume azaleas were grown in Japan as a hobby of plant lovers. In the 1900's, the propagation and marketing of Kurume azaleas was extended into gardening by eager

**Table 1** Dorsal leaf surface characteristics of 16 evergreen azalea species in Japan.

| Epidermal cell | Cuticular topography | Stomata (type[a], level[b]) | Species |
|---|---|---|---|
| polygonal | gentle undulation | A, raised | *R. kaempferi, R. kiusianum, R. sataense, R. tosaense* |
| | | C, equal | *R. yedoense* var. *poukhanense* |
| | plane | A, equal | *R. simsii, R. amanoi, R. boninense* |
| | | D, raised | *R. scabrum* |
| | | D, equal | *R. indicum, R. eriocarpum* |
| amoeboid | gentle undulation | A, equal | *R. serpyllifolium* |
| | | C, raised | *R. tschonoskii, R. trinerve* |
| elliptic | undulation | B, raised | *R. macrosepalum, R. ripense* |

[a] A, No cuticular striations; B, Prominent parallel striations oriented at right angles to the long axis of stomata; C, Striations formed rays radiated out from the outer face of guard cells; D, Strong striations randomly situated around the outer face of stomata.
[b] The position of the stomata in relation to the epidermis.

**Table 2** An outline of Kurume azalea propagation and cultivation.

| | |
|---|---|
| **Step 1. Cutting into nursery bed** | |
| Propagation method | Vegetative propagation by cutting |
| Optimum cutting time | June-July (rainy season in Japan) |
| Managements after cutting | Shading (60% of shading rate) and daily irrigation |
| Days for rooting | 40-60 days under 15-23°C in soil temperature |
| Fertilization | Liquid fertilizer application after rooting |
| **Step 2. Cultivation in nursing field** | |
| Planting time | March (9 or 10 months after cutting) |
| Planting density | 20,000-25,000 plants/10 a |
| Soil condition | Susceptible to excess soil moisture; optimum pH 4.5-5.5 |
| Fertilization | 2 t of compost as basal application and 20-30 kg/10a of nitrogen as annual topdressing (several times of split application during growth seasons) |
| Shipping time | March (3 to 5 year-old plants) |

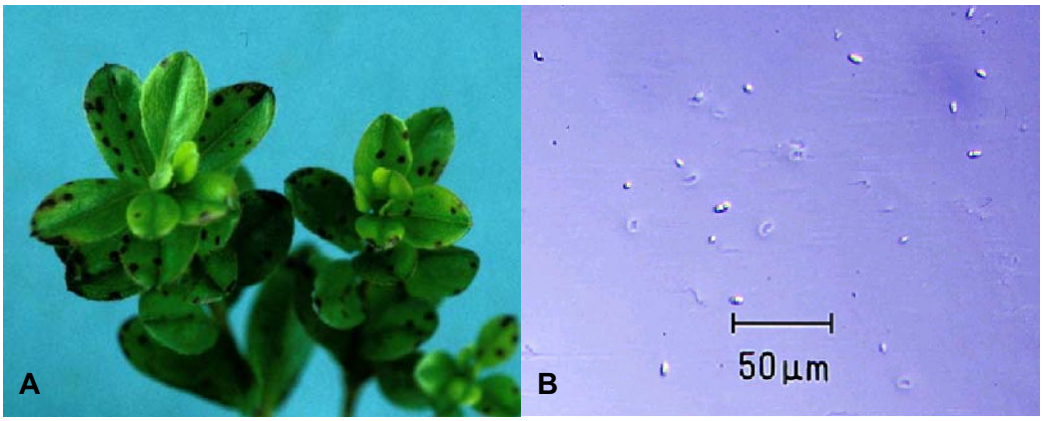


**Fig. 4 Typical symptoms on young leaves (A) and conidia (B) of *Sphaceloma* sp.**

floricultural growers. Kijiro Akashi in particular contributed greatly to the development of the industry in those days. He contrived artificial pollination and storage of pollen, and exported Kurume azaleas to the United States. The production of Kurume azaleas has increased significantly since the 1950's because of their great demand as a green plant for parks and other public spaces. At present, the main types of Kurume azaleas for public use are red, pink and white, and three cultivars are produced for each type. The main types for home use are red, pink, purple, white and splash, and five to seven cultivars are produced for each type. **Table 2** shows an example of commercial propagating and cultivating processes of Kurume azaleas in Japan (Horigu-chi 2002). Kurume azaleas require careful irrigation and fertilization because they have shallow root system occupied by a large quantity of fine roots (Horiguchi 2002). Molecular biological techniques are hardly introduced to breed Kurume azaleas.

Many cultivars including the white type are susceptive to Anthracnose Leaf Spot (*Sphaceloma* sp.). The disease was discovered in northern Kyushu of Japan in 1998 and officially named in 2004 (Kajitani 2004). The species name has not been identified yet. Small round and reddish brown spots formed on leaves and shoots characterize the disease (**Fig. 4A, 4B**). Severe damage causes early defoliation or plant death. This disease is most infectious in spring (April to June) and autumn (September) when young leaves are growing. The susceptibility to the disease differs among cultivars. For example, 'Kurenoyuki', 'Hanaasobi' and 'Imasyojo' are susceptive and 'Kirin', 'Oinomezame' and 'Chikushibeni' are resistant. The disease is spread by rain and can be effectively controlled by a covering to protect against rain. The disease had been prevalent in mountainous production areas. However, cultivating controls and selection of resistant cultivars has controlled the prevalence in recent years.

At present, ten thousands azalea growers produce US$17 million worth of azaleas on about 2000 ha. From the viewpoint of marketing needs, cultivars with yellow flowers are promising for private use and cultivars tolerant to drought in high temperature seasons are promising for public use, respectively. Azalea markets desire cultivars with novel color flowers to attract consumers and cultivars able to reduce managing cost for irrigation and complementary planting. Yamashita and Okamoto (2006) proposed a unique technique to evaluate the root regenerating potential (RRP) using young plants. RRP was useful as an early screening index for environmental stress tolerance because it was different from rooting ability of cuttings and closely related to plant vigor evaluated in fields. A severe growth disorder common to azaleas is the leaf yellowing that results in growth deterioration or death. This is attributed to nitrate in the soil because the nitrate is toxic to azaleas. The nitrate nitrogen exceeding 75% of the total nitrogen in soil is severely injurious to Kurume azaleas (Mametsuka *et al.* 1989). Cultivars tolerant to nitrate are also required.

## INTRODUCTION OF KURUME AZALEAS INTO EUROPE AND THE USA

Kurume azaleas were introduced to Europe and the USA in the 1870's. In the USA, they were loved as gardening plants, because the florist azaleas (Belgian azalea) developed in Europe were sensitive to cold. They are also used as parents to breed evergreen azaleas for gardening with high tolerance to cold and high flower quality. Azalea breeding in the USA created superior cultivar groups including the Glenn Dale azalea (Creech 1989). Europe is colder than the USA, so Kurume azaleas there were loved as a greenhouse plant because they could not survive outdoors. Cultivar 'Kirin' thrived especially well all over Europe because it propagated very easily and could be made to bloom just before Christmas by forced culturing (Heursel 1989).

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