

Effect of Hypocotyl Morphology on Survival Rate and Growth of Cucumber Seedlings Grafted on *Cucurbita* spp.

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Abstract

Horizontal grafting, in which scion and rootstock are cut at the hypocotyl level transversely, is essential for mechanization of grafting. The present studies have been conducted to improve the survival rate and growth of cucumber grafted on *Cucurbita* spp. through horizontal grafting at the level of hypocotyls. The survival rate of the cultivar Nankyoku No. 2 (*Cucumis sativus*) with six vascular bundles at the hypocotyl was different when it was grafted on Unryuh No. 1 or Kongoh (*C. moschata*) with mainly six vascular bundles. The survival rate of the scion grafted on Dairoku (*C. maxima*) with mainly 12 vascular bundles was the lowest. It was found that the survival rate was inversely correlated with the difference in the diameters of the hypocotyls of the scion and rootstock. Dry weight value of the surviving scion was larger on Unryuh No. 1 than on Kongoh and the smallest on Dairoku. It is concluded that by minimizing the difference in the diameter of the hypocotyls between the scion and rootstock the survival rate and growth of cucumbers which are horizontally grafted on *Cucurbita* spp. at the hypocotyl level could be enhanced.

Discipline: Horticulture

Additional key words: *Cucumis sativus*, grafting, rootstock, scion, vascular bundle

Introduction

Injury of fruit-bearing vegetables, including watermelons, cucumbers, melons of all kinds, eggplants and tomatoes, by continuous cropping was ascribed to soil-borne diseases at a rate of 85% in Japan⁷⁾. To prevent the occurrence of soil-borne diseases, grafting has been used for the production of fruit-bearing vegetables. Ratio of the production area using grafted plants to the total production area in Japan is 93% for watermelons, 72% for cucumbers, 50% for eggplants, 32% for tomatoes and 31% for melons of all kinds⁴⁾.

However, since grafting is laborious and time-consuming, farmers and nurseries aim at the use of a grafting instrument. Therefore, mechanized grafting of fruit-bearing vegetables has been studied in Japan since 1987. Suzuki and Kobayashi⁶⁾ developed

the first grafting instrument for the family *Cucurbitaceae*. Itagi et al.¹⁾ manually grafted tomato plants at the two-leaf stage in a plug tray using a device, and the method reduced the time required for the grafting by half. Morita²⁾ grafted cucumbers, eggplants and grape using an adhesive and hardener system. Oda et al.⁵⁾ used the adhesive and hardener system for the grafting of Chinese cabbage onto turnip.

Nagaoka et al.³⁾ succeeded in grafting simultaneously five tomato plants using grafting plates by which the hypocotyls of scion and rootstock were firmly held and cut horizontally to connect the cut surface of the hypocotyls of the scion and rootstock with each other. However, it is difficult to use grafting plates especially for young cucumber plants grafted onto young *Cucurbita* spp.

In the present study, the number of vascular bundles and the diameter of the hypocotyl were

determined in *C. moschata* and *C. maxima* in order to analyze the effect of the hypocotyl morphology on the survival rate and growth after the grafting of cucumber onto *Cucurbita* spp. by horizontal grafting.

Materials and methods

Cucumber (*Cucumis sativus*) cv. Nankyoku No. 2 was sown in plug trays (72 cells/tray, cell volume 45 ml) on 25 November (large scion) and 4 December (small scion) in 1991. Unryuh No. 1 and Kongoh (*C. moschata*), and Dairoku (*C. maxima*) were sown in plastic pots (300 ml) on 11 December. They were

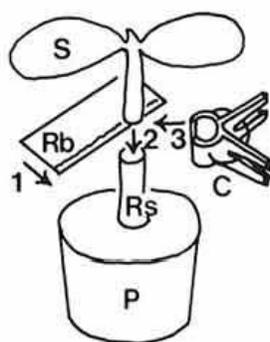


Fig. 1. Horizontal grafting at the hypocotyl level
1: Transverse cutting, 2: Splicing,
3: Clipping, S: Scion, Rs: Rootstock,
Rb: Razor blade, C: Clip, P: Pot.

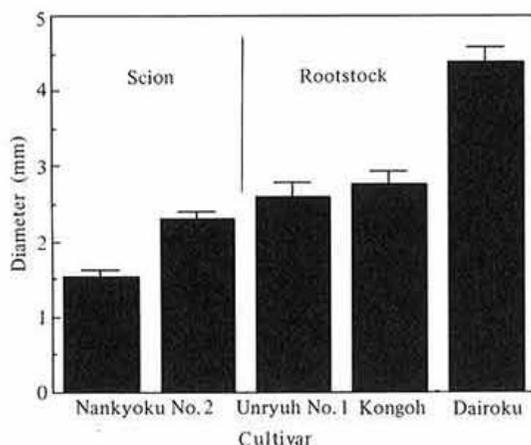


Fig. 2. Diameter of hypocotyls of scions and rootstocks used in this experiment
Vertical bars indicate SD.

grown in a plastic tunnel in a greenhouse. The tunnel was heated at 15°C and ventilated at 28°C. Cucumbers (scion) and *Cucurbita* spp. (rootstock) were cut transversely at the hypocotyl level with a sharp razor blade and the cut surfaces of the scion and rootstock were connected with each other as shown in Fig. 1 on 20 December, when the seedlings for rootstock and small scion unfolded cotyledons and those for the large scion unfolded the first leaf. Scion and rootstock were held with a grafting clip and sprayed with water. The grafted plants were transferred to a plastic container and covered with a transparent plastic film to keep the container at a high humidity. Diameter of the middle part of the hypocotyls was measured at right angles to the cotyledons. The diameters of the hypocotyls were 2.3 ± 0.1 mm (average ± standard deviation) for the large scion, 1.5 ± 0.1 mm for small scion, 2.6 ± 0.2 mm for Unryuh No. 1, 2.8 ± 0.2 mm for Kongoh and 4.4 ± 0.2 mm for Dairoku (Fig. 2). The number of vascular bundles was counted in more than 100 hypocotyl sections using a stereoscopic microscope and the arrangement of the vascular bundles was outlined in each cultivar. The grafted plants in the container were healed in a growth chamber conditioned at 30 ± 1°C, at 100 μmol/m²/s (continuous light) with fluorescent lamps. The plastic film was gradually opened to decrease the humidity in the container three days after grafting. The acclimatization was completed seven days after grafting. Then the grafted plants were transferred to a tunnel in the greenhouse. The number of grafted plants which survived was counted on 30 December, followed by the measurement of the number of leaves, fresh and dry weight of the stem and leaves on 7 January, 1992.

Results and discussion

It was considered that the morphology of the hypocotyl may affect the survival rate of grafted plants by horizontal grafting at the hypocotyl level, and that a larger number of vascular bundles and smaller difference in the diameter of the hypocotyls of the scion and rootstock would increase the survival rate. Hence, the number of vascular bundles at the hypocotyls of cucumber and *Cucurbita* spp. was counted, followed by investigations on the survival rate in some combinations of scions and rootstocks.

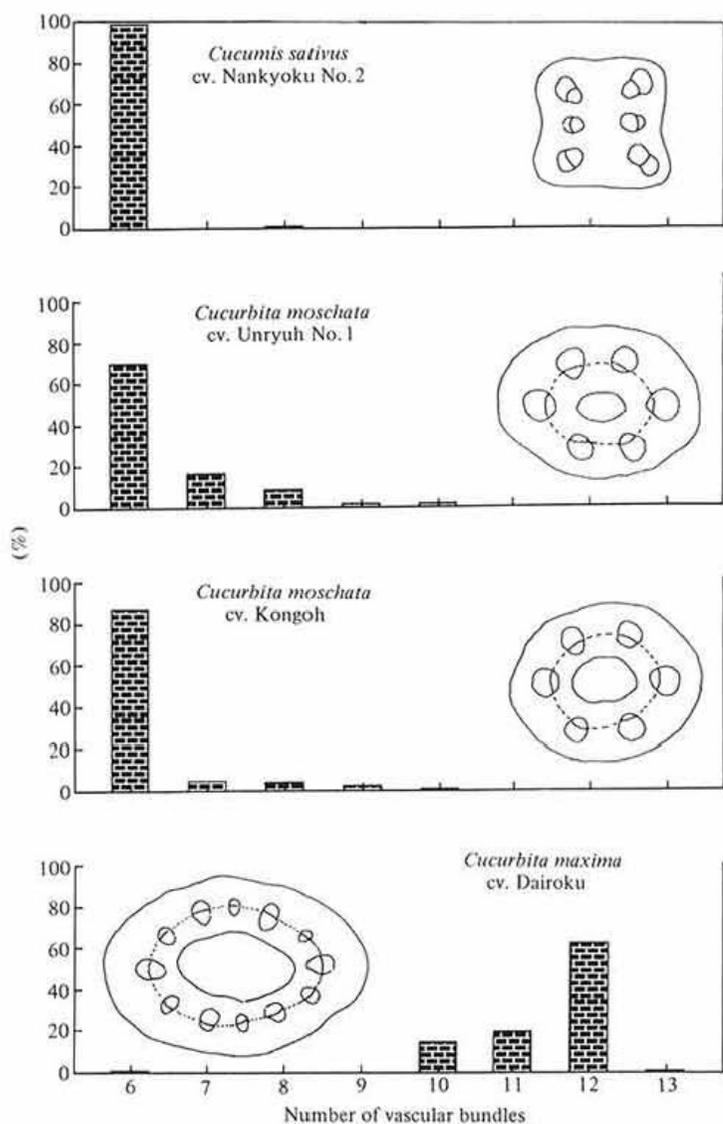


Fig. 3. Distribution of number of vascular bundles at hypocotyls in cucumber (scion) and *Cucurbita* spp. (rootstock)

There were six vascular bundles in Nankyoku No. 2, mainly six in Unryuh No. 1 and Kongoh (*C. moschata*), and mainly 12 in Dairoku (*C. maxima*) as shown in Fig. 3. Since these common cultivars for rootstock show a grafting compatibility, it was assumed that compatibility would not be a major factor in the survival rate which tended to be higher in Unryuh No. 1 than in Kongoh and the lowest in Dairoku (Fig. 4). Thus, the survival rate was differ-

ent between the two cultivars in the same *C. moschata* species, and did not increase in *C. maxima* in which the larger number of vascular bundles was assumed to increase the chance of contact between the vascular bundles at the cut surface of the hypocotyls. It was observed that the survival rate of the small scions was lower than that of the large scions in all the cultivars of the rootstocks. Therefore, the difference in the hypocotyl diameters

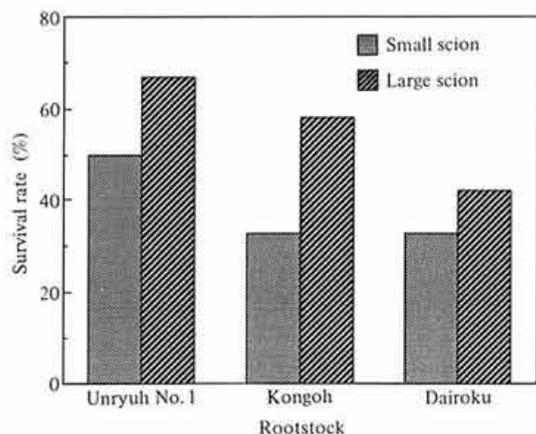


Fig. 4. Survival rate of cucumber plants grafted on some cultivars of *Cucurbita* spp. by horizontal grafting at the hypocotyl level

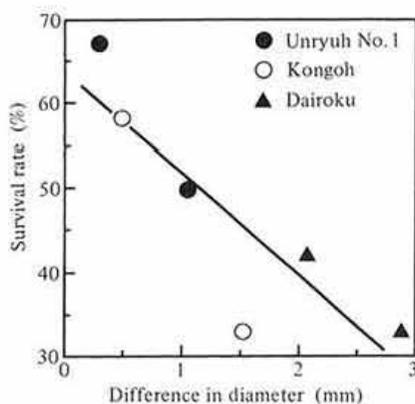


Fig. 5. Relationship between the difference in hypocotyl diameters (scion and rootstock) and survival rate of grafted plants by horizontal grafting at the hypocotyl level

between the scion and rootstock was correlated with the survival rate (Fig. 5). These results suggest that smaller differences in the hypocotyl diameter between the scion and rootstock may increase the survival rate after horizontal grafting at the hypocotyl level while the number of vascular bundles did not affect the survival rate in the present combination.

The value of the dry weight of the scion that survived was higher on Unryuh No. 1 than on Kongoh and the lowest on Dairoku (Fig. 6). It is considered that this high survival rate resulted in rapid growth

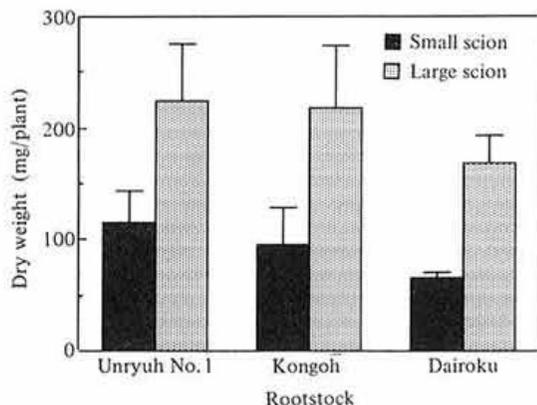


Fig. 6. Dry weight of scion which survived on the rootstock of some cultivars after horizontal grafting at the hypocotyl level. Vertical bars indicate SD.

after horizontal grafting at the hypocotyl level.

On the basis of these results, it was concluded that the reduction in the difference in the diameter of the hypocotyls between the scion and rootstock was effective in increasing the survival rate and promoting the growth of cucumber plants horizontally grafted on *Cucurbita* spp. at the hypocotyl level.

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