Technical Problems on Mulberry Cutting in Japan

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Main reasons why mulberry cutting is difficult in Japan

In Southeast Asian countries mulberry propagation is mainly carried out by cutting means. However, in Japan, mulberry cutting was difficult hitherto. Therefore, mulberry saplings were produced by grafting, layering and modified means of layering (shirodashi).

The principal reasons why mulberry cutting was unsuccessful in Japan are the following two:

(1) Number of principal mulberry cultivars in Japan totals approximately 20, including Ichinose and Kairyonezumigaeshi, both of which are most prevailing, but rooting ability is generally low except Kenmochi.

Although Kenmochi has especially high rooting ability in Japanese mulberry cultivars, its rooting ability is not so high in comparison to Southeast Asian cultivars such as Poo, Noi, Tadam, Mee, and Som, etc.

(2) The chief sericultural zones in Japan are located within the limits from N.L.31° to 40°. Generally the mulberry trees show leaf-fall in early winter after a dormant stage which lasts from October to December and continue to be leafless till bud-sprout in April of the following year.

In the case of cutting by use of the branches being before bud-sprout, rooting proves to be difficult because of low temperature. This is a problem concerning the climatic condition in Japan.

It is therefore, necessary to take measures to raise soil temperature in the nursery. While, in the case of cutting by use of new shoots which develop after bud-sprout, it was a difficult point to wilting of cuttings leave depend on vicelntly wilting of the mulberry leaves.

Studies on the propagation of mulberry trees by cutting

Studies on mulberry cutting have been carried out using both cuttings of hardwood, e.g., branches being before bud-sprout and those of semi-softwood, e.g., new shoots developed

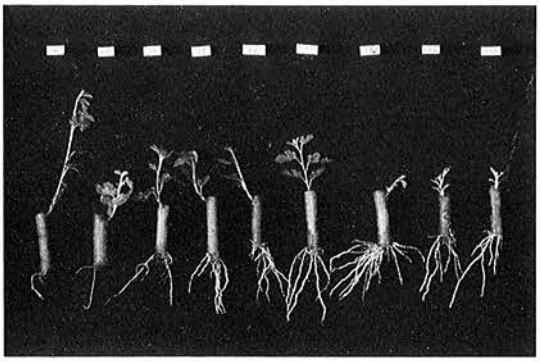

Fig. 1. Root and shoot development of hardwood cuttings of cultivar Ichinose on 20th day of planting in case of the 24-hour pretreatment with various concentrations of NAA. Left to right; 0, 25, 50, 75, 100, 125, 150, 175 and 200 ppm. The cuttings used in this experiment are approximately 5 cm long and bear 2 buds, contrary to those of practical use which are 15 to 20 cm long and bear 5 to 7 buds

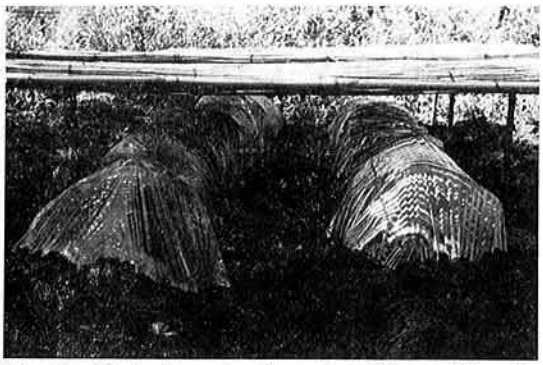

Fig. 2. Bed of semi-softwood cutting. After the cuttings are planted the bed is covered with a plastic film like a Quonset hut and shaded with marsh reed screens

after bud-sprout.

Application of rooting accelerators was taken up as an important problem to be investigated for it was necessary to enhance poor rooting activity of Japanese mulberry cultivars.

Semi-softwood cutting:

(1) Rooting ability of cuttings varies with growth stages of new shoots from which cuttings are made. Rooting ability in the basal parts of new shoots appears in approximately 20 days after bud-sprouting, reaches to the maximum in 40 to 45 days, and afterwards decreases.

In a shoot, the part where one to two cork layers are formed exhibits the highest rooting ability, and therefore, the location of the highest rooting ability moves upwards with growth of a shoot. However, in autumn, the location showing high rooting ability moves downwards from the upper part of a shoot.

(2) As to relationships between length of cuttings or number of leaves left on them and their rooting ability, it has been so far clarified that, in case of cuttings with the same number of leaves, percentgae of survival does not vary irrespective of their length, while quantity of roots increases in proportion to their length and that, in case of cuttings with the same length and various number of leaves, although there is no difference concerning percentage

Fig. 3. Semi-softwood cuttings of cultivar Ichinose on the 40th day of planting when the covers are removed

of survival, a positive correlation exists between the number of leaves and quantity of roots, while a negative correlation exists between the number of leaves and percentage of survived leaves and leafless cuttings do not initiate any roots.

(3) According to the results obtained in the experiments as to rooting accelerators, treatment of cuttings of cultivar Ichinose with NAA (α-naphthalene acetate) solution is especially effective, that is, both percentage of rooting and amount of roots increase when the cuttings are immersed in a weak solution of 10 to 20 ppm for 24 hours or in a concentrated solution of 4,000 ppm for a few seconds. The weak solution of NAA containing sucrose of 2 to 3 per cent is further effective.

(4) It is important to make clear various environmental factors which affect the cuttings after planting in order to give them the best possible conditions for rooting and shoot growth.

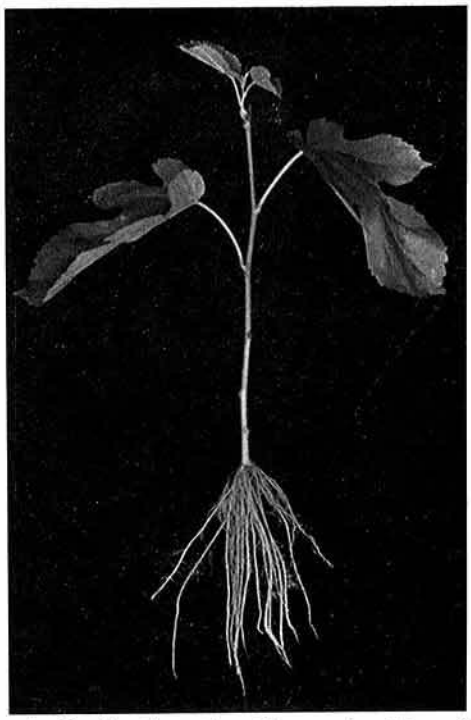

Fig. 4. Semi-softwood cuttings of cultivar Ichinose on the 20th day of planting in the bottom-heated electric frame where the medium temperature is always kept at 30°C. The cuttings are pre-treated with NAA solution of 10 ppm containing 2 per cent of sucrose for 24 hours

Above all, relative humidity in a nursery should be kept over 80 per cent to restrain transpiration of leaves since mulberry leaves transpire very actively. This condition may be obtained by covering a nursery bed like a Quonset hut with a plastic film after rainfall or water sprinkling.

The coverage should be continued until the newly-developed roots of a cutting weigh about one g or show a volume of a little over one ml. By that time the total effective soil temperature, as calculated by [(daily average soil temperature $-15°C) \times$ number of days covered with the plastic film], reaches to about 300°C.

Soil temperatures effective for root initiation range from 15°C at the lowest to 34°C at the highest, with an optimum of 28 to 30°C.

Photointensity of over 2,000 luxes brings about the highest percentage of rooting and the maximum quantity of roots. Belowe 2,000 luxes, both percentage of rooting and quantity of roots decrease in proportion to decrease in intensity of light. The lowest photointensity useful for root initiation ranges from 600 to 700 luxes, although it varied to some extent due to growth stage of cuttings.

Of various rooting media, the clay loam of volcanic ash soil of high water holding capacity is the best. As to water content in case of sand medium, the highest root initiation arises at about 75 per cent to the maximum water holding capacity, whereas callus formation on the lower cut surface of cuttings is the highest at about 25 per cent.

(5) Observations were made on the process of appearance and formation of adventitious roots in the cuttings which were planted. In case of cuttings which are pre-treated with NAA and planted under 30°C of soil temperature, callus formation and the early stage of development of root primordia are detected on the fifth and sixth day of planting, respectively. The root primordia break through the epidermal layer and rooting takes place on the 10th to 12th day of planting.

The number of roots increases rapidly day by day until the 18th to 20th day and, afterwards, this ascending tendency slows down. At that time, however, numerous root primordia remained latent at the phloem.

In case of cuttings which are not pretreated with NAA and planted under 30°C of soil temperature, callus formation procedure is almost the same as in the case of NAA treatment, while root primordia formation is slower compared to the latter and the number of the primordia is extremely small.

Based on the results described above, it may be concluded that NAA treatment stimulates initiation of root primordia but has no effect on callus formation, and that the number of roots depends on both number of root primordia and competition between the primordia.

Hardwood cutting

(1) Rooting ability of cuttings is different

according to tree age, growth stage and location on a branch even in the same mulberry cultivar. In general, rooting ability is high in cases of trees of over four years of age, of leafless branches being before bud sprouting and of lower parts of branches which develop from a low-cut trained tree.

There is a positive correlation between weight of cuttings and weight of newly-developed roots, and a much positive correlation between the number of axillary buds on cuttings and the weight of newly-developed roots. This may be due to the amount of reserve substances, in particular, of those which are present in axillary buds and nodes of cuttings.

A gradual decrease of rooting ability appears from the basal part to the upper part on a branch and this phenomenon is marked when temperature in a nursery is low.

Rooting ability of cuttings decreases when leaves are harvested in the previous year, in particular harvest in the early autumn has more adverse effects.

Of the fertilizer ingredients, potassium has an important effect on rooting of cuttings. In particular, in a mulberry field where nitrogen is fertilized, while no potassium is given, the branches show a remarkable decrease of potassium and, as a consequence, rooting ability of the cuttings is reduced.

(2) Among chemicals of an auxin group, both NAA and IBA (β-indole butyric acid) are highly effective on acceleration of rooting of cuttings, followed by IAA (β-indole acetate). There are some varietal differences as to the effects of NAA and IBA. For example, NAA acts comparatively effective on cultivars Ichinose and Kairyonezumigaeshi, whereas IBA is superior to NAA for cultivar Kairyoroso. For the majority of cultivars other than these, IBA surpasses NAA.

Concentration of NAA suitable for the dipping-in-concentrated-solution method ranges from 4,000 to 7,000 ppm, while about 150 ppm is appropriate in the case cuttings are immersed in a weak solution for 24 hours. In case of 24 hours immersion in a weak solution of below 100 ppm, effect of NAA can be enhanced by addition of sucrose and thiamine.

Removal of all axillary buds from cuttings results in a conspicuous reduction in rooting ability. However, treatment of such cuttings with NAA improves the rooting ability more than in case of non-treated cuttings with axillary buds.

This suggests that, although auxin synthesized in axillary buds may affect initiation of roots, the auxin level is not so high as it brings on plenty of root development, and application of NAA has a supplementary effect on it.

(3) Relation of temperature to root initiation in cuttings of cultivar Ichinose is as follows; the most appropriate, suitable range, the lower limit and the upper limit are 30°C, 25 to 31°C, 10°C and 36°C, respectively.

There is an interaction between a stimulative effect of NAA on rooting of cuttings and temperature while cuttings are planted. NAA application is highly effective at temperatures suitable for root initiation whereas little effect appears at lower temperature.

(4) There are two mechanisms responsible for root initiation of hardwood cuttings; namely, (1) roots originate from root primordia which remain latent adjacent to the nodes, and (2) roots originate from adventitious root primordia which develop newly after planting. The lowest temperature required for root initiation is 10°C in the former case and 15°C in the latter.

The development of roots from the latter case takes place much more than that of the former case, under best conditions for initiation of roots as mentioned above.

As to relation of temperature to rooting and bud sprouting of axillary buds in cuttings, it is obvious that development of roots is predominant over bud sprouting at a suitable temperature, while development of axillary buds is superior to root development at lower temperatures. This may be due to the fact that reserve substances are mainly utilized to develop roots at a suitable temperature and to develop axillary buds at lower temperatures.

Therefore, maintenance of a suitable temperature at the early stage of planting is

very important in order to obtain good results as to root development. Temperature of over 15°C which is the lowest temperature for development of adventitious root primordia is absolutely necessary for practical use.

Practices of mulberry cutting

Semi-softwood cutting: New shoots showing vigorous growth are gathered in spring in 40 to 50 days after bud-sprouting. The basal 15 to 20 cm of the shoots are used as cuttings, following removal of all leaves except two or three leaves being at the top.

As a rooting accelerator, NAA may be applied to the cuttings by dipping the bases of these for two to three seconds into a water solution of 2,000 to 4,000 ppm or by immersing for 24 hours in a solution of 10 ppm which contains 2 per cent of sucrose.

In the latter case washing by tapwater is necessary following NAA treatment. After the cuttings are planted, cover a nursery bed like a Quonset hut with a plastic film and shade it from the sun with marsh reed screens. Remove the cover in the 35th to 40th day and afterwards raise the rooted cuttings by a conventional way of cultivating young mulberry plants.

Hardwood-mulching-cutting: The branches of the previous year are pruned at the base in spring before bud-sprouting and the basal 15 to 20 cm of these are used as cuttings. As a rooting accelerator, NAA may be applied to the cuttings by dipping the bases of these for about three seconds into a water solution of 4,000 to 7,000 ppm or by immersing for 24 hours in a solution of 150 ppm.

Fig. 5. Hardwood-mulching-cuttings are being inserted into the bed covered with a polyethylene film

Fig. 6. Early growth stage of hardwood cuttings planted in the polyethylene-mulched bed

Cover soil surface of a cutting bed by a polyethylene film prior to cutting in order to raise soil temperature. Insert the cuttings into the bed 5 to 10 cm deep through the films, making holes at regular intervals. Remove the cover in about 40 days and afterwards raise the rooting cuttings by a conventional way of cultivating young mulberry plants.

Problems to be solved

In order to promote efficiency in mulberry cutting in this country, two problems are required to be solved. First, good mulberry cultivars with vigorous rooting ability should be produced. Cross-breeding is to be carried out between Japanese leading cultivars and foreign cultivars with high rooting ability such as those in Southeast Asia in order to transmit the desirable trait to the former.

Second, facilities which may give favorable conditions in the early rooting stage should be established in order to get rid of bad effects as soon as possible on rooting due to natural environment.

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