

MOISTURE AS A FACTOR IN THE ROOTING OF CUTTINGS

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Reprinted from the Report of the XIVth International Horticultural Congress, Netherlands, 1955
published by H. Veenman & Zonen, Wageningen (Netherlands)

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SUMMARY

Experiments with hardwood cuttings of rootstocks for apples and plums in different soils led to the conclusion that, with a given source of material, moisture is the predominant factor in the rooting of these cuttings.

Hardwood cuttings of apple, pear, plum and cherry varieties could be rooted by grafting an easy rooting cutting or a root onto the cutting that was difficult to root. From the data available, the fact that rooting took place can be explained by assuming that through a provisional graft union moisture was taken up till the shy rooting cutting was on its own roots.

The moisture requirements of softwood cuttings were then investigated with a view to adapting the new technique of mist propagation to a modern version of the old and very successful practice of watering at short intervals and exposing at the same time to full sunshine. With mist it might be possible to combine optimal moisture requirements with optimal light requirements, better than hitherto. It is, therefore, reasonable to expect an important improvement in the technique of cutting propagation. From a practical point of view, the most important gain will be the saving of labour, as the careful attention of the propagator will be replaced almost entirely by automatic devices.

The above research programme has made good progress since 1953. Good rooting has been obtained with cuttings under constant mist in a frame covered with glass. A special flat spraying nozzle has been developed for the purpose.

EXPERIMENTS WITH HARDWOOD CUTTINGS

At the Institute for Horticultural Plant Breeding at Wageningen research on plant propagation was started in 1947.

In the early years, with few facilities available, the propagation of rootstocks by hardwood cuttings was mainly investigated. This method is attractive as it is simple and requires little labour. Moreover, it is quite conceivable that the method will lend itself to mechanisation. However, rooting is not always very reliable, which can be a serious drawback for the commercial propagator. To improve on this, the conditions essential to rooting have been studied, such as source of material, time of collecting and handling of cuttings prior to planting, the soil as the planting medium, growth substance treatment and climatic conditions.

MOISTURE, THE PREDOMINANT FACTOR IN ROOTING

Various experiments, and also results obtained at the Boskoop Research Station, pointed to the conclusion that moisture is a predominant factor in the rooting of cuttings. Best rooting was obtained in a good moisture holding sandy soil. Growth

substances were here of little use as the rooting percentages of treated and untreated cuttings did not greatly differ, although the growth of treated cuttings was usually better than that of the controls. However, in a soil with less adequate moisture conditions, significantly better rooting was obtained with a growth substance treatment. On clay with an inadequate moisture supply, rooting was very poor and the effect of a growth substance treatment of no significant importance.

GRAFTING AS AN AID IN ROOTING

In experiments of VAN OVERBEEK and GREGORY a difficult-to-root white-flowered form of *Hibiscus* was rooted by grafting a shoot of an easy-rooting red *Hibiscus* on cuttings of the white form, provided the base of the white cuttings was treated with growth substances. To adapt this method for propagation in the field, two hardwood cuttings were approach-grafted, one of a shy rooting plant, the other of a closely related, easily rooting species. Because of their shape, such grafted cuttings were called X-cuttings (fig. 1). Various difficult plants were rooted by this method. Fig. 2 and 3 show examples of rooted X-cuttings at the end of one season.

VAN OVERBEEK and GREGORY explained the rooting of their grafted cuttings by the



FIG. 1. X-cutting.

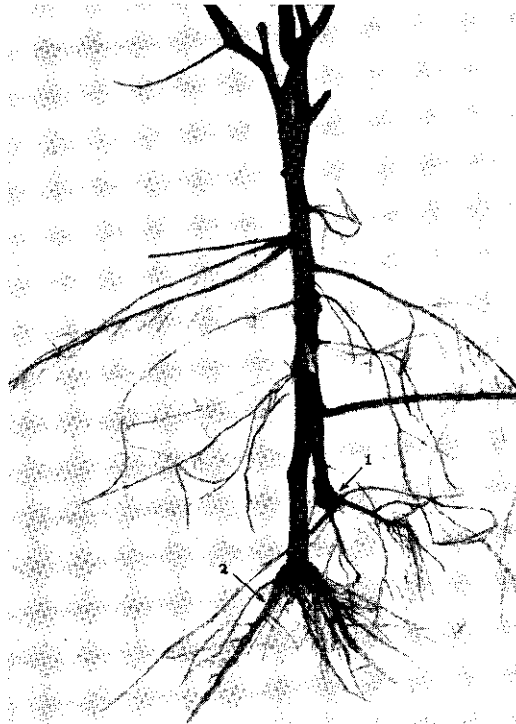


FIG. 2. Rooted X-cutting (1) roots of quince, (2) roots of pear.

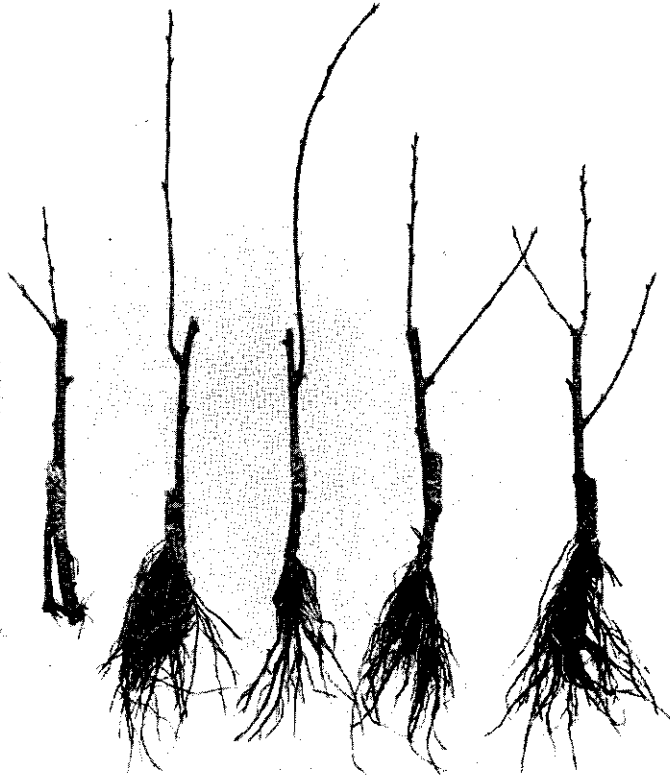


FIG. 3. Rooted X-cutting
(l) *Populus lasiocarpa*
(tr) *P. tremula*.

combined action of auxin and nutritional factors coming from the leaves of the red *Hibiscus*. Similarly the rooting of X-cuttings was explained by assuming that nutritional and perhaps specific substances from the leaves of the easily rooting species would pass across the graft union and cause rooting at the base of the difficult-to-root variety. To test this hypothesis, side-grafted cuttings were made in which the easily rooting component was leafless (fig. 4). Where a union could be established, side-grafted cuttings and X-cuttings rooted similarly. It appears, therefore, that no substances from the leafy shoot of the easily rooting component pass across the graft union, which in any way add materially to the rooting performance of the shyly rooting component.

In X-cuttings, as well as in side-grafted cuttings, the root system of the easily rooting component will supply the shy-rooting cutting with moisture, as soon as a provisional graft-union makes this possible. Thus the shy rooting cutting is kept alive until it has mobilised all the substances necessary for root formation. That a difficult-to-root cutting can indeed mobilise these substances is indicated by an experiment with hardwood cuttings of the pear variety Nouveau Poiteau. In a cold greenhouse these cuttings were given bottom heat, while the temperature of the air was kept at least 5°C

FIG. 4. Side-grafted cuttings of May-Duke.



lower. Thus activities at the base of the cuttings were speeded up, whereas those at the top were slowed down. Without a treatment with growth substances these cuttings formed roots, apparently in time to supply adequate moisture during the period of leaf development. So here again, moisture comes to the fore as a predominant factor in the rooting of cuttings.

This explanation for the rooting of X-cuttings differs from those given by VAN OVERBEEK and GREGORY for the rooting of their grafted cuttings. Is there perhaps something wrong somewhere? I don't think so. VAN OVERBEEK and GREGORY worked with leafy cuttings which were placed in a frame where the air humidity was kept high. Under such conditions the moisture supply is more or less optimal, so that other factors can come into play. X-cuttings, however, are hardwood cuttings planted in the field during the second half of March. The weather in spring is variable, but spells of dry winds always occur. The moisture conditions can then hardly be worse. Therefore, factors other than moisture will not often get a chance to come into action. There is still another difference. VAN OVERBEEK and GREGORY took cuttings of the semi-hardwood type. The soft terminal part of the shoots was removed as this part is in all probability a source of natural auxin. A treatment with growth substances

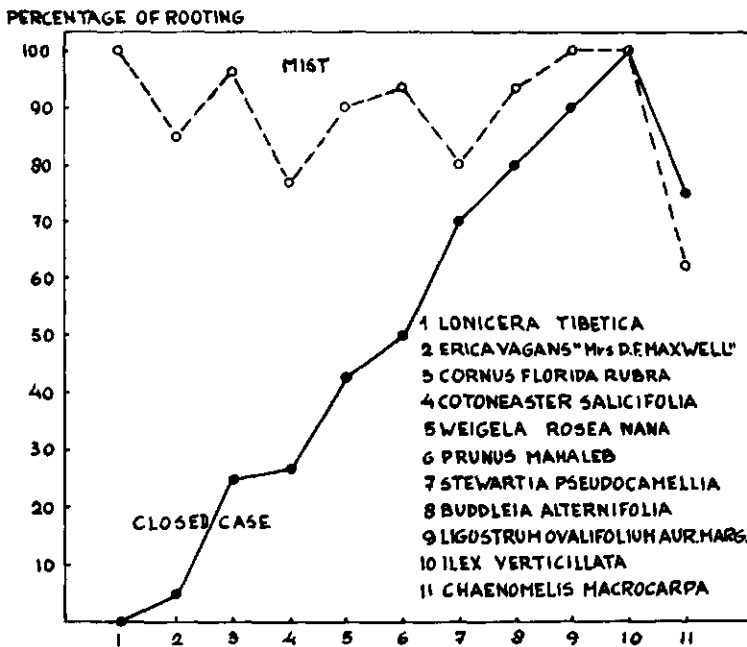


FIG. 5. Rooting under mist *versus* closed case.

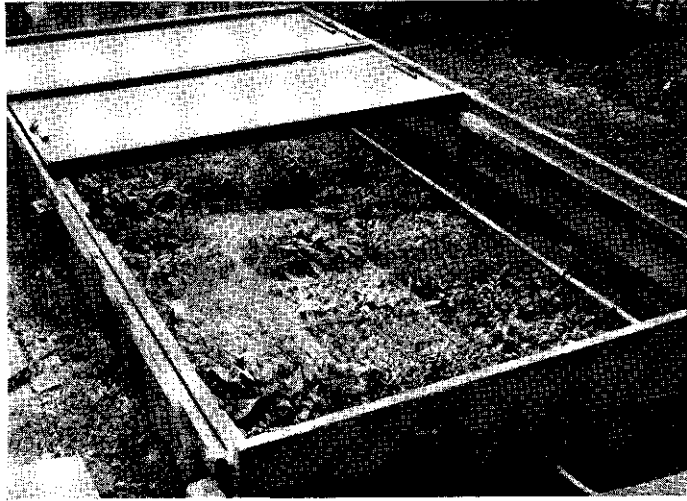
also appeared necessary. X-cuttings, on the other hand, do not require such treatment. They form natural auxin and perhaps other specific substances when the buds start to develop, and to judge from the rooting obtained, these substances are produced in adequate amounts.

EXPERIMENTS WITH MIST PROPAGATION

When the conclusion was reached that moisture is a predominant factor in the rooting of hardwood cuttings, the moisture requirements of softwood cuttings was investigated. These cuttings are placed in a closed case where conditions of moisture are more or less optimal, although a slight wilting of the cuttings during the middle of the day cannot always be avoided. It was noticed that in many cases improved rooting could be obtained by the practice of watering at short intervals, in combination with exposure to full sunshine. BAILEY BALFOUR reported on the method as far back as 1912, and it turned out that a nurseryman in Holland, with an excellent reputation as a propagator, followed the same practice.

The first report that came to hand on a modern version of this old practice is from EVANS, who obtained a spectacular effect with the rooting of difficult clones of cacao by combining humidification with optimal light and temperature requirements. He found Tee Jet nozzles the ideal solution to the rooting of cacao stem cuttings under a continuous spray. Therefore, in our first experiments in 1953 the same nozzles were used. No shade was given and when the temperature rose to 30°C the greenhouse was ventilated. The first aim was just to reconnoitre the possibilities of humidification

FIG. 6. Mist propagation in a frame.



or mist application according to the American definition. To do this, cuttings of various plants were placed under a constant mist (comparable lots in a closed case). The difference in rooting between the two methods is shown in fig. 5.

With nearly all plants best rooting was obtained under mist. For *Lonicera tibetica* the comparison was not good, as we took very soft cuttings which did not have a chance in a closed case. *Chaenomeles*, on the other hand, was better in a closed case. This might be due to the rooting medium, which was sand for cuttings under mist and a mixture of sand and peat in a closed case. The following year we found that even under constant mist *Chaenomeles* was significantly better in a mixed medium.

The same year constant mist was tried in an unshaded frame covered with glass. Results were comparable with those obtained in a greenhouse, although rooting was much slower. It was then decided to adapt mist for outdoor propagation, and to exploit to the utmost the possibilities of saving labour, which this new technique offers.

Firstly, a new nozzle was developed in cooperation with the Physico-Technical Service for Agriculture, which uses less water and gives a more even distribution than Tee jet nozzles. Nozzles of this type have subsequently been used for constant mist propagation in an unshaded frame, under glass cover (fig. 6). Rooting has been considered satisfactory as even difficult plants such as *Chaenomeles* and *Tilia* have done well (fig. a7).

Practically no attention to the cuttings proved necessary during the constant cool weather of last summer, except turning on of the water supply in the morning and turning it off in the evening.

However, further improvements are conceivable as the temperature of the propagating medium was mostly sub-optimal, although the maximum temperature reached 20°C every day with hardly an exception.

This summer we had a reimproved nozzle of the deflection type in operation (fig. 8). It delivers approx. 10 l of water per hour per m² and covers one meter of frame. A

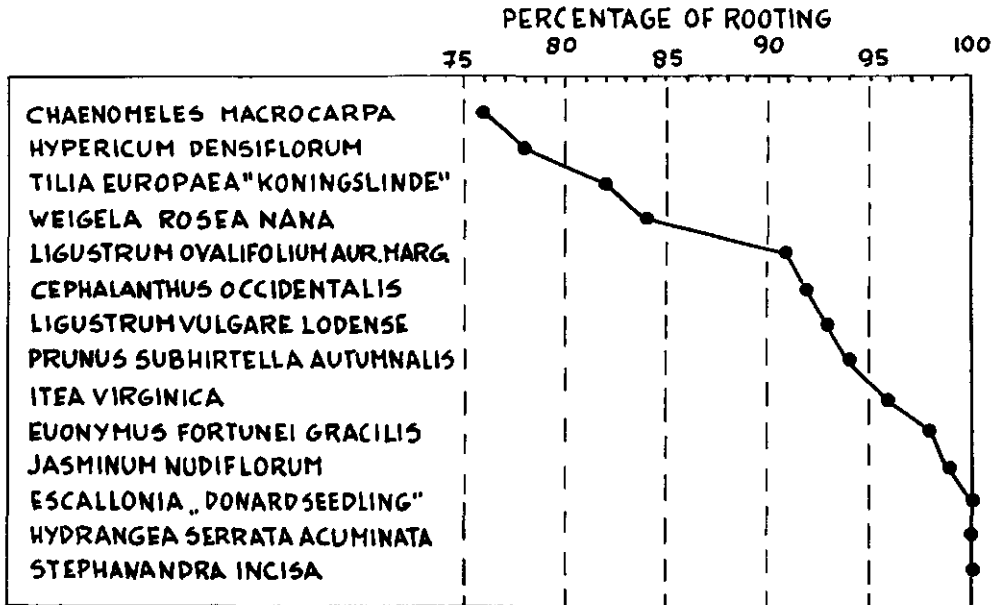


FIG. 7. Rooting in a frame under constant mist.

single line of nozzles has been placed above the centre of the propagation bed. Because of dripping no cuttings were placed directly under a nozzle. It is presumed that the overhead system might have the advantage of a somewhat higher water temperature than the in-bed system, especially so as we apply *intermittent* spraying with an 'on' period of 20 seconds at the maximum. The cuttings were inserted in boxes with a bottom of saran gauze, which were placed some 10 cm above soil level for the benefit of drainage and the required temperature of the propagating medium. Mist propagation was also applied in a plastic tent in comparison with a frame (fig. 9). After the experience of one season, I am inclined to prefer the plastic tent, because it allows the line of nozzles to be installed higher than would be possible in a frame. Moreover, a plastic tent can be closed more tightly than a frame. More details will be given of one of the plants which hold our special interest, namely,

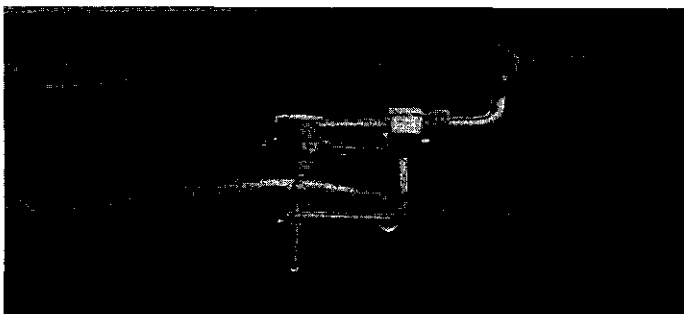
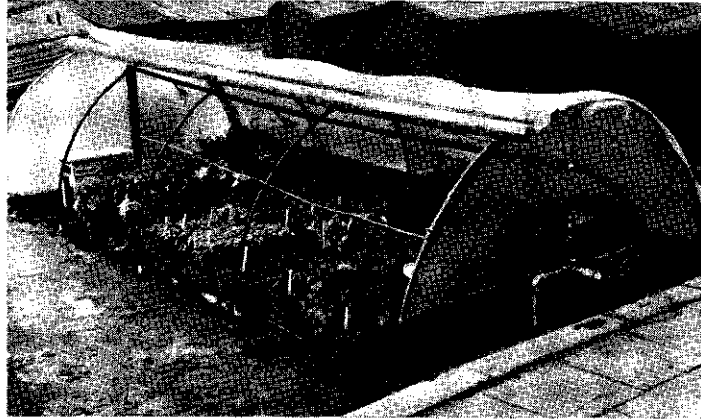


FIG. 8. Nozzle used for mist propagation.

FIG. 9. Mist propagation in a plastic tent.



linden. In a small scale experiment, in 1953, rooting under mist was faster than in a closed case where the cuttings were treated with growth substances (fig. 10). The cuttings established the following year were 42 out of 49 from those rooted under mist, and 40 out of 42 from cuttings rooted in a closed case. The average height of all these cuttings was 58 cm, varying from 18-98 cm.

In 1954 from 360 cuttings of the same linden, treated with 4 mg IB/ml, 85 % rooted in a greenhouse under mist, while 72 % of the original number of cuttings were established.

To conclude, the experience gained through three seasons has given us the firm belief

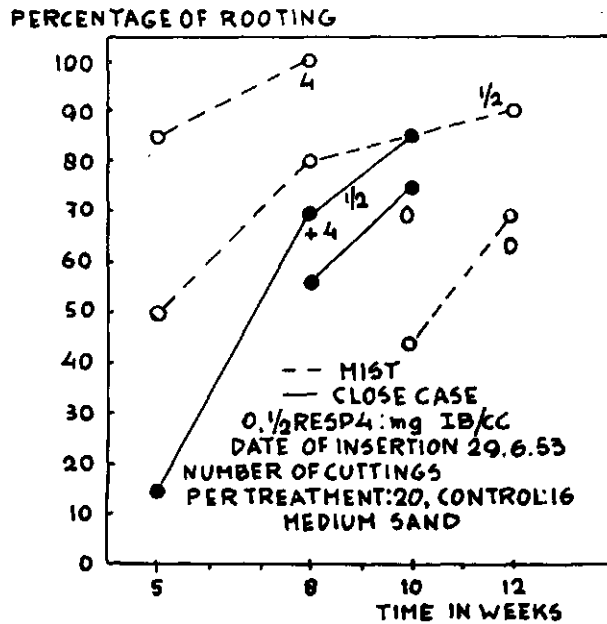


FIG. 10. *Tilia europaea* 'Koningslinde'.

that mist propagation has come to stay. Improved rooting has already been achieved and further progress seems likely, as this new technique makes it possible to combine optimal requirements for moisture, light and temperature better than hitherto. From a practical point of view the most important gain may be the saving of labour, as the careful attention of the propagator will be replaced almost entirely by automatic devices.

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