

A method for Improving the Efficiency of Pear Tree Crossbreeding

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Abstract In view of the short blooming period of pear tree crossbreeding and the complexity of pollination process, a method that can improve the efficiency of crossbreeding of pear trees was provided. Meanwhile, this method can also be applied to the study of pollen xenia effect, pollination tree selection and pure pollen collection in pear tree cultivation.

Key words Pear tree; Cross breeding; Efficiency; Method

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Hybrid breeding refers to the process of selecting parents according to specific breeding objectives, obtaining hybrids through hybridization, and then selecting offspring from the hybrids to cultivate new varieties that meet production and consumption requirements. Crossbreeding is a widely used and effective breeding approach at home and abroad. Crossbreeding is the most important way in fruit tree breeding in the past, present and future^[1].

Pear is highly self-incompatible, so it can generally be bred without castration. The flowering period of pear trees is concentrated and short, usually 7–10 d. During cross pollination, the flowers in the big bud stage should be selected, that is, the period before the petals are about to bloom out of the stamen, which is even shorter. Pear belongs to corymbose inflorescence, with 5–10 florets in each inflorescence, and 7–8 florets in common. The flowers bloom irregularly, and the side flowers of the same inflorescence bloom first before the central flowers, which brings great trouble to the selection of flowers in parental pear trees, hybridization marking and hybrid fruit collection.

At present, in this field, the hybrid fruit is mainly obtained by the methods of pollinating flower by flower, bagging inflorescence by inflorescence and marking fruit stalk fruit by fruit, and then hybrid seeds are obtained. The existing hybrid methods have complicated processes, require a lot of manpower and are inefficient. When there are many cross combinations, the disadvantages are more obvious.

Among the present techniques, there is also a hybridization method in which a female parent tree is covered with an insect-proof device^[2], and *Osmia* beehives, *Osmia* bee cocoons and male parent target pollen are placed in the area covered by the

insect-proof net, so that the *Osmia* bees hatched from the bee cocoons carry the target pollen to pollinate the female parent tree, and after pollination, the insect-proof device is removed and *Osmia* bee eggs are recovered. However, the setting of the aperture of the insect net has a great influence on the survival of *Osmia* bees, and the aperture size of the insect net cover cannot solve the problem of pollen drift at the same time^[3].

Therefore, after years of practice, aiming at the short cross-pollination period and the complexity of conventional cross-pollination process, a fast and efficient cross-pollination method was proposed^[4]. Meanwhile, this method can also be applied to the study of pollen xenia effect, pollination tree selection and pure pollen collection in fruit tree cultivation.

Aiming at the problems of traditional cross pollination methods, such as many procedures, low efficiency, tight construction period and relatively high requirements on the specialization of operators, this method provides a systematic solution, which reduces the requirement for specialization, improves the cross pollination efficiency and relieves the concentration of labor, and has been applied in practice.

Technical Points

Pruning parental trees

During the winter pruning or postponed until the flowering period, according to the breeding objectives, the female parent trees^[5] with strong growth, full crown, high seed setting rate and meeting the breeding objectives are selected, and the over-extended side branches or over-extended heads in the female parent trees are trimmed off by short cutting or retraction, so that the height of the trees is less than 3 m, the crown width is within 1–2 m, and the tree structure is more square.

Setting up frames

According to the size and shape of the crown of a pruned mother tree, a firm frame is built around and at the top of the tree, so that the tree body is completely located in the frame. Also, several continuous female trees can be located in the same frame, so as to ensure that the crowns of the female trees are not

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squeezed, and all the crowns of the female trees can be covered.

Laying shed covers

In "Setting up frames", the four peripheral walls and the top of each frame are tightly laid with nylon mesh until it is close to the ground. The nylon mesh can be selected with an aperture of 350 – 500 meshes, and it is fixed with ropes and ground anchors to make it firm.

Opening an observation window/operation window

In "laying shed covers", one side or two sides which are convenient to operate (the east side or/and the west side near the interspace of rows are generally chosen) are chosen, and a sharp wallpaper knife or scissors is employed to cut off a piece of square nylon net at a slightly higher position or in the middle, and a transparent plastic sheet is used to replace it, and it is mounted firmly and seamlessly. It is the observation window, which is also the operation window for pollination in the future. The length and width of the observation window are generally 40 – 60 cm.

Setting up a shade net bracket

In order to prevent high temperature in the net, a simple shade net bracket can be set up in advance. If necessary, the shade net can be temporarily fixed on the trunk to prevent the flowers and leaves from being burned by the high temperature in the net.

Collecting pollen

At the flowering stage, male parent trees with high seed setting rate and meeting the breeding target traits is selected, and referring to the S genotype statistics of pear^[6], the buds that have not yet opened in the big bud stage are collected. The anthers are kneaded, and dried in the air or oven-dried at a low temperature to make them loose, and pollen is collected by screening out the anthers, petals and filaments, and dried and preserved^[7].

Cross pollination

Through the observation window in "Opening an observation window/operation window", when the flowers of the parent trees in the nets are more than 50% open, the pollen collected in "Collecting pollen" is used. Through the operation window in the "Opening an observation window/operation window", a mature and efficient pollen spraying gun^[8] (pollen 1 g; dried starch 20 – 250 g) or a liquid pollination method (clean water 1 000 g : white sugar 250 g : fine pollen 0.6 g) is applied to realize rapid and efficient cross pollination. There is no need to look for flowers at the big bud stage, remove petals one by one, pollinate one by one, bag one by one and mark one by one. The operation window is closed after pollination.

Laying a shade net

In the high temperature period at noon, a shade net can be laid along the set shade net bracket, or it is directly fixed on the surrounding tree trunks to achieve the purpose of sun protection. The temperature in the net should not be higher than 28 °C.

Removing nylon nets and frames

After flowering, the nylon nets and frames can be removed without marking each fruit. If the female parent trees will be used

continuously in the next year, the nylon nets can be removed without removing the frames.

Collecting hybrid seeds

After normal maturity, the whole tree fruit is collected and the seeds are taken out. The collected seeds are the desired hybrid seeds.

Beneficial Effects

No requirement for operating skills

In this method, the steps of pruning the mother trees, setting up frames, laying shed covers, opening an observation window/operation window and setting up shade net bracket can all be completed in advance before the flowering period, and the requirements for operators' operating skills are not high. The degree of specialization is significantly reduced, and the problem of labor shortage during the flowering period is also solved.

Being efficient and intensive, saving a lot of land for traditional breeding

In this method, the method of setting up frames and laying nylon nets in this technique can also be adopted to the male trees for collecting pollen to achieve the purpose of collecting pure pollen quickly and efficiently, and it is not necessary to collect pollen only at the big bud stage, while the pollen quantity is more sufficient. Meanwhile, all the flowers of the mother trees can be used as pollination flowers in this technique. Due to the technical characteristics of being efficient and intensive, a large number of hybrid seeds can be obtained with a small number of mother trees, which can save a lot of land for traditional breeding.

Effectively lowering the high temperature in the covers and improving the breeding efficiency

The method adopts 350 – 500 mesh nylon nets, which can effectively prevent insect pollination and solve the problem of pollen spreading with the wind, and effectively isolate natural pollination, so that in the process of cross pollination using this technique, the purpose of cross pollination can be achieved quickly and efficiently by using a powder gun or a liquid pollination technique. Meanwhile, there is no need to mark the hybrid fruit one by one, and all pieces of fruit in the whole tree are hybrid fruit. Only the tree number should be remembered or the tree bodies should be marked. Setting up the shade net brackets and laying the shade nets can effectively lower the high temperature in the covers, and then improve breeding efficiency.

Simple operation and low labor cost

Compared with conventional artificial pollination, which can only pollinate 68 flowers in 60 min, spray pollination can pollinate the whole pear tree in 3 min, and the average number of fruit set per inflorescence reaches 3.19 and the number of hybrid seeds reaches 1 335. Compared with conventional techniques, the number of hybrid seeds increases by 602, but the time consumption is only 1/20, and the efficiency is 36.42 times that of conventional techniques. Moreover, after pollination, only the observation

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Conclusions and Discussion

(1) Of the two different curing systems, MDI-50 and IPDI, the IPDI system was more suitable for spray polyurea for EPS foam floating balls.

(2) Through the screening of chain extenders, it was determined that polyurea synthesized from IPDI quasi-prepolymer and E-300 chain extender could meet the gel time of forming a complete and continuous coating on the surface of EPS floating balls during spraying, and the polyurea coating had good adhesion.

(3) Adding different nano wear-resistant fillers into chain extender E-300 could improve the wear resistance of spray polyurea to varying degrees, and among them, the wear resistance of carborundum and silica polyurea composites was the best.

(4) The formula of hard spray polyurea material for EPS floating balls obtained by adjusting the ratio of soft to hard segment was more in line with the requirements of aquacultural floating balls.

(5) The physical properties and chemical resistance of the spray polyurea sample obtained with the hard material formula were tested. The results showed that it had good physical properties and acid and alkali resistance, and its performance was still excellent after accelerated aging, and could meet the requirements of spraying and protection of EPS floating ball surface in marine environment.

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window needs to be closed without bagging, so the operation is simple and convenient, and the labor cost is reduced.

Matters needing attention

Mechanical pollen spraying has high efficiency and good pollination effect, but the pollen consumption is large and the cost is high. When using a pollen spraying gun for pollination, common fillers can be added, such as dry starch, talcum powder and failed pear pollen. In liquid pollination, after adding pollen, we should pay attention to fully shaking until the pollen is evenly dispersed in the nutrient liquid. Because the pollen is easy to expand when it meets water, the liquid should be prepared freshly for use, and especially, a sprayer which has been used for spraying herbicides should not be used.

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