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Pollination and Pollen Handling in Horticultural Crops

by

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The expansion of the fruit and vegetable industry throughout the world, with increased acreages of insect pollinated crops, has created a growing need for a more basic understanding of pollens and for more effective methods of artificial pollination. This is particularly true when either the natural process fails or is insufficient to set a good commercial crop of fruit for the grower or when the plant breeder knows that his methods of pollination, or the pollen he uses, are inadequate for his purpose.

Nature has provided many remarkable contrivances to help assure natural pollination; however, high production of many commercial crops, such as the deciduous fruits, often requires additional help for the natural process, either as pollinizer interplants or grafts or by artificial pollination; while artificial pollination methods should always be used in breeding experiments in order that the purity of the breeding material can be assured.

Commercial production methods of many fruits and vegetables today make it necessary for the grower to know the value of the process of pollination in the setting of his crop. He should know, for example, whether his crop varieties must be cross pollinated, and, if so, what variety or other varieties would be the best pollinizer. His orchard, or plantation, planting plan must provide for the proper interplanting of the pollinizer plants among the crop producing plants; and facilities must be provided, when necessary, for the activities of pollen-carrying insects. Artificial "mass" pollinations to supplement the failure of natural pollination are yearly saving some tree-fruit crops in certain areas of the U. S., and should be experimented with elsewhere. Many methods, and devices, have been tested to replace the natural process, such as, the mixing of hand or bee-collected pollen with Lycopodium spores, diatomaceous earth, talc, etc., and dusting it over the plants with hand and power dusters or from an airplane. Such mixtures have also been exploded

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from hand-made bombs and shotgun shells, or sprayed as a water solution over the plants. These methods, and others like them, are spectacular and have some merit; however, none of them has, thus far, been as successful in the setting of a crop as has the slower hand pollination of individual flowers. The placing of bouquets of pollinizer variety flowers among the crop plants, which is an effective method of substituting for the absence of pollinizer plants, cannot be considered as entirely a practice in artificial pollination.

Lyophilization or Freeze-drying of pollen. Picture shows the sealing of the 'tear' bulbs containing pollen.

Research on pollen handling and commercial crop pollination methods has disclosed valuable information on pollen behaviour under various environmental and biological conditions relative to the process of artificial pollination. A mixture of pollens from two or more varieties, for example, will often induce a better fruit set than will the pollen from just one pollinizer; while the artificial supplementary pollination of some vine crops will often increase the yield. The amount of crop set, the number of seeds per fruit, and even seed germination and seedling growth are sometimes increased from cross-pollination by the addition of maternal pollen to that of the pollinizer variety, as in the case of some apples. There has been only limited success from pollination by bees which before leaving the hive must crawl through beehive inserts which contain the pollen of the pollinizer variety. The bees either carry very little of the pollen out of the hive since they often crawl along a narrow path through the

pollen, or they have too little of it left on them when they begin to visit flowers. Pollen carried by bees for long distances has been found to sometimes be nonviable when deposited by the insect on the female flower structure in the process of pollination, while artificial mass pollination of deciduous fruit trees with power sprayers is ineffective since the pollen is maserated by nozzle pressure. Natural pollination, however, has been aided by the spraying of the flowers with a sugar solution in order to attract the pollinating insects.

Few areas of horticultural research have brought greater returns to the fruit and vegetable grower and to the consumer in recent years than has crop breeding ; still, the research on pollination methods and on the use of pollens for breeding purposes have been limited, for the most part, unfortunately, to the needs of individual plant breeders. More attention is being given now, however, to the overall field of pollination and pollen handling (which includes pollen collecting, drying, viability testing, storage and shipping).

Methods of collecting pollens for breeding purposes have not been greatly improved on in recent years. When pollen is not transferred directly from the anther to the stigma, it is secured by the collection of flowers, from which the pollen-laden anthers are extracted with fine-pointed scissors, a comb, forceps, a screen, or with specially constructed extractors, such as notched scissors, the mechanical vibrator, or the vacuum collector. The anthers are then often dried (when necessary for the release of the grains from the pollen sacs), and are placed in vials for use in pollination. The techniques of emasculation and application of the pollen to the stigma are almost as numerous as are the variations in floral structure of horticultural crops. The possible future practical use on some horticultural crops of the new gametocides (male suppressor chemicals) to breeding techniques offers a ray of hope for the breeder's release from the tedious task of flower emasculation ; but he will continue to apply pollen to the stigma with a brush, a cork, a syringe, a rubber bulb, a cotton swab, an atomizer, the finger, or by various similar ways, depending on the kind of pollen and the floral structure involved in the pollination.

Certain aids to fruit and seed development in breeding experiments have been recorded. The application for example of large quantities of pollen to the stigma or the repeated application of pollen within 12 or 24 hours often results in greater fertilization in

intra-varietal and intervarietal crosses and in the hybridization of more distantly related forms. Also, the application to the stigma before pollination of an aqueous solution of crushed anthers of another variety has been found to increase fertilization, presumably by correcting the deficiency of certain hormones responsible for fruit set. Many tree fruit and vegetables furthermore are known to have increased fruit set and seed development when hand pollination is carried out in the bud stage, rather than when the flower is mature; while increased flowering and a more even blooming period is now often brought about, especially in vegetable breeding, by regulation of day length with artificial lighting.

The potency of pollen at the time of its transfer to the stigma is vitally important to the success of both plant breeding procedures and the set of a commercial crop. The viability of pollen varies even within the anthers of the same flower; and is, of course, greatly influenced by environmental conditions. It is unusual for pollen to be 100 per cent viable. The increase in the use of artificial pollination during recent years has resulted in the realisation of the importance of maintaining the viability of pollen in artificial environments, since it is after the collection of pollen (for latter use in artificial pollination) that the greatest care should be taken in the handling of it. The vitality of most pollens goes down rapidly after collection; and few pollens are potent enough for use in pollinatian after a few days in an uncontrolled environment, particularly when the temperature is high. Many horticultural crop pollens will stay strong enough for repeated use in pollination over a period of several days to a week when they are kept in a household refrigerator (after drying and storage in vials); while some tree fruit pollens have remained viable for many months (undisturbed) under these conditions.

Research on long-period storage (from several months to several years) has shown that, in general, pollens of many horticultural crops will survive for many months, but with gradually decreasing vitality, in temperatures just above freezing, as long as the relative humidity of the storage environment is controlled and the pollen is not disturbed. Quick freeze and liquid oxygen methods have shown promise for such storage (although the latter is impractical for general purpose storage), and there are encouraging results at L. S. U. on pollen longevity under freezedry conditions. The physiological responses of the pollen grain to environmental changes are, however, still too little understood for longperiod storage methods now in use to be considered routine and practical.

It is to be expected that since pollens of the various fruits and vegetables are structurally different, they will react differently, physiologically, to such drastic changes in their environment as those brought about by sudden low temperatures. It is safe to say, nevertheless, that the season-to-season storage of pollens will be a routine procedure in the near future.

The basic problem relative to the long-distance shipment of pollens are similar to those of storage; and an economy size and weight package has not yet been designed which will protect the pollen for more than a few days from excessive heat, and consequent loss of vitality, during transit. The possibility of shipment in an evacuated capsule-type of container is being explored at L. S. U. and, again, there is little doubt but that continued research will overcome this problem. The way will then be open for the establishment of pollen distribution centers and for co-operative national and international exchanges of pollens among plant breeders.

The problems of pollen handling, pollination requirements for horticultural crops, and other factors associated with the set of fruit are basic to plant breeding techniques and to the production of commercial crops. The uninformed, or careless, fruit grower has had to learn this fact the hard way by the loss of a crop, or even his investment, through the failure of natural pollination and his own failure to provide either pollinizer interplants or for artificial pollination. Many problems and inconveniences in breeding methods, furthermore, might have been, or could still be, overcome if the behaviour of pollens were better understood and proper handling procedures were carried out.

Hardly more than a beginning has been made in this field of basic horticultural research; but a more constructive approach to an understanding of pollen behaviour in relation to its use in plant breeding and to crop production can be expected when there is a more extensive integration of interests, ideas, and efforts among research workers, breeders, and commercial growers on the problems involved.