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Cytoplasmic Male Sterility and Intergrafts between Lycopersicon esculentum *and* Solanum pennellii corr.*

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ABSTRACT — Attempts to transmit cytoplasmic male sterility through intergrafts between *Lycopersicon esculentum* and *Solanum pennellii* have been unsuccessful. This implies that in these materials, the factor conditioning cytoplasmic male sterility is noninfective. The results of this study and other similar studies by other workers suggest the possibility that grafting might be used as a tool in the classification of cytoplasmic factors affecting male sterility in plants.

Correns in his genetic studies in the early part of the century, recognized that "two kinds of heritable patterns might well exist" (Wilson, 1920), one controlled by nuclear genes and the other by the cytoplasm. The latter would generally be inherited maternally.

The genetic agents responsible for cytoplasmic inheritance have been disclosed in a few instances. In *Drosophila*, l'Heritier (1958) and Iconomidis and L'Heritier (1961) have shown that a virus-like organism inherited through the maternal cytoplasm is responsible for the CO_2 sensitive trait. Poulson and Sakaguchi (1961) have shown that a *Treponema*-like organism found in the maternal cytoplasm is responsible for drastic alterations of the sex ratio found in certain *Drosophila* populations. The killer characteristic in paramecium has been associated with small particles which, according to Preer (1950), resemble in many ways nuclear apparati of bacteria. In plants, several cases of maternally transmitted plastid types have been described (Rhoades, 1946). Michaelis (1958) reviewed studies describing somatic segregation of color variegated plastids in *Epilobium*. Here plastid factors were transmitted maternally, with differences between branches. It was noted that the differences between branches depended on somatic segregation of plastid particles.

If each case of cytoplasmically transmitted phenotype were investigated intensively, important qualitative and quantitative differences between cases might become apparent. These findings would permit intercomparisons between and classification of cases which could be an important aid in interpreting the nature of cytoplasmic inheritance.

Recent attempts to transmit cytoplasmic male sterility through grafting have proven interesting. Frankel (1956, 1962) and Edwardson and Corbet (1961) have successfully demonstrated graft transmission of a cytoplasmic male sterile factor in petunia. Male fertile (*mf*) plants become infected with the male sterile (*ms*) factor when intergrafted with the cytoplasmic male sterile line. The *ms* line can serve as scion or rootstock. The flowers of the *mf* line remain self-fertile indefinitely when intergrafted with the *ms* line but true cytoplasmic male sterility appears in the progeny of the self-pollinated flowers of the male fertile stock or scion. The breeding behavior of these induced cytoplasmic steriles is precisely similar to the original *ms* line in that male sterile cytoplasm is inherited maternally independently of the nucleus. In addition, successful transmission of male sterility through grafts from male sterile to male fertile graft components appears to be conditioned by the genotype of the male fertile plants. Not all male fertile varieties are susceptible.

Andersen (1963) recently reported cytoplasmic male sterility in crosses between *Lycopersicon esculentum* and *Solanum pennellii* Corr. Attempts have been made to describe the male sterile character genetically and morphologically. In view of Frankel's success noted above, attempts were made to further classify this male sterile character by grafting. The results of this latter experiment are reported below.

Materials and Methods

Reciprocal cleft graftings were made between *Lycopersicon esculentum*, variety VFII, a tomato cultivar known to transmit male sterile cytoplasm, and a *Solanum pennellii* accession from Atico, Peru, known to possess the "*Lycopersicon* sensitive" genome. The two species served alternately as root stock and scion. Intact controls representing both biotypes were included. The controls, scion and stock of the grafted materials were self-pollinated. The resulting progenies were transplanted to 4-inch pots and placed in a completely random design in the greenhouse. Measurements for anther length and percentage of aborted pollen were taken six to eight weeks later.

RESULTS: Average anther length in millimeters and percentage aborted pollen are listed in Table 1. The results are recorded for the self-pollinated progeny from *L. esculentum* and *S. pennellii* controls and from the progeny of scions and stocks of their reciprocal grafts. Only the averages for the measurements are given. The associated variances and corresponding standard errors are excluded because of their extremely low magnitude.

The means for another length and percentage of pollen abortion are essentially the same for each species regardless of treatment. No male sterile plants were observed in

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TABLE 1. Average per cent pollen abortion and average anther length in selfed progeny from the *L. esculentum* (var. VF ii) and *S. pennellii* (atico accession) controls and their respective reciprocal grafts.

	Pollen abortion, Average per cent	Number Plants	Average anther Length (mm)
Control *esculentum*	25.06	10	8.13
Control *pennellii*	10.01	10	7.85
Selfed *esculentum* scion	24.78	160	8.07
Selfed *pennellii* scion	11.19	175	7.80
Selfed *esculentum* stock	25.01	90	8.12
Selfed *pennellii* stock	9.69	134	7.81

the progenies studies. Therefore, under the conditions of the experiment, grafting has no observable effect on male fertility.

Discussion and Conclusions

Ohta (1961) and Sand (1960), working in *Capsicum* and *Tobaccum* respectively, also reported negative results in attempts to transmit cytoplasmic male sterility through grafts. Ohta suggested that grafting might be a means of classifying cytoplasmic male sterility and that, basically, two kinds of cytoplasmic male sterility must exist in plants. One is viral in nature and is infective, and the other is plasmon (cytoplasmic system) controlled and is essentially noninfective. The difficulties in demonstrating such conclusions are exemplified by the work in petunia noted above. Here the genotype of the fertile graft component may convey immunity to the cytoplasmic factor. This type of genetic-cytoplasmic factor interaction could well confuse the interpretations of grafting experiments, particularly, if one is attempting to interpret his results within the framework prescribed by Ohta.

The unsuccessful attempts to transmit cytoplasmic male sterility through grafts in the *Lycopersicon-Solanum* materials described earlier conveys little biological meaning. In this case, under the conditions of the experiment and with the biotypes utilized, the male sterile character does not appear to be transmissible through grafts. Nothing can yet be inferred in respect to plasmon versus viral control.

The positive results of Frankel and Edwardson and Corbet, however, do suggest that grafting may be used as a tool for detecting characteristics of cytoplasmic inheritance. The studies of Ohta, Sand and Andersen in widely different plants emphasize the need for extensive screening of biotypes within the species or races studied before valid interpretations can be made.

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