Heating Seedlings of Normal, Cytosterile and Restored-Sterile Corn and its Effect on Pollen Production[1]

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Abstract. Plants of sweet corn from germinated seeds treated at sub-lethal temperatures were less vigorous and shorter than their controls. The pollen shedding patterns of plants from normal C13, T-sterile C13 and restored-sterile sweet corn inbreds were not altered by the heat treatments. Pollen shedding patterns among several commercial sweet and field corn hybrids were also unaffected by the treatments. If a virus is responsible for cytoplasmic male sterility in corn it appears to be less sensitive to heat treatment than do the seedlings.

Certain environmental factors, particularly temperature, have been reported to modify the pollen shedding pattern among some types of corn. This effect is of considerable importance since it may affect yield and quality of the crop intended for seed or food.

Jones and Mangelsdorf (5) called attention to some potentially normal fertile corn plants started in the greenhouse and later transplanted to the field that were sterile at the end of the season. Presumably, this was because of their exposure to very high temperatures. According to Crookham[2], some sweet corn inbreds which produce pollen normally in the Northeast, including normal as well as certain restored-sterile pollinator lines, fail to produce pollen in the hot, dry summer climate of the Snake River Valley of Idaho. It was noted at this station that T-sterile versions of C30, C13 and C5 inbreds, while apparently pollen sterile, frequently display exserted anthers on plants when grown in the greenhouse. On the other hand, when grown out-of-doors at Amherst, Massachusetts plants from the same seed stocks did not have exserted anthers.

In 1933 Rhoades (8) was unsuccessful in transmitting the male sterile character as a result of inoculating plant juices into normal plants and assumed it was not a virus. Edwardson (3) using electron microscopy noted small inclusions in the cytoplasm of male sterile plants, but they were not present in maintainer plants. Gabelman[3] (4) reported that the cytoplasmic particle was probably about the size of a large virus but he was unable to transmit the male sterile character either by grafting or several inoculation techniques. Viable pollen production resulted, however, after treatment of dormant S-sterile seeds by x-rays with a dosage of 1000 r units.

Later, Lederberg (7) also stated that cyto-sterility might be conditioned by the presence of a virus in the plant. Sheard[4] reported that he eliminated tobacco mosaic virus from the inside of tomato seed by heat treatment. Hence, heat treatment might restore fertility among cytosterile lines.

To test this hypothesis, Lachman et al. (6) heated dry embryos of sweet corn at sub-lethal temperatures over a period of 3 years without any effect in modifying the pollen shedding patterns of normal, cyto-sterile or restored sterile versions of several sweet corn inbreds. Previously, Brawn (2) had been able to induce pollen shedding in a few plants of T-sterile corn after subjecting seedlings to heat shocks, but he was unable to repeat the results. In Connecticut (1), however, germinated seedlings of normal field corn (Wf9xP8) with shoots one-fourth to one-half inch long held at 104, 122 and 140°F for 1 hr produced plants that were pollen sterile in all treated lots.

These anomalous results prompted the present experiments with heat treatments to germinated seed of normal, cyto-sterile and restored-sterile versions of C13 sweet corn inbreds, and sweet and field corn hybrids. The results are presented in this report.

Materials and Methods

Seed of homozygous lines of normal C13, T-sterile C13 and restored-sterile C13 were used in most of the tests. These lines had been selfed for many years and were uniform. Two commercial sweet corn hybrids, 'Early Golden Giant' and 'Seneca Chief', and the field corn hybrids, 'Agway 7151', 'Minhybrid 806' and 'Pennsylvania 290' were also used in the tests.

Seeds were placed on wet paper towels in Petri dishes and germinated at room temperature. Seedlings whose shoots and roots had developed to one-fourth to one-half inch long were exposed to temperatures ranging from 104°F to 140°F for periods of 1 or 2 hours. When removed from the oven the seedlings were planted in 'Jiffy" peat pots and after 2 weeks in the greenhouse were transplanted to the field.

To determine whether hybrids might react differently from the C13 inbred, 2 sweet corn and several field corn hybrids were treated for comparison. Seedlings germinated as described above, of 'Early Golden Giant', 'Seneca Chief', 'Agway 7151', 'Penna. 290' and 'Minhybrid 806' were heated for 1 hour at 122, 130, 135 and 140°F respectively, but none of the seedlings survived at the 3 higher temperatures. It has been reported, however, that Wf9 x P8 seedlings withstood a temperature of 140°F for an hr (1).

Results

Results of tests with the C13 inbreds are presented in Table 1. Some of the seedlings died in all the heat treated lots but none survived that were held at temperatures higher than 130°F. Good cultural conditions were provided in the field, but plants that survived the heat treatments were less vigorous and shorter than corresponding untreated plants.

It is noteworthy that none of the 3 treated versions of C13 changed their pattern of pollen shedding when compared to the corresponding checks. These results are similar to those obtained from heating dried seed of the same 3 lines of C13 (6).

Results of treating seedlings of the hybrids at 122°F are shown in Table 2. Sterile and fertile seedlings were found in both the check and treated lots of 'Minhybrid 806'. None of the other hybrids developed sterile plants in either the treated or control lots. The departure of the results with 'Minhybrid 806' is attributed to the method of seed production. Undoubtedly,

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[2]Crookham, G. L. 1965. Personal Correspondence. Crookham Company, Caldwell, Idaho.

[3]Gabelman, Warren H. 1949. Cytogenetic studies of cytoplasmic inheritance of male sterility in Zea mays. Ph.D. Dissertation, Yale University, New Haven, Connecticut.

[4]Sheard, G. T. 1964. Personal Correspondence. Glasshouse Crops Research Institute, Sussex, England.

this seed lot resulted from blending sterile and fertile types or a sterile female parent was pollinated with a male parent heterozygous for restoration of fertility.

The discrepancy of these results compared to those of others (1, 2) is not readily explainable. Under the conditions prevailing in these tests, which were conducted over a period of 2 years, sub-lethal heating of germinating corn seedlings did not change the pollen shedding pattern of 3 versions of C13 inbred or of several commercial hybrids. If cytoplasmic male sterility in corn is conditioned by a virus as proposed by Lederberg (7) it is evident that the embryo is more sensitive to heat than is the virus.

Table 1. Effect of heating germinated seed on pollen fertility of C13 lines.

Treatment	Normal C13		Cyto-Sterile C13T19		Restored C13 Rf Rf	
	Fertile	Sterile	Fertile	Sterile	Fertile	Sterile
1 hr 104°F	22[a]	0	0	12[a]	17[a]	0
1 hr 120°F	6	0	0	16	6	0
1 hr 122°F	107	0	0	78	44	0
1 hr 125°F	21	0	0	9	12	0
1.5 hr 122°F	3	0	0	4	15	0
2 hr 122°F	15	0	0	17	3	0
1 hr 130°F	7	0	–	–	–	–
1 hr 131°F	lethal					
1 hr 135°F	lethal					
1 hr 140°F	lethal					
Check	80	0	0	80	79	0

[a]Number of plants.

Table 2. Effect of treating germinated seed of sweet and field corn hybrids for 1 hr at 122°F.

Cultivar	Treated		Check		Treated	Check
	Fertile	sterile	Fertile	sterile	Plant height	Plant height
Early Golden Giant	40[a]	0	48[a]	0	47"	55"
Seneca Chief	28	0	28	0	74"	82"
Agway 7151	39	0	24	0	87"	96"
Minhybrid 806	15	15	13	9	80"	103"
Penna 290	29	0	23	0	89"	103"

[a]Number of plants.

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