A Quantitative Method for the In Vivo Measurement of the Viability of Corn Pollen

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THERE are several distinct type-reactions of pollen grains: stainability, germinability, viability, and zygotic potential or fertilizing ability. Thus, stainability and germinability refer to in vitro pollen classification whereas viability and the fertilizing ability of the pollen grains necessarily are measured in vivo. Pollen viability may be defined as the ability of the male gametophyte to grow in suitable stylar tissue, and the fertilizing ability or zygotic potential of the pollen grain as the ability to complete fertilization. A method of analysis is described here for the consideration of data based on the number of kernels produced on an ear of corn, the kernels resulting from a controlled pollination. It is accepted that a kernel produced on an ear represents a pollen grain that was placed on the silk in a 'viable' condition.

The method of analysis of corn pollen viability consists of an assay (referred to as the K assay), yielding data (referred to as K data) which are the number of kernels obtained on an ear from a controlled pollination, and the subsequent statistical analysis of these K data. The assay is the subject to be discussed, as the analysis of the data follows the standard analysis of variance procedures.

The K data reflect, in addition to a measure of pollen viability, variation in the performance of the K assay from two sources—the "female" and the "male." The contribution of the female moiety to the individual K values concerns the number of ovules available for fertilization—and any factor that influences this availability. Experimental results will be introduced which show that the source of variability attributable to the female can be minimized and essentially controlled.

Several factors may be concerned with the contribution of the male portion of the K assay to the variation of K data. In addition to the quality of the pollen, which is being measured, the quantity of pollen applied to the stigmatic surfaces and the time of day during which the pollination was made can be listed among these factors.

Thus, the K assay actually can be used to study several aspects of the pollination-fertilization phenomena prior to syngamy. Some of these aspects would be:

(a) pollen viability;
(b) silk viability;
(c) environmental influences on (a) and (b).

In this paper, the controls necessary on (b) and (c) are considered in relation to (a).

Proper experimental designs are essential for the successful use of the K assay in testing different pollen treatments, and for comparisons of K data within and among experiments. The relationship between treatment replication and treatment subsampling was experimentally tested in this study, thus allowing the estimate of the variance of a treatment mean for some replication-subsampling values.

REVIEW OF THE LITERATURE

The many facets of pollen biology have been reviewed by Walden (20) and more recently by Brewbaker (1). Crandall (2) was among the first to use the product of fertilization as a criterion for the "vitality" of pollen. Knowlton (8) presented the results of studies on corn pollen viability, using as his criterion the ability of the pollen to fertilize and produce kernels. Knowlton's data consist in part of the fertilization percentage, determined as the number of kernels divided by the total number of ovules per ear. No statistical analysis of the data was attempted. More recently, Jones and Newell (6) presented data on the average number of kernels per ear from pollinations with treated pollen.

Several workers, studying pollen viability, followed the lead of Crandall and Knowlton in using the capacity of fertilization as a criterion of pollen viability. Penson (16) tested Brassica oleracea pollen viability in this manner, as did Harrison and Fulton (4) with cotton pollen; Gondo (3) with sugarcane pollen; Newcomer (11) with Gingko pollen; Olino (12) with grape pollen, and Stone et al. (17) with Pistacia vera pollen, to mention only a few.

However, it remained for Johnson and Griffiths (5) to test viability by the seed set criterion and analyze their data through the use of variance analysis. These workers studied capsule formation and seed set from pollinations with treated Helenium pollen.

In the methods used in the present study, the receptivity of the ovule-silk complex must be considered. Since the K value of a single ear is considered as a datum, it is sufficient to consider the population of ovules on a ear as a single factor. Thus, for the most efficient operation of the K assay, efforts must be made to insure the homogeneity of the many parts (ovule plus silk) of this factor.

Few studies have been conducted on the relative aging of silks and its effect on fertilization in maize. One approach to this problem has been undertaken to date—namely, the attempt to achieve maximum seed set from a series of pollinations in which the variable being studied was the time interval between silk extrusion and pollination. The data from the studies of Mangelsdorf (9), Paareva (14), Manrique-Chavez et al. (10), Kadnopoulos (7), and Simonguljan (18) are in relatively good agreement. Optimum seed set was obtained, where one pollination was made, four to five days after the first silk extrusion. By making serial pollinations on the same ear, Manrique-Chavez et al. (10) demonstrated that maximum seed set could be obtained ten days after the first silk emerged. These studies indicate that silk emergence took place over a period of at least ten days, but that the silks emerging first retained the ability to foster the growth of the male gametophyte for less than a week. Randolph (15) mentioned that the silk is receptive for a week to ten days after it is first exposed.

MATERIALS AND METHODS

1. The K bio-assay for corn pollen viability.

The K assay for corn pollen viability has been described in detail elsewhere (20). The single criterion of success or failure for each individual pollen grain was the ability of that grain to complete the fertilization process as manifested by the production of a kernel. Thus, a sample of pollen was placed on the silks of an ear in a controlled manner and the resultant number of kernels (K) was the datum for that pollination.

In an effort to test the validity and statistical significance of K data, P data were also collected and analyzed in some experiments; P1, (P datum) may be defined as K, divided by the number of