Pollination in Corn: Timeline of Key Steps

CROP BULLETIN

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KEY POINTS

- One can determine successful ovule fertilization shortly after pollination by gently shaking the ear and estimating the number of detached silks.
- Silks detach from developing, fertilized ovules on the second day after pollination.
- The number of detached silks two days or more after pollination corresponds with the number of kernels on the harvested ear.
- When scouting a field, it is more efficient to observe wilted silks and to feel for reduced silk elasticity to qualitatively estimate pollination success than to harvest ears and estimate the number of detached silks.
- The greater value of harvesting ears and estimating detached silks shortly after pollination is to quantitatively estimate ovule fertilization or to demonstrate the success rate of ovule fertilization to others.

POLLINATION TIMELINE IN CORN

One method to determine successful ovule fertilization following pollination in corn is to harvest the ear, remove the husk, gently shake the ear, and observe the number of detached silks that fall from the ear (Figure 1). Silks detach from all fertilized ovules while silks remain attached to unfertilized ovules. How soon after fertilization do silks detach from fertilized ovules? A field study was conducted to examine the timeline from pollen shed through ovule fertilization, silk detachment, and eventual kernel set.

FIELD STUDY

Corn ears were covered before silks emerged. Silks of selected ears were exposed to pollen for one day only on July 17, 18, 19, or 20, the third, fourth, fifth, or sixth day after the field was at 50% silk and the second, third, fourth, or fifth day after the field was at 50% anthesis, respectively. After this single day of exposure, silks were again covered with shoot bags to eliminate further pollination.

Selected ears were harvested at 1, 2, 3, 4, or 5 days after silk exposure to pollen, husks were carefully removed, the ears were shaken gently to allow detached silks to fall, and the number of detached silks per ear were estimated. Pollen density was heavy and silk growth was rapid on July 17 and 18. Pollen density was lighter and silk growth was slower on July 19, and both were dramatically reduced on July 20.

Figure 1. Successful pollination can be demonstrated by gently shaking the silks from an ear and estimating the number of detached silks.

Corresponding ears for each day of exposure were harvested at corn maturity, and the number of kernels on each ear were counted. There was a minimum of six replications for each sample timing for each exposure treatment.

SILKS DETACH TWO DAYS AFTER POLLINATION

For all four exposure dates, no silks detached the first day after exposure (Figure 2). Silks started to detach the second day after exposure for all four exposure dates. The number of detached silks remained constant (within one standard deviation unit of the mean) at 2, 3, 4, and 5 days after exposure. Kernel counts per ear at maturity corresponded closely to the estimated number of detached silks at 2, 3, 4, and 5 days after exposure. Figure 4 shows representative ears with no silks attached to fertilized, developing kernels at 2 to 5 days after exposure to pollen and kernel set of corresponding ears at maturity. Many silks originating from ovules that were not fertilized during pollination are still attached to the cob at grain maturity.

TIMELINE: POLLINATION TO SILK DETACHMENT

Results from this study indicate that silks detach from fertilized ovules on the second day after these silks are exposed to pollen. This time interval is consistent with previous research that describes and documents with photomicrographs the growth and development of the corn embryo during the fertilization process (Kiesselbach, 1999).

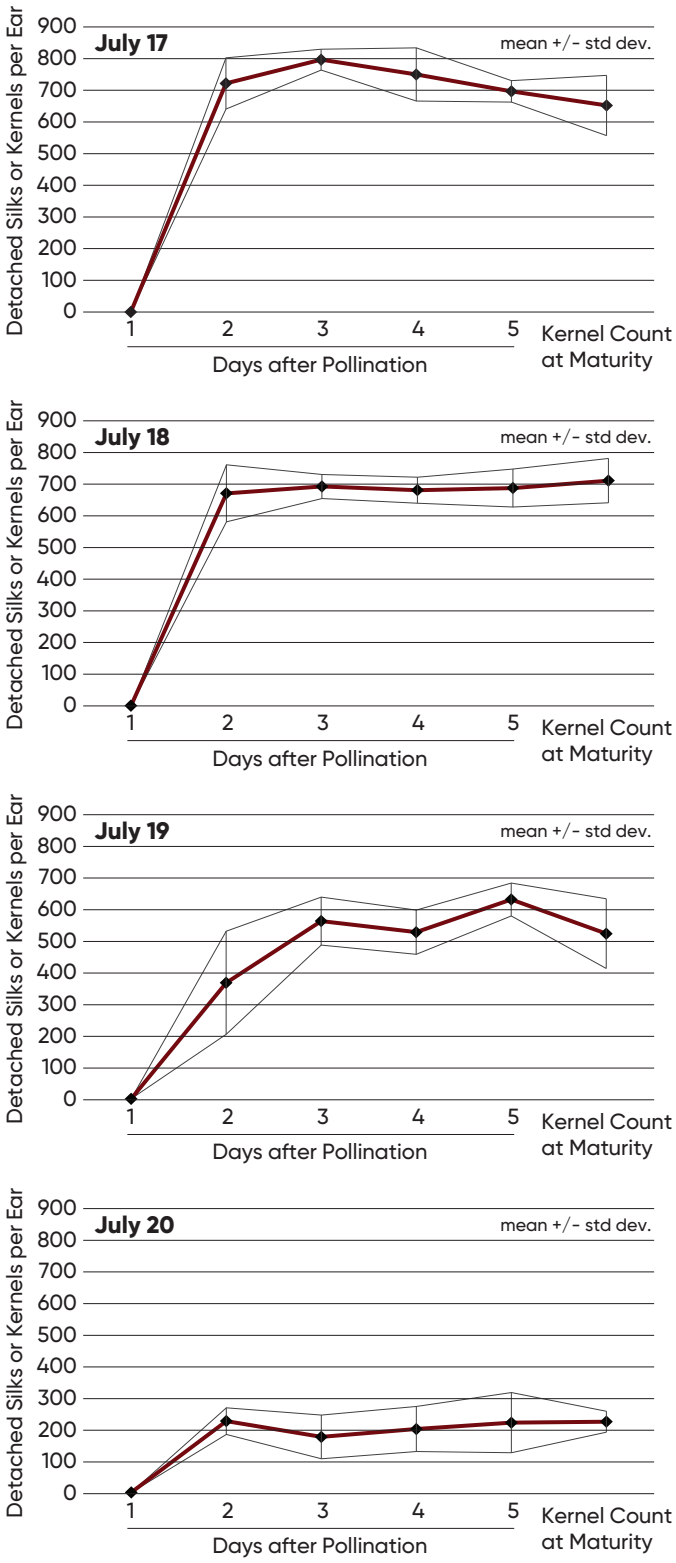

Figure 2. Estimated number of detached silks at 1, 2, 3, 4, and 5 days after pollination and corresponding kernel counts for ears exposed to pollination for one day only at 3, 4, 5, or 6 days after the field was at 50% silk.

Pollen shed starts when mature pollen grains fall through open pores of dehisced anthers. Gravity and wind influence pollen movement as pollen grains fall. If no wind is present, pollen falls at a rate of about 8 inches per second. It would therefore require just a few seconds for a pollen grain to fall the few feet from the tassel to receptive silks on the same corn plant if the pollen grain fell straight down. The flight time for the vast majority of pollen grains to land on receptive silks would very probably be less than one minute.

Very shortly after pollen grains land on receptive silks, pollen grains start to extrude pollen tubes. Pollen tubes begin to penetrate silk trichomes within about 15 minutes after capturing the fallen pollen. The purpose of the pollen tube is to create a channel within the silk to move the male genetic material from the pollen grain to the receptive female embryo. If corn plants have ample water, pollen tubes complete their growth process within 12 to 18 hours. This time interval depends on where pollen grains land on silks; time intervals increase if pollen tubes must penetrate longer silk lengths. If corn plants are under moisture stress, more than 24 hours may be required to complete pollen tube growth.

After the pollen tube penetrates the embryo sac, one male nucleus fertilizes the egg nucleus to create a fertile zygote that eventually becomes the seed embryo in the mature grain. A second male nucleus fertilizes two polar nuclei to create what eventually becomes the starch in harvested grain. The time required for this double fertilization is not known, but the time interval is probably very short because the male genetic material exits the pollen tube in very close proximity to the female gametes. Kiesselbach showed that a fertilized embryo and the genesis of starch formation are present by 40 hours after pollination.

Figure 3. Some hybrids have visible scars on the kernels where the silk was attached.

As soon as the fertile embryo has formed, cells connecting the silk to the embryo sac begin to desiccate. As these cells dry, the silk no longer has access to food and water. The silk detaches from the embryo sac, dries, and turns brown. The point at which this silk detaches creates a silk scar on the mature grain. Seeds of some hybrids have visible silk scars while silk scars on seeds of other hybrids are barely visible (Figure 3). This desiccation and silk detachment process does not happen instantaneously. Time must elapse before this process is complete. Apparently, this desiccation and detachment process takes just a few hours because, based on the results of this study, all silks originating from fertilized embryos detach from these fertilized embryos during the second day after pollination. This result is also consistent with Kiesselbach's research. Kiesselbach showed that silk scars are present on the developing seed five days after pollination. Figure 5 briefly summarizes this pollination, fertilization, desiccation, and detachment timeline.

Figure 4. Representative ears showing fertilized ovules with no attached silks two or more days after pollination and kernel set at maturity. The field was at 50% silk on July 14. Each date shown in the figure is the single day of silk exposure to available pollen for each treatment date.

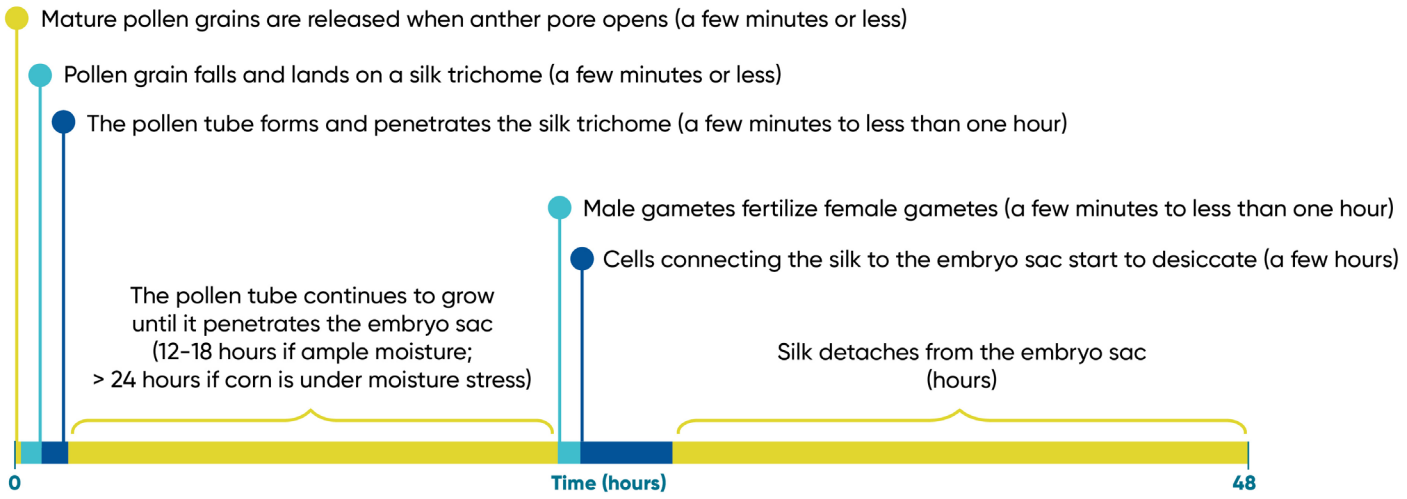

Figure 5. Timeline for pollination, ovule fertilization, and eventual silk detachment.

SILK DETACHMENT AS A SCOUTING TECHNIQUE

Silk detachment confirms successful fertilization of the corn embryo and occurs on the second day after pollination of exposed silks. It takes quite a bit of time to harvest an ear, carefully peel back the husks, and gently shake the ear to estimate the number of detached silks. From an efficiency perspective, it is faster to estimate fertilization success by observing the turgor of exposed silks. Silks in the early process of detachment or that are recently detached appear wilted and lose some of their elasticity when they are touched. The silk detachment method has value when the observer wants to quantify successful fertilization or the observer desires to show how far the fertilization process has progressed to another who is less familiar or less knowledgeable of the corn pollination process. In these studies, the number of detached silks two or more days after successful fertilization correlated well with the number of kernels at maturity. The silk detachment method therefore also has value if one wants to estimate the number of potential kernels per ear at harvest.

REFERENCE

Kiesselbach, T. A. 1999. The Structure and Reproduction of Corn, 50th Anniversary Edition. Cold Spring Harbor Press, New York.

ACKNOWLEDGEMENT

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