EFFECT OF GLYPHOSATE (ROUNDUP ULTRA) ON POLLEN VIABILITY AND POLLINATION IN ROUNDUP-READY COTTON.

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Abstract

Laboratory, field, and greenhouse studies were conducted to investigate the affect of Roundup applications on pollen viability and pollination in Roundup Ready cotton. The objectives of these studies were to determine a method to reliably estimate the viability of cotton pollen, use this methodology to measure the pollen viability of Roundup Ready cotton plants in greenhouse and field studies, determine if reduced pollen viability corresponds to a reduced number of seeds per boll, and determine if the male portions of the flower (anther and pollen) or the female portions of the flower (stigma, style, and ovary) are affected by Roundup.

To develop a reliable method of estimating pollen viability, a media which has been used to determine the pollen viability of various other agricultural crops, Brewbaker & Kwack[1] media (B & K) was tested with concentrations of sucrose ranging from 0-20% w/v. B & K media with a 5% w/v sucrose concentration was found to be ideal for germination of cotton pollen. Lower sucrose concentrations caused pollen grains to explode because of the difference in osmotic potential. In higher sucrose concentrations, pollen grains did not form pollen tubes. Pollen was harvested by dipping anthers into a vial containing B & K media + 5% w/v sucrose. A sample was then taken and placed on a microscope slide where the percentage of pollen grains which had formed a pollen tube were counted under a light microscope. Pollen germinates very rapidly in this media (usually in 3-5 minutes), but germination could still reliably be measured 24 hours after pollen harvest making this method suitable for taking samples while in the field and assessing viability later.

B & K media +5% w/v sucrose was used to assess pollen viability of flowers in greenhouse and field studies. Pollen viability of plants treated with 4 lf postemergence applications (POST) and 8 lf post-directed (PD) Roundup applications of 1 qt/A, was significantly less than untreated plants at 1-3 weeks after first bloom (WAFB) in the field study and 1-2 WAFB in greenhouse studies. Pollen viability from 4-lf POST/8-lf PD treated DP 5415RR in greenhouse studies was 35% lower than DP 5415RR which did not receive Roundup treatments. Differences in pollen viability from greenhouse studies were not apparent at 3 and 4 WAFB. In field studies, pollen viability in DP 5415RR receiving 4-lf POST/8-lf PD treatments of Roundup was less than untreated DP 5415RR at 1, 2, and 3 WAFB, with a maximum viability reduction of 25% at 3 WAFB. In greenhouse studies, this reduction in pollen viability translated into a reduction of the number seeds/boll in DP 5415RR and DP 458B/RR plants treated with 4-lf POT/8-lf PD Roundup applications. Reductions of between 9-11 seeds/boll, or 33% were evident in these treatments.

A field study was conducted to determine which floral organs are being affected by Roundup applications, the male portions (anthers, pollen) or the female portions (stigma, ovary). Previous research has shown that male portions of the flower are formed earlier in square development than female portions. Therefore, the potential exists early on for damage of male organs by early Roundup applications. Reductions in pollen viability in greenhouse and field studies by Roundup applications have confirmed this potential. However, it is still possible that female plant organs could be harmed by Roundup during development if the Roundup-Ready gene is not adequately expressed in floral tissue. By conducting crosses with Roundup treated and non-treated plants as both the female parent of the cross and the male parent, differences in sensitivity between male and female organs could be differentiated. Thus, all possible crosses and self-pollinations of DP 5415 conventional, DP 5415RR-untreated, DP 5415RR-4 lf POST, and DP 5415RR-4 lf POST & 8 lf PD were conducted over the 4 weeks of blooming. Bolls were hand harvested at maturity and seeds counted. Bolls which were self-pollinated had significantly more seeds than those which were cross-pollinated, regardless of Roundup treatment. Bolls which were to be self-pollinated were not emasculated, whereas bolls to be cross-pollinated were emasculated to remove male organs. The stress of this emasculation procedure likely reduced the number of seeds/boll. There were no other consistent differences between treatments or crosses suggesting that on the field level, the flower may have some method to compensate for lower pollen viability. Perhaps, even in crosses with reduced pollen viability, there was ample viable pollen available to fertilize the majority of ovules.

[1]Brewbaker, JL and BH Kwack. 1963. The essential role of calcium ion in pollen germination and pollen tube growth. American Journal of Botany. 50(9): 747-858

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