Flower shedding and sprinkler irrigation — When not to irrigate?

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Sprinkler irrigation can induce flower and young boll shedding by destroying pollen during flower development. Novel research at Katherine Research Station in the Northern Territory is investigating the development of cotton flowers to determine when not to irrigate.

That young bolls and flowers abort as a result of rain has long been known. A researcher called Lloyd observed in 1920 that pollen immersed in water explodes, and said "the wetting of pollen by rain will destroy it, as indeed is the case". Lloyd also correctly observed that in the flower, pollen was susceptible to water in the period between release from anthers and germination on the stigma.

He stated: "A very light, it may be a practically unmeasurable precipitation intervening at the right time — as when the pollen is all discharged and germination hardly begun — will do more damage than a cloud burst at night."

The damage Lloyd referred to was boll shedding resulting from the destruction of pollen during flowering. Lloyd continued: "In interpreting our records of boll shedding therefore, we are compelled to ascribe importance, in some cases a very great deal of importance, to rainfall."

You've got to love the old fashioned scientist talk!

Unfortunately Lloyd did not have the technology to test his theory artificially. This was left to modern-day researchers Pennington and Pringle (1987) in the Mississippi Delta and Burke (2003) in the Texas High Plains. Using centre pivots equipped with sprinklers they irrigated cotton at different times of the day and recorded the survival of tagged flowers.

A wallaby proof fence surrounds the temperature data loggers. The solar panel keeps the 12 volt battery charged which powers the time lapse camera.

Pennington and Pringle found that a 65 per cent loss of tagged flowers in the portion of the pivot watered in the morning (9:00am), translated to a potential 2.25 per cent yield loss across the whole pivot if the crop was watered three times a week.

Burke found that flowers were most susceptible to abortion between 12 noon and 2:00pm. Sprinklers gave a 21 to 13 per cent yield reduction compared to drag sock irrigation at this time. Burke attributed the difference in flower susceptibility times to different night temperatures between the sites.

FIGURE 1: Plot of time of pollen release against the average temperature measured in half hour intervals in the 48 hours prior to the time of pollen release

So what happens at Katherine?

Most of our cotton is watered with sprinklers and nights are very cool during flowering. We expected that our flowering times would be different to the Mississippi Delta and the Texas High Plains. Unfortunately we didn't have the resources for a rigourous flower tagging experiment along with the rest of our research program.

Luckily for us, Burke had photographically documented the appearance of flowers when pollen was being released. To discover the time of day our flowers were susceptible, we compared Burke's photos from Texas to photos obtained from time-lapse photography of cotton flowers in Katherine.

We compared time lapse photography of cotton flowers in Katherine to US photographic studies of pollen release.

A digital camera (Nikon CoolPix3700) with a time-lapse feature was placed on a tripod near the flower to be photographed. It was powered by a 12 volt battery connected to a 240 volt inverter.

A solar panel kept the battery charged. A 12 volt computer cooling fan attached to a lamp stand was aimed at the camera to prevent the formation of dew and discourage insects from crawling on the lens.

For this experiment, first position flowers only were monitored. Burke's standard photographs were used to identify the rain-sensitive flowers. Sixteen time-lapse films with half hour shutter intervals were taken during the season. The time of pollen release was determined from the start of the photographic sequence, the photo-frame number, the time between frames, and the visual appearance of the flower.

A plot of the time of pollen release against the average temperature in the 48 hours prior to pollen release is shown in Figure 1.

Pollen was released earlier in the day with increasing temperature. Some of the photos showed that when flowers opened in the late afternoon and then experienced nights below 12°C they remained unchanged for up to eight hours.

Flower development in a cotton crop is well synchronised, with 90 per cent of flowers opening within one hour of each other. So the correlation in Figure 1 can be used to predict when the flowers in a crop will be susceptible to abortion from water damage.

More work needs to be done to determine how long the flowers are susceptible and whether avoiding sprinkler irrigation in this period will increase yield.

Work also needs to be done to determine if the time of flower opening is affected by genotype, Pix application and nutritional factors.

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