THE EFFECT OF SIMULATED 2,4-D AT VARIOUS GROWTH STAGES ON PLANT HEIGHT AND YIELD OF COTTON

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Abstract

With the impending release of 2,4-D resistant cotton cultivars, the interface between tolerant and non-tolerant cotton cultivars will be inevitably increase, raising concern over the impact of 2,4-D drift on cotton. Furthermore, growers in many areas of the cotton belt plant cotton in a wide window, potentially resulting in exposure of various growth stages of cotton to 2,4-D drift from nearby applications. Cotton is known to be one of the most sensitive crops to 2,4-D (Farwell et al., 1976), previous research has documented that exposure to 2,4-D results in detrimental effects on the growth, fruiting development, and yield of cotton (Everitt and Keeling, 2009; Johnson et al., 2012). However, the magnitude of the reduction in growth and yield has been reported to be influenced by the growth stage of cotton at the time of exposure and the rate of 2,4-D (Egan et al., 2014). In the current experiment, the effect of simulated drift rates of 2,4-D, applied at six different growth stages, on the growth and yield of cotton was investigated. In 2013, the experiment was conducted in Tifton and Moultrie, GA. In 2014, locations ranged across the cotton belt including Georgia (GA), North Carolina (NC), Florida (FL), Mississippi (MS), Missouri (MO), and two locations in Texas (Lubbock, TX and College Station, TX). The cultivar, PhytoGen 499 WRF, was planted in all trials. Two simulated drift rates of 2,4-D amine were applied at six different growth stages; four leaf (4-leaf), nine leaf (9-leaf), first bloom (FB), two weeks after first bloom (FB + 2 wks.), four weeks after first bloom (FB + 4 wks.), and six weeks after first bloom (FB + 6 wks.). The simulated drift rates represented fractions of the full rate (0.532 kg ai ha^{-1}): 0.002 kg ai ha^{-1} (low rate), or 1/266 of the full rate, and 0.04 kg ai ha^{-1} (high rate), or 1/13 of the full rate. A non-treated control (NTC) was also included. Plant height was measured every two weeks at the three

site years in Georgia and seedcotton yield was quantified at all site years. Means were separated by Fisher's Protected LSD at $p \leq 0.05$ in ARM 8 (Gylling Data Management Inc., Brookings, SD) and regressions were performed by SAS JMP Pro 11 (SAS Institute, Cary, NC).

Plant height showed no clear trend with treatments that resulted in yield loss, and in multiple instances, treatments that resulted in yield loss showed no difference in plant height compared to the NTC. In 2013 at the Tifton, GA site, the low rate of 2,4-D resulted in no yield loss when applied at any growth stage, while the high rate of 2,4-D reduced yield compared to the NTC at every growth stage except FB + 6 wks., with the most severe yield loss occurring in the FB and FB + 2 wks. stages. At the Moultrie, GA site in 2013, the low rate of 2,4-D reduced yield when applied from 9-leaf to FB + 2 wks. The high rate reduced yield from the 9-leaf to FB + 4 wks., with the greatest reduction occurring at the 9-leaf stage. In GA during 2014, the low rate had no effect on yield while the high rate resulted in yield reductions in the 4-leaf through FB + 4 wks. stages, with the greatest reduction occurring at the FB stage. In FL, the low rate of 2,4-D reduced yield at FB and FB + 2 wks. with the greatest reduction occurring in the FB stage. The high rate reduced yield from 4-leaf through FB + 4 wks. with the most severe reduction occurring in the FB and FB + 2 wks. stages. In MS, the low rate of 2,4-D had no effect on yield, while the high rate of 2,4-D reduced yield when applied at the 9-leaf through FB + 2 wks. stages. At the MO site, the low rate of 2,4-D resulted in yield reductions when applied at the 9-leaf and FB growth stages, while the high rate of 2,4-D reduced yield when applied at the 4-leaf through FB + 2 wks. with the most severe reductions occurring when applied at the 4-leaf through FB stage. In NC, both 2,4-D rates reduced yield with the exception of the low rate applied at the 4-leaf growth stage, with the most severe yield loss occurring in the FB growth stage. At the Lubbock, TX site, the low rate of 2,4-D had no effect on yield, while the high rate of 2,4-D resulted in yield reductions when applied at the 4-leaf and 9-leaf growth stages. In College Station, TX the low rate of 2,4-D reduced yield when applied at the 9-leaf growth stage while the high rate of 2,4-D reduced yield at all growth stages with the most severe yield loss occurring in the FB stage.

There were 12 growth stage and 2,4-D rate combinations at each site, with nine site years included in this study, for a total of 108 treatment observations. Of these, 51% resulted in no yield loss, 38% resulted in yield loss as a result of the high rate of 2,4-D, and 11% resulted in yield loss resulting from the low rate of 2,4-D. Of the 53 total growth stage and rate combinations across all nine site years in which a yield loss was observed, 77% were resulting from the high rate of 2, 4-D, with 23% resulting from the low rate. Of all the observations of yield loss, the high rate applied at the 9-leaf growth stage reduced yield at all nine site years, while the high rate at 4-leaf, FB, and FB + 2 wks. growth stages reduced yield in eight out of the nine site years. The low rate of 2,4-D applied at all growth stages resulted in yield reductions at less than half of the site years across all growth stages. When yield loss was averaged across all nine site years, the high rate of 2,4-D applied at the FB growth stage resulted in the greatest yield reduction, followed by the high rate applied at the FB + 2 wks., the high rate applied at 9-leaf, and the low rate applied at the FB growth stage.

Across all nine site years included in the study, the yield of the NTC (or yield environment), ranged from 1834.57 to 5593.15 kg ha^{-1}. The correlation between the frequency of yield-reducing treatments and yield of the NTC by site year was weak (R^2 = 0.275) indicating that there was little relationship between the yield environment and the number of treatments that resulted in yield reductions. There was a slightly higher correlation between the average yield loss (of all treatments that resulted in yield loss) in each site year and yield environment, but it was still weak (R^2 = 0.547) indicating little correlation between the yield lost (average over all treatment resulting in yield loss at a site year) and the yield of the NTC. A similar observation was found when the range of yield loss was related to the yield environment. Average percent yield loss was calculated by averaging the yield in all treatments that resulted in significant yield loss from each site year independently and then comparing the average yield of these treatments to the yield of the NTC at that site year. The highest correlation was found in the relationship between percent of NTC yield lost and yield environment (R^2 = 0.799) indicating that regardless of yield potential, or yield of the NTC, the simulated 2,4-D drift had the greatest effect in low yielding environments. The greatest percent yield loss (as a proportion of the NTC) was observed in the lowest yielding environment, with percent yield loss declining as the yield of the NTC increased. In conclusion, the high rate of simulated 2,4-D drift accounted for the vast majority of instances of yield loss observed across all site years. Furthermore, growth stages nearer to first bloom were the most sensitive to 2,4-D drift, with regard to yield loss. The percent of NTC yield lost by 2,4-D was related to the yield environment, with lower yielding environments experiencing a greater percent yield loss.

References

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