Poster Articles

Cotton Response to Simulated Drift Rates of Seven Hormonal-Type Herbicides

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Abstract

Cotton response was evaluated when 2,4-D amine, 2,4-D ester, clopyralid, picloram, fluroxypyr, triclopyr, and dicamba were applied at rates simulating spray drift during the 6 to 8 leaf stage at Manhattan and Hesston, Kansas. Herbicide rates applied represented 0, 1/100, 1/200, 1/300, and 1/400 of the use rates of 561, 561, 280, 561, 210, 561, and 561 g ai/ha for 2,4-D amine, 2,4-D ester, clopyralid, picloram, fluroxypyr, triclopyr, and dicamba, respectively. Injury from 2,4-D amine and 2,4-D ester were similar and was greater than that of other herbicides. The order of phytotoxicity was 2,4-D>picloram>dicamba> fluroxypyr>triclopyr>clopyralid. All herbicides caused characteristic symptoms of hormonal-type herbicide, except triclopyr and clopyralid which caused severe bleaching and chlorosis. By 56 days after treatment, plants recovered from injury symptoms of all herbicides except, 2,4-D, picloram, and dicamba. All rates of 2,4-D and the two highest rates of picloram, and dicamba caused flower abortion. This research clearly showed that cotton is extremely susceptible to simulated drift rates of 2,4-D.

Introduction

Herbicide may drift off target during application causing considerable injury if they contact susceptible plants. Research has shown that downwind drift deposits from ground sprayers ranged from 1 to 8% (Bode 1987; Maybank et al. 1978). Herbicide drift can be a serious problem in many crops throughout Kansas (Al-Khatib and Peterson 1999, Al-Khatib et al. 2003), especially when farmers apply herbicides under environmental conditions that favor volatilization and redeposition. Damage to crops from drift depends on many factors, including herbicide and formulation, plant species, cultivars, growth stage, environmental conditions, droplet size, and height above the ground that the spray is applied.

The use of herbicides in field crop production and fallow has contributed greatly to increasing agricultural production in Kansas. However, herbicide use also has resulted in herbicide injury on nearby susceptible crops. Because of hormonal herbicide use in fallow and crop land, off target herbicide injury in cotton has been very common in southwest Kansas.

Hormonal-type herbicides such as 2,4-D, dicamba, clopyralid, triclopyr, fluroxypyr, and picloram are widely used to control broadleaf weeds in many cropping systems. Some of these herbicides can cause serious drift injury on cotton since they are highly phytotoxic and readily translocated from leaves or roots to growing points (Devine et al. 1993). These herbicides kill plants by changing the hormonal balance at the growing point.

Damage to cotton by 2,4-D has been reported since 2,4-D was first commercially introduced. Cotton is considered one of the most susceptible agricultural crops to 2,4-D (Staten 1946; Regier et al. 1986; Bayley et al. 1992; Miller et al. 1963). While cotton response to 2,4-D has been established, the response of cotton to other hormonal-type herbicides is not well studied. Therefore, if other hormonal-type herbicides are safer on cotton then the herbicide could potentially be used to control broadleaf weeds around cotton less risk of drift damage to cotton. These hormonal-type herbicides also may provide equal or better control of certain broadleaf weeds compared to 2,4-D.

In response to 2,4-D drift and injury on cotton, several regulatory agencies and universities have tried to develop mechanisms to reduce hormonal-type herbicide injury on cotton. However, their efforts were hindered by lack of research on the response of cotton to different hormonal-type herbicides. In addition, no data are available to quantify the relationship between injury symptoms and cotton growth and development. While the correlation between herbicide injury symptoms and growth and development was well established on many crops, no data are available to illustrate the effect of low rates of hormonal-type herbicide on cotton. The objective of this research is to determine injury and symptoms caused by simulated drift rates of 2,4-D and other hormonal type herbicides.

Materials and Methods

Field experiments were established in 2004 at Kansas State University research fields near Manhattan in northeast Kansas, and Hesston in central Kansas. Plots contain four rows of “PM 2145” Roundup-Ready cotton planted according to Kansas State University recommendations. Plots were maintained weed free with *S*-metolachlor applied preemergence at 1121 g ai/ha and postemergence application of glyphosate to control weed escapes. In addition, hand weeding was used to control late emerging weeds.

At the 6- to 8-leaf growth stage, cotton was treated over the top with simulated drift rates of seven herbicides. Herbicides were dicamba (diglycolamine salt), 2,4-D amine (dimethyl amine), 2,4-D ester (2-ethylhexyl ester), clopyralid, picloram, fluroxypyr, and triclopyr. Herbicide rates represent 0, 1/100, 1/200, 1/300, and 1/400 of the use rate. The use rates were 561, 561, 280, 561, 210, 561, and 561 g ai/ha for 2,4-D amine, 2,4-D ester, clopyralid, picloram, fluroxypyr, triclopyr, and dicamba, respectively All treatments included 0.25% nonionic surfactant. Nontreated control plots were sprayed with water plus nonionic surfactant.

Herbicides were applied with a CO_2-pressurized backpack sprayer equipped with 8004 flat-fan nozzles. To eliminate drift to surrounding plants, herbicides were applied when air was calm and a plastic shield between plots was used during herbicide application. In addition, a buffer zone of three row of cotton was established between plots to eliminate cross contamination.

Plants were observed for injury symptoms and recovery. Injury was rated 7, 14, 28, and 56 days after treatment (DAT). The injury ratings were based on 0 = no injury and 100 = complete kill. Plant population and plant height was measured 56 DAT.

The experimental design was a split plot with four replications. The main plots were the seven herbicides and the five subplots were the herbicide rates and the nontreated control. The data were analyzed by location using regression analysis.

Results and Discussion

All herbicides caused leaf rolling and petiole twisting within 24 hours after applications. At 7 DAT, picloram, 2,4-D ester, 2,4-D amine, dicamba, and fluroxypyr caused severe leaf rolling, stem and petiole twisting and bending. The intensity of these symptoms was greatest with picloram and the least with fluroxypyr (Figure 1). Clopyralid and triclopyr caused slight leaf rolling, petiole twisting, and severe leaf bleaching. At 14 DAT, injury symptoms were greater compared to 7 DAT, with the greatest injury from picloram and the least injury from clopyralid (Figure 2). Developing leaves were narrow and curled, with chlorotic veins, and lacked interveinal growth. Symptom severity intensified with increased herbicide rate. No treatment caused death of the apical growth, except the highest rate of picloram.

At 28 DAT, plants had partially recovered from dicamba, clopyralid, triclopyr, fluroxypyr, and picloram injury, however, injury from 2,4-D application had intensified (Figure 3). The greatest recovery occurred with the clopyralid and triclopyr treatments. At the lowest two rates of clopyralid, plants appeared normal. At 56 DAT, plants continued to recover from injury symptoms caused by dicamba, clopyralid, triclopyr, fluroxypyr, and picloram (Figure 4). Plants treated with the three lower rates of dicamba, clopyralid, triclopyr, and fluroxypyr appeared normal. Again, 2,4-D injury symptoms intensified at 56 DAT compared to 28 DAT. All rates of 2,4-D amine and 2,4-D ester caused significant injury at both locations. However, plants continued to have new growth with severe epinasty.

Plant height was reduced only by the two highest rates of 2,4-D amine and ester and the highest rate of picloram by 56 DAT (data not shown). In addition, all rates of 2,4-D and the two highest rates of picloram and dicamba caused flower abortion, with complete abortion at the two highest rates of 2,4-D (data not shown). Boll size was reduced by all rates of 2,4-D, the two highest rates of picloram, and the highest rate of dicamba (data not shown).

This research showed that the order of herbicide injury to cotton was 2,4-D amine = 2,4-D ester>picloram> dicamba>fluroxypyr>triclopyr>clopyralid. In addition, this research clearly showed that cotton is extremely susceptible to simulated drift rates of 2,4-D, and thus the use of 2,4-D should be avoided around cotton fields.

References

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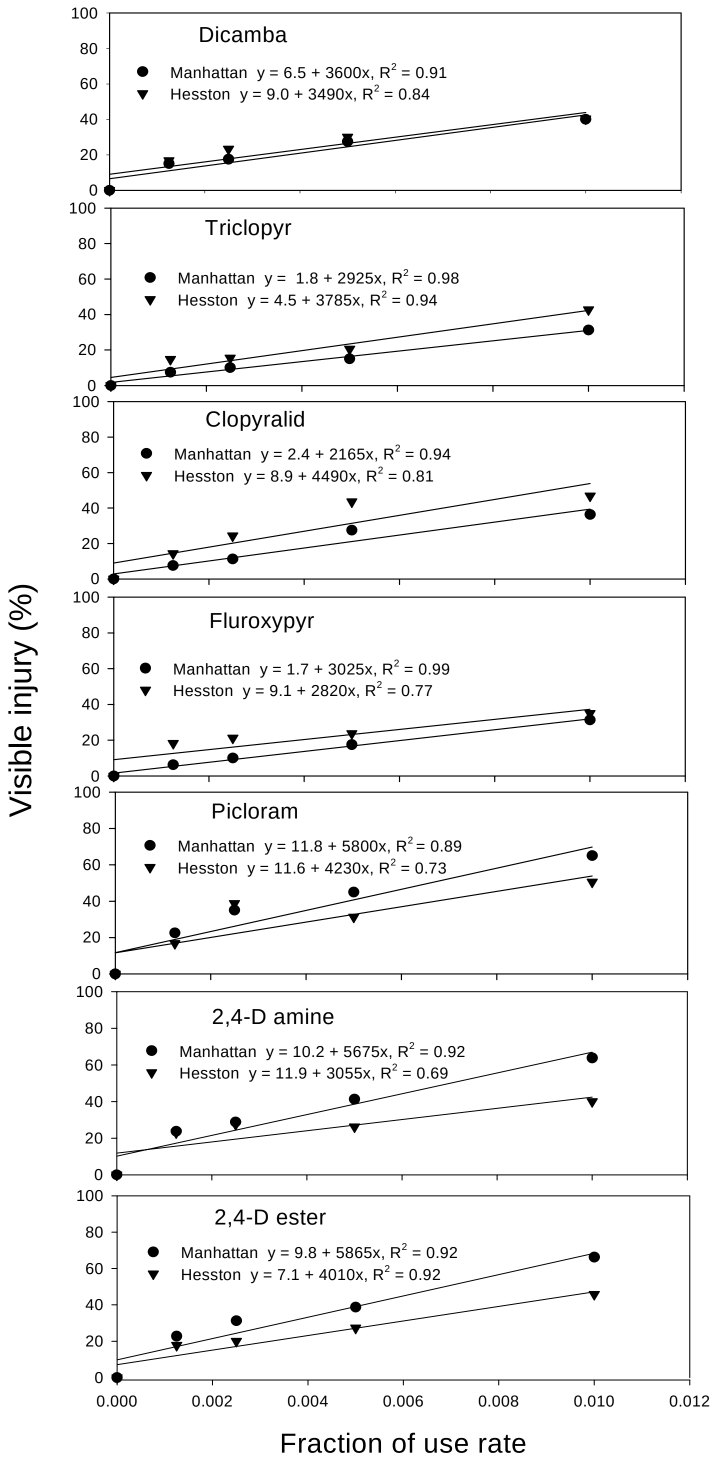

Figure 1. Cotton visible injury ratings 7 days after treatment with seven hormonal-type herbicides applied at Manhattan and Hesston, Kansas in 2004.

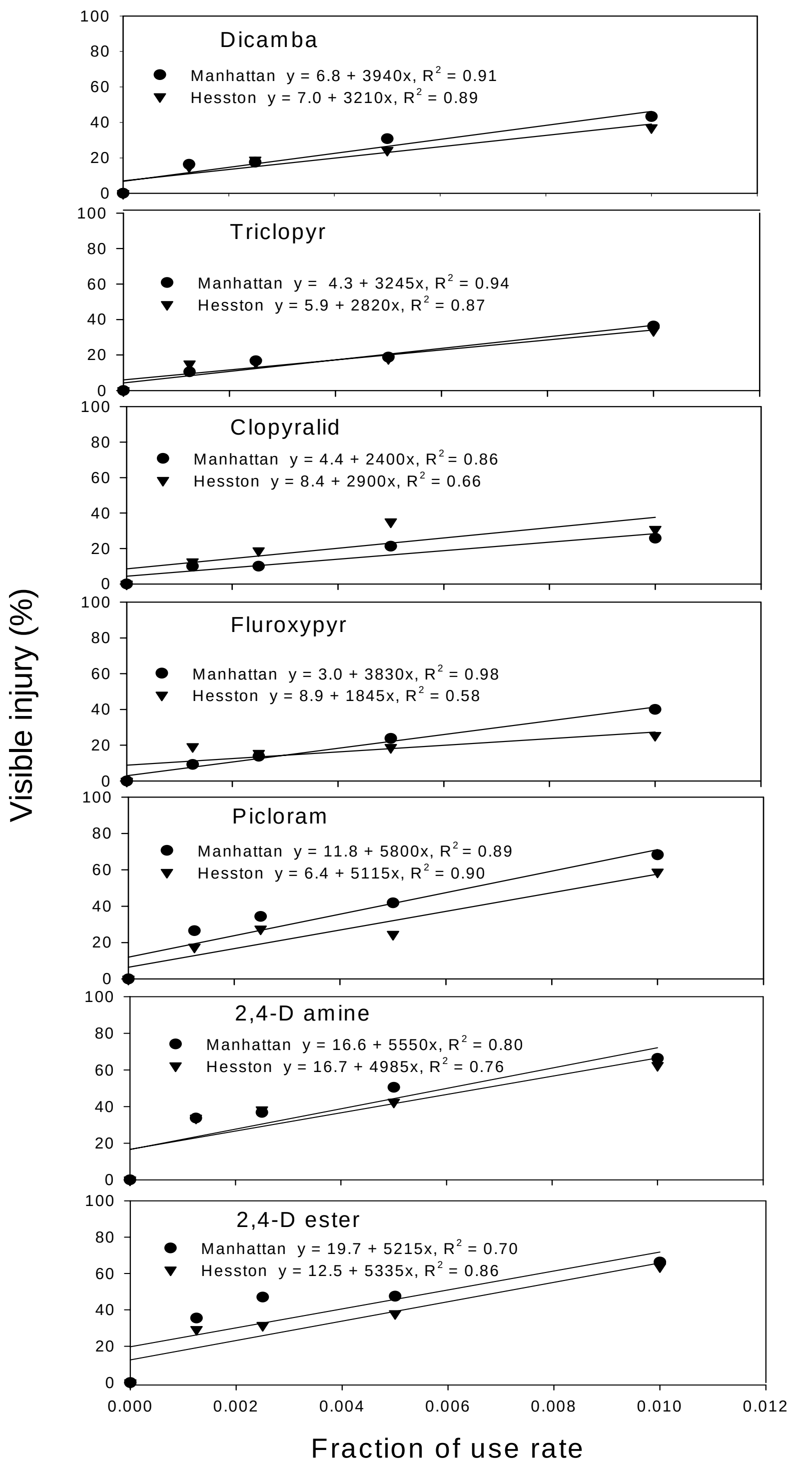

Figure 2. Cotton visible injury ratings 14 days after treatment with seven hormonal-type herbicides applied at Manhattan and Hesston, Kansas in 2004.

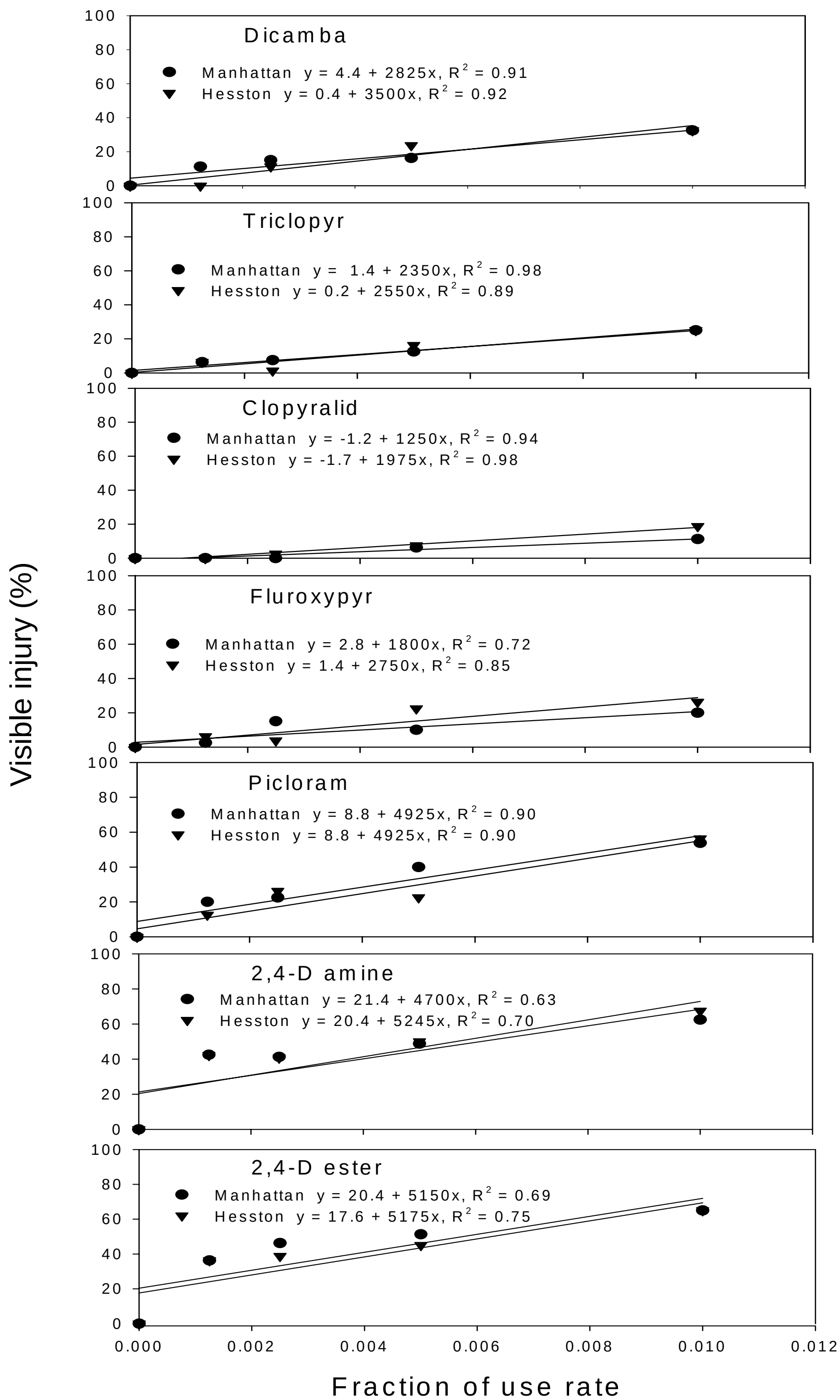

Figure 3. Cotton visible injury ratings 28 days after treatment with seven hormonal-type herbicides applied at Manhattan and Hesston, Kansas in 2004.

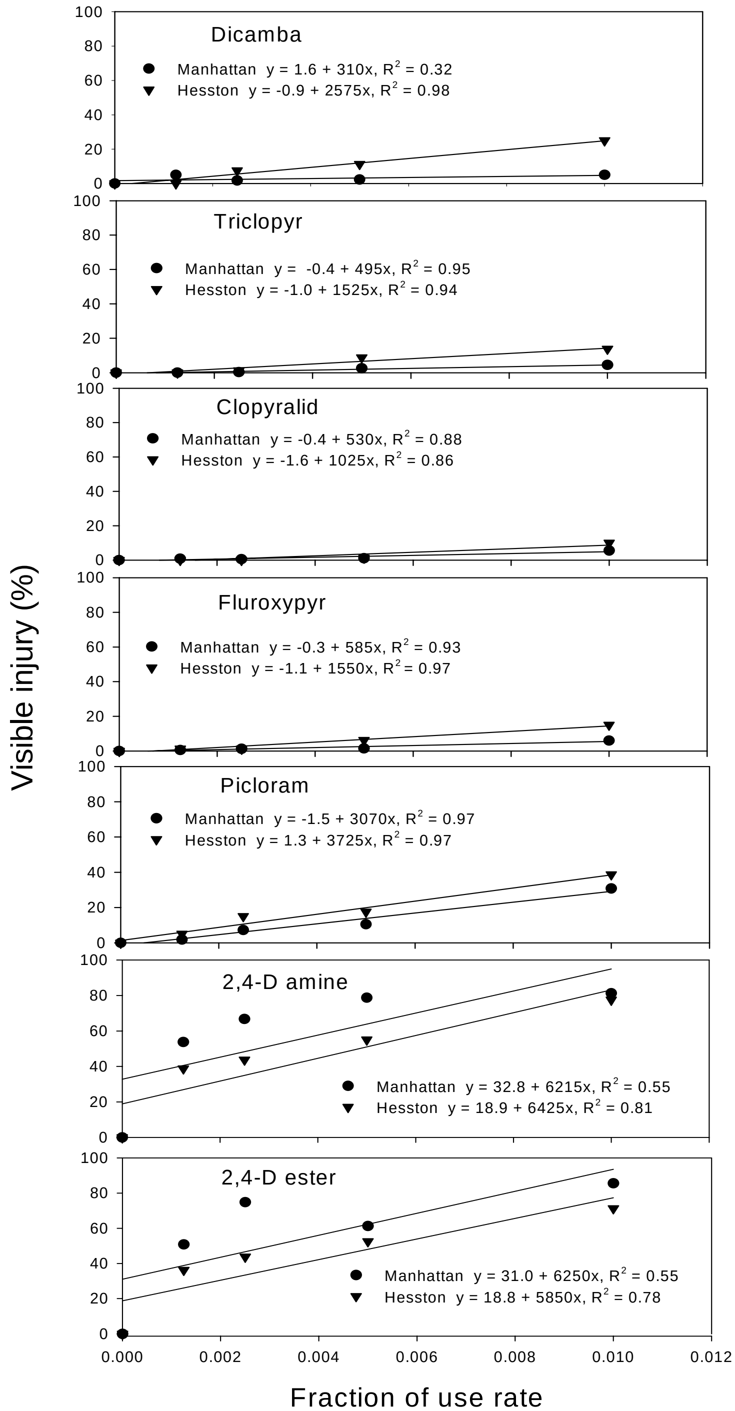

Figure 4. Cotton visible injury ratings 56 days after treatment with seven hormonal-type herbicides applied at Manhattan and Hesston, Kansas in 2004.