The Utility of Activated Charcoal for the Remediation of Herbicide Contaminated Soils

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Background

- Crop injury caused by herbicide carryover is a common issue in vegetable production
- Commercial growers and gardeners have reported injury to vegetable crops following the application of grass clippings, hay or livestock manure (Davis 2009)
- Some pasture herbicides such as aminopyralid, aminocyclopyrachlor, and picloram show prolonged residual effects, with trace levels of herbicides carried in hay and even in manure of livestock fed with treated hay
- Burned plant residues are known to have pesticide absorption properties (e. g. Xu et al. 2008)
- Limited information is available on the effectiveness of activated charcoal for remediating some of the persistent pasture herbicides

Objective

The objective of the present study is to evaluate the ability of activated charcoal to reducing injury caused by aminopyralid, aminocyclopyrachlor, and picloram on tomato, okra, and cantaloupe melon (cantaloupe)

Materials and Methods

- Greenhouse experiments were conducted during spring to late summer 2015
- Factorial completely randomized design with 8 replications and 2 independent runs
- Factor 1: herbicide with 4 levels – no herbicide, aminopyralid, aminocylopyrachlor, and picloram
- Factor 2: activated charcoal with 4 levels - 0, 0.5X, 1X, and 2 X
- Factor 3: vegetable crop species with 3 levels - tomato, okra, and cantaloupe Herbicides were applied at recommended field rates of 20 g ae ha^{-1}, 303 g ai ha^{-1}, and 70 g ai ha^{-1}, respectively for aminopyralid, picloram, and aminocyclopyrachlor
- A commercial source of activated charcoal was used (GRO-SAFE®, Norit Americas Inc., Marshall, TX) with a 1X rate of 336 kg ha^{-1}.
- Herbicides were applied to field soil in boxes (10 cm deep soil column to represent the depth of incorporation)
- Required amount of activated charcoal for each treatment was subsequently added and thoroughly mixed
- Treated soil was kept for four weeks, with regular watering as required prior to filling them in cone-tainers and seeding with the vegetables
- Crop injury was estimated at 14 and 28 days after treatment (DAT) on a scale of 0 to 100%, with 0 representing no injury and 100 indicating complete plant death
- Data were analyzed using the Mixed Procedure in JMP Pro v.12 (SAS Institute Inc.)

Results

- In general, activated charcoal reduced crop injury levels, with greater reduction in injury at higher rates of application (figure 1)
- The degree of reduction in injury levels due to charcoal application was variable among herbicide compounds and crop species
- When no activated charcoal was applied, aminopyralid caused the greatest injury to tomato and okra, causing complete plant death at 28 DAT
- At 2X activated charcoal, crop injuries due to aminopyralid were reduced by 72 and 78% in okra and cantaloupe, respectively at 28 DAT

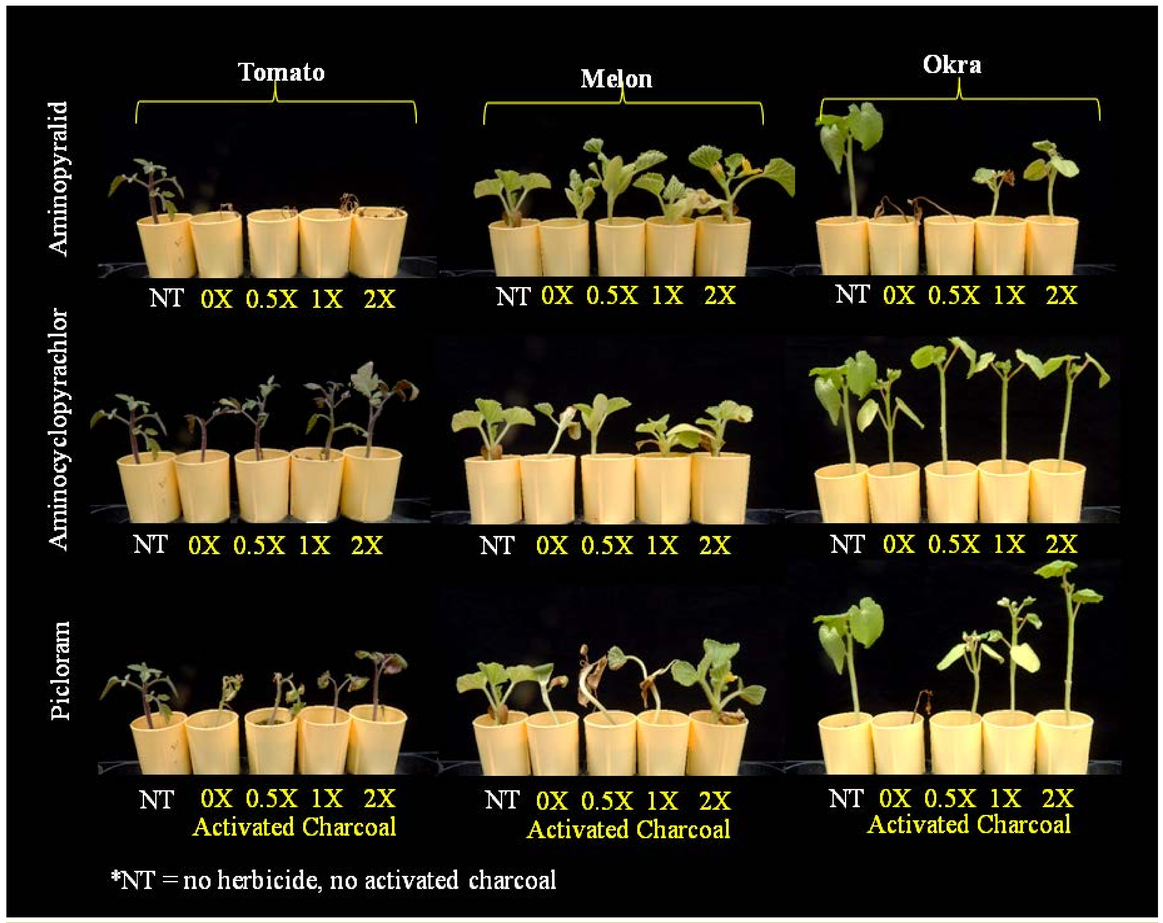

Figure 1. Effect of activated charcoal on injury levels caused by different herbicides on tomato, cantaloupe, and okra at 28 days after treatment

Results (contd…)

- Lower rates of activated charcoal (0.5 X) were sufficient to reduce the residual effect of aminocyclopyrachlor on okra and cantaloupe by more than 70%.
- All the three vegetable species were sensitive to picloram, but with a 2X rate of activated charcoal, picloram injuries were reduced by 78-94% across crop species
- Reduction of plant biomass also showed similar trends (data not shown)

Conclusion

- Activated charcoal is effective in reducing injury levels caused by herbicides and thus can be used for remediating herbicide contaminated soil
- The rate of activated charcoal required will depend on the herbicide compound and crop species affected
- This study used field application rates for these herbicides to simulate a worst-case scenario, but under typically low residue levels, a low rate of charcoal may be sufficient
- Further research is necessary to understand the long-term kinetics of the herbicide absorbed by activated charcoal

References

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