ORGANIC SUCKER CONTROL: SCREENING DIFFERENT ACTIVE INGREDIENTS FOR COMMERCIAL APPLICATION

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Organically derived fatty alcohol is useful for the control of tobacco axillary buds (suckers) and is greatly needed by commercial organic tobacco farmers. Recently, its approval by the U.S. Department of Agriculture (USDA)-National Organic Program has been scrutinized. The objective of this research was to evaluate the suggested alternatives: pelargonic acid, vegetable oil, canola oil, and peppermint + spearmint oil using two different application methods, a standard 3-nozzle boom or a dropline. Chemical injury was not observed within any treatment except for those containing pelargonic acid. Injury was greatest when applied with the 3-nozzle boom and was reduced by nearly 50% with the dropline; however, injury after the dropline application was 2.5 to 7 times greater than any other treatment. Despite significant injury, sucker control was acceptable with pelargonic acid (≈90%) and was similar to that resulting from fatty alcohol (99–100%). Sucker control was <40% among all other treatments, with peppermint + spearmint oil providing better efficacy than canola (10 to 15%) or vegetable oil (−1 to −10%). Cured leaf yield, quality, and value were likewise greatest in fatty alcohol treatments because of maximized sucker control and minimized chemical injury. Producers are encouraged to utilize fatty alcohol until the alternative products can be reformulated and reevaluated.

Additional key words: axillary buds, suckercides

INTRODUCTION

North Carolina is the leading U.S. producer of certified organic tobacco (7). Current estimates put forth that organic flue-cured tobacco is grown on 119 family farms, accounting for more than 2,500 ha of commercial production and revenue approaching $39 million (7). One of the major factors behind the success of organic tobacco production was the development of a certified organic fatty alcohol suckercide that nearly eliminated the requirement to hand sucker tobacco plants on a weekly basis. Recently, the USDA National Organic Standards Board has suggested that this product may be prohibited from the National Organic Program (5). Chemical sucker control alternatives to fatty alcohol do not currently exist; however, producers greatly need these products to reduce worker exposure to green tobacco and to reduce manual labor requirements. The purpose of the research presented was to screen several organic materials for sucker control efficacy and crop injury potential.

METHODS AND MATERIALS

Field experiments were conducted in 2018 at the Upper Coastal Plain Research Station (UCPRS) near Rocky Mount, NC and the Oxford Tobacco Research Station (OTRS) in Oxford, NC. Five compounds were evaluated: fatty alcohol (O-Tac, 85% active ingredient [a.i.], Fair Products, Cary, NC), pelargonic acid (680 g/L a.i., Belchim Crop Protection, Londerzeel, Belgium B-1840), vegetable oil (Natur'l Oil, 93% a.i., Stoller USA, Houston, TX), canola oil (100% a.i., Catania Spagna Corporation, Ayer, MA), and peppermint + spearmint oil (SuckerZap, 10% a.i., ExcelAg Corp, USA, Miami, FL). Each suckercide was delivered using 2 methods, the standard foliar application (3-nozzle boom per row) or a dropline application (single nozzle, focused downstalk). Foliar applications were delivered with a CO_2-pressurized backpack sprayer calibrated at a delivery volume of 467 L/ha using a standard 50.8-cm 3-nozzle boom that contained a TG3-TG5-TG3 directed spray nozzle arrangement (TeeJet Spraying Systems Co., Wheaton, IL). Dropline applications were also delivered with a CO_2-pressurized backpack sprayer outfitted with a single output nozzle calibrated to deliver 30 mL of solution per plant. A treatment that was manually topped but not hand suckered or chemically treated was included as a control. The topped, not-suckered control treatment was used for injury and sucker control determinations but was not included in the statistical analysis. Chemical applications were initiated at 50% elongated button, CORESTA growth stage 59 (6) of plant growth, with subsequent application occurring every 5 days thereafter until 6 applications had occurred. Peppermint + spearmint oil concentration was 3% v/v in application 1 and was increased to 4% v/v in applications 2 through 6. All other materials were mixed to a concentration of 4% v/v for application 1 and were increased to 5% v/v in applications 2 through 6. The cultivar 'NC 196' (Goldleaf Seed Co., Hartsville, SC) was planted in both environments. Individual plots comprised a single row measuring 1.22 m × 15.2 m. Tobacco was produced using practices recommended by the North Carolina Cooperative Extension Service (2), with the exception of treatments imposed. Treatments were arranged in a randomized complete block design with a 5 (suckercide) × 2 (application method) factorial treatment arrangement and were replicated a minimum of 3 times in each environment.

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Immediately before applications 2 through 6, visual chemical injury was assessed within each plot using a scale of 0–10 with 0 indicating no injury and 10 indicating plant death. Four stalk positions (lugs, cutter, leaf, and tip) were hand harvested and bulk cured on each research station to quantify treatment yield. Likewise, each stalk position was assigned a USDA quality grade after curing. Each grade describes leaf maturity and ripeness and has an associated index value and price (1). Crop value was determined using a combination of leaf yield and quality with price indices reported by Fisher et al. (3). After the final harvest interval, all suckers from 10 plants per plot were removed, counted, and weighed while green using the methods of Yelverton et al. (9). Data for chemical injury, percent sucker control, cured leaf yield, and cured leaf quality were subjected to an analysis of variance using the PROC GLIMMIX procedure in SAS version 9.4 (SAS Institute Inc., Cary, NC). In the analysis, suckercide and application method were treated as fixed effects; environment and replication were treated as random effects. When appropriate, means were separated using Fisher's Protected LSD at $P \leq 0.05$.

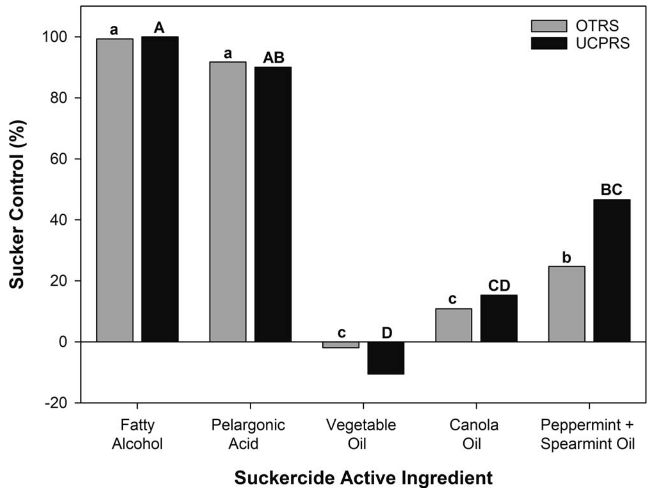

Figure 1. Percent sucker control as influenced by the main effect of suckercide active ingredient. Data are presented individually for the OTRS and the UCPRS. Data are pooled across the main effect of application method in each environment. Treatment means followed by the same lowercase or uppercase letter are not significantly different at the $\alpha = 0.05$ level.

RESULTS AND DISCUSSION

Chemical Injury. Chemical injury was visually documented at each rating interval and was always highest in treatments containing pelargonic acid (data not shown). Injury after 5 pelargonic acid applications was typically reduced by about 50% when droplines were used instead of the 3-nozzle boom. However, injury was still about 2.5 to 7 times more severe than what was recorded in all other treatment combinations, which was typically less than 0.5 among all treatments and rating intervals. Chemical injury tended to increase over time because of the repeated suckercide applications but remained at an acceptable level when fatty alcohol, vegetable oil, canola oil, or peppermint + spearmint oil was used. Previous reports have suggested that pelargonic acid application to flue-cured and burley tobacco can produce extreme injury (L. Fisher, personal communication) and that application rates may need to be greatly lowered to avoid this issue (4).

Percent Sucker Control. Sucker control efficacy was influenced by the main effect of suckercide in both environments (OTRS, $P < 0.001$; UCPRS, $P = 0.004$). Consistently, sucker control was highest in treatments containing fatty alcohol (99 to 100%) and pelargonic acid (89 to 92%; Figure 1). Despite expressing similar efficacy, pelargonic acid was too injurious to harvestable leaves to warrant commercial application. Sucker control declined to 25 to 47% when peppermint oil + spearmint oil was utilized, indicating that the efficacy of the present formulation of the suckercide may be limiting. This product was applied at the lowest solution concentration per manufacturer recommendation; therefore, it is also plausible that application rates were too low for sufficient efficacy. Very little injury was documented after peppermint oil + spearmint oil (<1%), further confirming this hypothesis. Finally, sucker control ranged from 10 to 15% and −2 to −11% in canola oil and vegetable oil treatments, respectively. Negative sucker control efficacy was reported by Vann (8) and was attributed to actively growing suckers after treatment application and older, senescent suckers in the topped, not-suckered control. Neither of these products appears to be ready for commercial application with large machinery, but should be considered for evaluation using nontraditional application techniques that utilize less carrier volume and pressure for delivery.

Yield. Cured leaf yield generally followed a similar pattern to sucker control. However, within the OTRS growing environment, results were influenced by the interaction of suckercide and application method (0.035). Treatments receiving fatty alcohol via 3-nozzle boom and dropline produced the highest yield in this environment (Table 1). Dropline applications of pelargonic acid reduced yield, though not as much as 3-nozzle boom application (Table 1). Sucker control averaged approximately 90% in these treatments; therefore, the reduced yield is a result of severe chemical injury (Table 1). In treatments comprised of vegetable oil, canola oil, and peppermint + spearmint oil, yield further declined, but was minimized when peppermint oil + spearmint oil was applied with a 3-nozzle boom (Table 1). Cured leaf yield at the UCPRS was influenced by both main effects. Dropline applications outyielded 3-nozzle boom applications by 199 kg/ha (2,366 vs. 2,167 kg/ha, respectively; $P = 0.035$). It is plausible that this yield increase is a result of reduced leaf injury and slightly better sucker control with the dropline application, which would have reduced product exposure to harvestable leaves and improved sucker coverage. Yield was also influenced by the main effect of suckercide ($P < 0.001$), with fatty alcohol and pelargonic acid producing the highest and lowest yields, respectively. Chemical injury was absent in the fatty alcohol treatment and resulted in nearly 100% sucker control; therefore, it would be expected to have a higher yield. Alternatively, pelargonic acid injury was significantly greater than other

Table 1. Chemical leaf injury after 5 suckercide applications at the OTRS[a] and UCPRS[a] and cured leaf yield and value at the OTRS as influenced by the interaction of suckercide product and application method[b].

Suckercide	Application Method	Injury (1–10)[c]		Yield kg/ha	Value $/ha
		OTRS	UCPRS		
Fatty alcohol	3-Nozzle	0.3 c	0.4 c	2,918 a	11,314 a
Fatty alcohol	Dropline	0.5 c	0.0 c	2,702 a	10,309 a
Pelargonic acid	3-Nozzle	7.2 a	6.9 a	1,477 c	4,522 cd
Pelargonic acid	Dropline	3.2 b	4.0 b	1,983 b	7,219 b
Vegetable oil	3-Nozzle	0.6 c	0.0 c	1,263 cd	3,442 cd
Vegetable oil	Dropline	0.2 c	0.0 c	1,322 cd	4,217 cd
Canola oil	3-Nozzle	0.0 c	0.0 c	1,177 cd	3,382 d
Canola oil	Dropline	0.0 c	0.0 c	1,221 cd	3,678 cd
Peppermint + spearmint oil	3-Nozzle	0.2 c	0.2 c	1,105 d	3,280 d
Peppermint + spearmint oil	Dropline	0.1 c	0.0 c	1,521 c	4,647 c

[a] OTRS, Oxford Tobacco Research Station in Oxford, NC; UCPRS, Upper Coastal Plain Research Station near Rocky Mount, NC.
[b] Treatment means followed by the same letter within the same column are not statistically different at the $\alpha = 0.05$ level.
[c] Injury assessed on a scale of 0–10, with 0 being absent of visual injury and 10 meaning complete plant death.

suckercides, which produced the lowest-yielding treatments evaluated. Yield was moderate among the other suckercides because of poor sucker control.

Quality. In both environments, cured leaf quality was influenced by suckercide application method. Consistently, it was the dropline application method that produced higher-quality tobacco. At the UCPRS, dropline applications resulted in a cured leaf quality index that averaged 84, with 3-nozzle boom applications averaging 79 ($P = 0.024$). The same difference was noted at the OTRS, where cured leaf quality indices after dropline and 3-nozzle boom applications averaged 75 and 69, respectively ($P < 0.001$). In addition, suckercide product selection affected cured leaf quality at OTRS ($P < 0.001$). Fatty alcohol application produced the highest cured leaf quality (84) and was followed by pelargonic acid (74). Peppermint oil + spearmint oil (67), vegetable oil (67), and canola oil (66) were similar to one another. The reduction in cured leaf quality from pelargonic acid has not been previously reported but is likely due to excessive leaf injury (Table 1). Alternatively, it is plausible that reduced quality resulting from peppermint oil + spearmint oil, vegetable oil, and canola oil is due to poor sucker control, as excessive sucker growth will divert nutrients and photosynthate away from harvestable leaves—which could negatively affect overall leaf quality.

Value. Within the OTRS, cured leaf value was influenced by the interaction of suckercide and application method ($P = 0.004$). Treatments containing fatty alcohol produced the greatest cured leaf value because of maximized sucker control and minimized chemical injury (Table 1). The dropline application of pelargonic acid was next highest and resulted in a higher value than pelargonic acid applied with the 3-nozzle boom because of difference documented in chemical injury and the impact to yield (Table 1). Differences were likewise documented with the other suckercides and application methods, which generally had a cured leaf value that was $5,000 to $6,000 less than fatty alcohol (Table 1). However, differences among peppermint oil + spearmint oil, vegetable oil, and canola oil were minimal (Table 1). Cured leaf value at the UCPRS was influenced by both main effects (suckercide, $P < 0.001$) and method ($P = 0.018$). Results for leaf value followed those previously reported for yield (data not shown).

CONCLUSION

On the basis of the results obtained from this study, it appears that the evaluated alternatives to fatty alcohol are of minimal value from a sucker control and economic perspective. The only product offering similar control to fatty alcohol did so at the expense of cured leaf yield and sometimes cured leaf quality—both of which are unacceptable from a commercial perspective. Likewise, the other active ingredients evaluated in this study may be of use in the future after reformulation, altered application rates, and additional testing, but are not presently ready for use. The fatty alcohol products currently available should be applied where approved.

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