THE EFFECT OF SUCKERCIDE APPLICATION TIMING AND CULTIVAR MATURITY ON CHEMICAL TOPPING OF BURLEY TOBACCO

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Experiments were initiated in 2015 to evaluate the efficacy of chemical topping for burley tobacco (*Nicotiana tabacum* L.). The major objectives for this study were to determine the optimum timing of suckercide application and appropriate cultivar maturity for effective chemical topping. Burley tobacco cultivars TN 90 (medium maturity), KT 210, and KT 215 (late maturity) were chemically topped at the 10% button, 50% button, and 10% bloom growth stages. The 10% button and 50% button application timings were best suited for chemical topping practices. Treatments that targeted the 10% bloom stage did not completely halt inflorescence growth; however, all application timings resulted in excellent sucker control. Both medium and late maturing burley cultivars proved to be acceptable for chemical topping methods; however, timing the suckercide application may be less difficult with later maturing cultivars. Chemically topped treatments generally resulted in shorter, narrower tip leaves than manually topped treatments. There were no significant differences in total yield of TN 90 when comparing tobacco that was manually topped at 10% bloom to tobacco that was chemically topped at 10% button, 50% button, or 10% bloom across all environments. In 4 out of 6 environments, total yield was not significantly different between manual topping and any chemically topped application timing in the late maturing burley cultivars; however, at least 1 chemically topped application timing had equivalent yield to manually topped tobacco in all environments.

Additional key words: Topping, Suckercide, Maturity, Burley Tobacco

INTRODUCTION

Topping, the removal of the terminal bud or inflorescence of the tobacco plant, is ordinarily accomplished by manually removing the top of each tobacco plant in an entire field, which is labor intensive and costly. Removal of the terminal bud or inflorescence prevents reproductive development (i.e., seed head), and results in energy transferred to increased leaf size, weight, nicotine, and other chemical constituents (12). Topping eliminates apical dominance in the plant resulting in axillary bud growth, known as suckers (5). It has been shown that controlling sucker growth and yield are positively correlated (3).

Topping burley tobacco at 10–25% bloom with an optimum leaf number of 22–24 leaves has been shown to provide the best yield, leaf quality, and a better opportunity for a true tip grade (1). Higher yields were observed when flue-cured tobacco was topped in the button or early flower stages in hand-suckered treatments with a yield penalty of around 28 kg day^{-1} when topping was delayed beyond this point (8). Other studies have found no significant differences in burley tobacco yield and value when topped at early bloom or midbloom stages (11). However, the number of leaves left on the plant after topping was shown to be positively related to yield (6), but value has been shown to have a negative relationship with number of leaves left on the plant (3). A chemical topping study applying a tank mixture of maleic hydrazide (MH) and flumetralin when the 20th leaf expanded to 15 cm on photoperiod-sensitive cultivars of flue-cured tobacco found no differences in yield compared to manually topped and sprayed tobacco (7). Peek (10) found that chemical topping at the 25% button stage was the most effective timing of application but resulted in the largest yield reduction. The associated yield reduction was attributed to reduced leaf size, specifically in the upper stalk positions (10). Long et al. (7) found that chemically topped plants generally resulted in taller plants with shorter, narrower top leaves. The primary objectives of this research were to determine the optimum stage of apical bud growth to target that could chemically top the plant while simultaneously controlling axillary bud growth (suckers) using currently registered suckercide products in medium and late maturing burley tobacco cultivars.

MATERIALS AND METHODS

In 2015, this study was conducted at the Spindletop Farm and the West Farm of Murray State University near Murray, KY. Field experiments were conducted in 2016 and 2017 at the Agricultural Experiment Station Spindletop Farm near Lexington, KY and the University of Kentucky Research and Education Center near Princeton, KY. Transplants of burley tobacco cultivars ‘KT 210’ and ‘KT 215’ (late maturity) and ‘TN 90’ (medium maturity) were grown in a greenhouse float system according to current University of Kentucky recommendations (9). Tobacco plants were transplanted to the field in late

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Table 1. Suckercide application date for manual topping and chemical topping application timings.

				Treatment Applied					
			Manually topped	Spindletop			Princeton		
Maturity	Treatment	Timing[a]	Yes/No	2015	2016	2017	2015[b]	2016	2017
Medium	UTC[c]	10% bloom	Yes	7/24	7/29	7/29	8/20	8/8	7/31
	GS	10% bloom	Yes	7/24	7/29	7/29	8/20	8/8	7/31
	10% button	10% button	No	7/20	7/26	7/20	8/14	8/2	7/26
	50% button	50% button	No	7/20	7/26	7/25	8/14	8/5	7/26
	10% bloom	10% bloom	No	7/27	7/29	7/27	8/20	8/8	7/31
Late	UTC	10% bloom	Yes	7/27	8/9	7/28	8/28	8/14	7/31
	GS	10% bloom	Yes	7/27	8/9	7/29	8/28	8/14	7/31
	10% button	10% button	No	7/20	8/1	7/25	8/20	8/8	7/26
	50% button	50% button	No	7/24	8/1	7/27	8/24	8/11	7/28
	10% bloom	10% bloom	No	7/27	8/9	7/29	8/28	8/14	7/31

[a]Maleic hydrazide (2.52 kg a.i. ha^{-1}) and butralin (1.68 kg a.i. ha^{-1}) were used in the 10% button, 50% button, and 10% bloom chemically topped treatments.
[b]2015 location was at Murray, KY.
[c]UTC = untreated control; GS = grower standard.

May/early June in all years and locations of these experiments. All field production practices, other than topping, followed recommendations based on the University Extension guidelines (9).

The experimental design was a randomized complete block with treatments replicated 4 times. Suckercides were applied with a CO_2-pressurized sprayer calibrated to 468 L ha^{-1} with a directed 3-nozzle per row configuration (TG3-TG5-TG3, Spraying Systems Co., Wheaton, IL). Maleic hydrazide (Royal MH-30®, 2.52 kg a.i. ha^{-1}, Arysta LifeScience, Middlebury, CT) tank mixed with butralin (Butralin®, 1.68 kg a.i. ha^{-1}, Arysta LifeScience) was used as the suckercide application. Chemical topping treatments were applied at either the 10% button, 50% button, or 10% bloom stages. There was also a manually topped and unsprayed (untreated control or UTC) and a manually topped and sprayed treatment (grower standard or GS) imposed at the 10% bloom stage (Table 1). Button percentage was calculated by dividing the total number of plants in the 2 center rows of each plot by the number of plants with a visible terminal bud between the apical leaves, or growth stage 51 (4). Bloom percentage was calculated by dividing the total number of plants in the 2 center rows of each plot by the number of plants with at least 1 flower open, or growth stage 60 (4). Sucker control data were collected on 10 plants per plot within 7 days before tobacco harvest and are reported as percent control based on the fresh weight of suckers from treated plots compared to fresh weight of suckers in the manually topped untreated control that did not receive suckercide treatment.

Thirty tobacco plants from the center 2 rows in each plot were stalk harvested 3–4 weeks after manual topping, placed on sticks, and cured in traditional air-curing barns. Prior to harvest, sucker control data and plant height measurements were collected from the center 2 rows of each 4-row plot. After curing, tobacco leaves were removed from the stalk, sorted into 4 stalk positions including flyings (lower stalk), lug (lower midstalk), leaf (upper midstalk), and tip (upper stalk), and weighed to calculate yield per hectare. A sample of 25 leaves from the tip grade of each plot was measured to determine leaf length and leaf width. A U.S. Department of Agriculture (USDA) grader evaluated cured leaf to USDA standards for type 31 light air-cured burley tobacco and grades were assigned an index value between 1 and 100. Grade index data are a weighted average of grade across stalk positions based on the grade received for each stalk position, and the percent contribution of that stalk position to total yield (2). All data were subjected to analysis of variance (ANOVA) with the general linear model procedure (proc GLM), and means were separated using the least-square means multiple comparison procedure at $P = 0.10$ using SAS 9.4 (SAS Institute Inc., Cary, NC).

RESULTS AND DISCUSSION

Data for sucker control effectiveness, plant height, tip leaf stalk position length, tobacco yield, and quality grade index are presented by year, location, and cultivar maturity, as there were significant environment by treatment interactions.

Sucker Control. There was a significant application timing effect on percent sucker control in each environment as shown in Table 2. Overall, sucker control ranged from 89–100% control in treated plots across all environments. In 2015 at Murray, there was a significant reduction in sucker control when suckercides were applied at the 10% bloom stage in the late maturing KT 215 compared to all other timings; however, this difference was only 1%. There were no significant differences between application timings in the medium maturity TN 90 at Murray. In 2015 at Lexington, there was a significant reduction in sucker control when applications were made at the 10% bloom stage in TN 90, but this difference was only 5% in comparison with the GS. There was a significant 3% reduction in sucker control in the 10% button timing as compared to the GS in the late maturing KT 210.

Table 2. Sucker control effectiveness as percent of the control for manual and chemical topping application timings for medium and late maturing cultivars.

		2015[a]		2016		2017	
		Murray	Lexington	Princeton	Lexington	Princeton	Lexington
Maturity	Timing[b]	%					
Medium	UTC[c]	0 B	0 C	0 B	0 B	0 C	0 C
	GS	100 A	100 A	97 A	100 A	100 A	96 B
	10% button	100 A	97 AB	100 A	100 A	99 AB	100 A
	50% button	100 A	97 AB	91 A	100 A	98 B	100 A
	10% bloom	99 A	95 B	96 A	100 A	99 AB	95 B
	P value	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Late	UTC	0 c	0 c	0 b	0 c	0 b	0 c
	GS	100 a	100 a	97 a	100 a	100 a	100 a
	10% button	100 a	97 b	100 a	98 ab	100 a	100 a
	50% button	100 a	100 a	89 a	98 ab	100 a	91 b
	10% bloom	99 b	100 a	94 a	96 b	100 a	100 a
	P value	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*

[a]Means within a column followed by the same uppercase or lowercase letter are not significantly different according to Fisher's Protected LSD at P = 0.10.

[b]Maleic hydrazide (2.52 kg a.i. ha^{-1}) and butralin (1.68 kg a.i. ha^{-1}) were used in the 10% button, 50% button, and 10% bloom chemically topped treatments.

[c]UTC = untreated control; GS = grower standard.

The range of sucker control efficacy across application timings in treated plots for medium and late maturing cultivars was 91–100% and 89–100%, respectively, in 2016 at Princeton. There were no significant differences in the medium maturing TN 90 between the GS and any application timing at Lexington in 2016, as excellent sucker control was observed in all treated plots. There was a significant 4% reduction in sucker control when late maturing cultivars were chemically topped at the 10% bloom application timing. In 2017, there was a significant 2% reduction in sucker control in the 50% button application timing when compared to the GS at Princeton in the medium maturing TN 90. There were no significant differences between the GS and any chemical topping application timing in the late maturing cultivars. At Lexington in 2017, the 10% and 50% button chemical topping application timings resulted in significantly higher sucker control than the GS and the 10% bloom stage in the medium maturing TN 90. The 50% button application timing resulted in a significant 9% reduction in sucker control compared to all other treated plots.

In summary, excellent sucker control was achieved in all chemical topping application timings. Peek (10) observed reduced sucker control when suckercides were applied at later blooming stages. Chemical topping at 10% bloom resulted in around 10% flower spikes present at harvest as the blooms were not manually removed. Therefore, we concluded that the 10% or 50% button application timings were better suited for chemical topping of burley tobacco.

Plant Height. Investigating the height of the tobacco plants to be harvested and cured was of interest to determine if there would be harvest difficulties encountered when using chemical topping compared to traditional manual topping. Plant height was measured while plants were still in the field, and was determined by measuring from the ground to the uppermost plant part. There was a significant timing effect on plant height in all years and locations (Table 3). There was variability in plant height across all environments, maturity, and application timings ranging from 123 to 231 cm. The UTC had significantly higher plant height compared to all other application timings for the medium maturity TN 90, which was due to no sucker control applied after topping. Within the medium maturity TN 90, the 10% bloom application timing resulted in significantly lower plant height than the UTC but significantly higher plant height compared to the GS and 10 or 50% button timings within each environment. There was a 1–13-cm difference in plant heights across all environments when comparing the chemical topping application timings at 10% button and 50% button to the GS within the medium maturity TN 90. Therefore, 10% and 50% button application timings appeared to be more suitable target timings for chemical topping when comparing plant height for the medium maturity cultivar used in these experiments.

Unlike in the medium maturity cultivar, the UTC did not always result in significantly higher plant height in all years and locations for the late maturing cultivars. Either the UTC or 10% bloom application timing had significantly higher plant height compared to all other application timings and the GS within each environment (Table 3) for the late maturing cultivars used in these experiments. In 3 of the 6 environments within the late maturing cultivars (Murray, 2015; Lexington, 2016; and Princeton, 2017), there were no significant differences between 10% button application timing and the GS. The 10% button application timing resulted in significantly lower plant height at Lexington in 2015 and Princeton in 2016 but significantly higher plant height in Lexington in 2017 compared to the GS. Within the late maturing cultivars, the 50% button application timing resulted in significantly higher plant height compared to the GS and 10% button in all environments with the exception of

Table 3. Plant height following manual topping and chemical topping application timings for medium and late maturing cultivars.

		2015[a]		2016		2017	
		Murray	Lexington	Princeton	Lexington	Princeton	Lexington
Maturity	Timing[b]	cm					
Medium	UTC[c]	231 A	199 A	216 A	187 A	169 A	164 A
	GS	150 D	160 C	166 C	144 E	135 C	134 D
	10% button	137 E	164 C	153 D	149 D	134 C	123 E
	50% button	162 C	164 C	166 C	157 C	137 C	144 C
	10% bloom	185 B	176 B	188 B	166 B	154 B	159 B
	P value	*<0.00001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Late	UTC	198 c	191 a	177 c	192 b	181 a	165 a
	GS	179 d	161 c	187 b	177 c	140 d	123 d
	10% button	178 d	144 d	167 d	176 c	139 d	134 c
	50% button	207 b	176 b	201 a	175 c	149 c	154 b
	10% bloom	220 a	180 b	206 a	202 a	156 b	139 c
	P value	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*

[a]Means within a column followed by the same uppercase or lowercase letter are not significantly different according to Fisher's Protected LSD at P = 0.10.
[b]Maleic hydrazide (2.52 kg a.i. ha^{-1}) and butralin (1.68 kg a.i. ha^{-1}) were used in the 10% button, 50% button, and 10% bloom chemically topped treatments.
[c]UTC = untreated control; GS = grower standard.

Lexington in 2016, where there were no significant differences between either timing. There were no undesirable plant heights that caused problems in harvesting or curing except no sucker control within the UTC and the existence of blooms within the 10% bloom application timing. The UTC was trimmed immediately prior to harvest to meet the size requirements of the curing facility; however, the plots were not suckered. Therefore, we concluded that the 10 or 50% button application timings should be targeted.

Leaf Dimensions. Leaf dimension data were collected from a 25-leaf sample of cured leaf from the tip stalk position. There was a significant application timing effect on leaf length in each environment except Princeton in 2017, as shown in Table 4. The range of tip leaf length for medium maturity was 32–54 cm across all environments and treatments. The GS resulted in significantly longer tip leaves than any chemically topped application timing within the medium maturity cultivar in 4 of 5 environments where tip leaf length was measured. In the late maturing cultivars, either the UTC or the GS resulted in significantly longer tip leaves when comparing all treatments within each environment. Chemical topping in the late maturity cultivars resulted in significantly shorter tip leaf length at Lexington in all years of this study.

Table 4. Leaf length for tip stalk position following manual topping and chemical topping application timings for medium and late maturing cultivars.

		2015[a]		2016		2017	
		Murray[b]	Lexington	Princeton	Lexington	Princeton	Lexington
Maturity	Timing[c]	cm					
Medium	UTC[d]	–	52 A	42 A	48 A	34	37 B
	GS	–	54 A	41 A	43 B	34	41 A
	10% button	–	44 C	39 B	39 C	35	34 C
	50% button	–	47 B	40 B	39 C	32	33 C
	10% bloom	–	45 BC	39 B	40 C	32	33 C
	P value	–	*<0.0001*	*<0.0001*	*<0.0001*	*0.6979*	*<0.0001*
Late	UTC	–	56 a	51 a	48 b	40 a	40 b
	GS	–	51 b	48 b	50 a	37 b	45 a
	10% button	–	45 c	44 c	44 c	36 bc	36 c
	50% button	–	44 c	47 b	43 d	35 c	36 cd
	10% bloom	–	43 c	47 b	41 d	35 c	35 d
	P value	–	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*

[a]Means within a column followed by the same uppercase or lowercase letter are not significantly different according to Fisher's Protected LSD at P = 0.10.
[b]Leaf length data not collected at Murray in 2015.
[c]Maleic hydrazide (2.52 kg a.i. ha^{-1}) and butralin (1.68 kg a.i. ha^{-1}) were used in the 10% button, 50% button, and 10% bloom chemically topped treatments.
[d]UTC = untreated control; GS = grower standard.

Table 5. Leaf width for tip stalk position following manual topping and chemical topping application timings for medium and late maturing cultivars.

		2015[a]		2016		2017	
		Murray[b]	Lexington	Princeton	Lexington	Princeton	Lexington
Maturity	Timing[c]	cm					
Medium	UTC[d]	–	22.7 A	22.4 A	23.0 A	14.8 B	15.0 B
	GS	–	23.5 A	21.3 B	18.9 B	17.1 A	16.7 A
	10% button	–	17.4 C	18.2 D	15.7 C	12.7 C	13.5 C
	50% button	–	19.1 B	19.4 C	16.1 C	12.9 BC	13.6 C
	10% bloom	–	20.0 B	19.8 C	17.8 BC	14.7 B	13.9 C
	P value	–	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Late	UTC	–	24.2 a	28.2 a	22.5 b	18.7 a	19.8 a
	GS	–	22.9 a	26.7 b	25.8 a	17.4 b	20.1 a
	10% button	–	18.1 b	22.8 d	18.3 d	15.4 c	15.2 b
	50% button	–	18.9 b	26.2 b	17.3 e	15.7 c	15.3 b
	10% bloom	–	18.7 b	25.1 c	19.3 c	16.3 c	15.1 b
	P value	–	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.0016*

[a]Means within a column followed by the same uppercase or lowercase letter are not significantly different according to Fisher's Protected LSD at P = 0.10.
[b]Leaf width data not collected at Murray in 2015.
[c]Maleic hydrazide (2.52 kg a.i. ha^{-1}) and butralin (1.68 kg a.i. ha^{-1}) were used in the 10% button, 50% button, and 10% bloom chemically topped treatments.
[d]UTC = untreated control; GS = grower; S = standard.

However, only the 10% button application timing resulted in significantly shorter tip leaves at Princeton in 2016 with the 50% button and 10% bloom timings not significantly different than the GS. Significant differences at Princeton in 2017 were likely not biologically relevant, as the total range in tip leaf length was only 2 cm when comparing all treatments excluding the UTC. The total difference between the 10% button, 50% button, and 10% bloom application timings within each environment and maturity ranged from 1 to 3 cm.

There was a significant application timing effect on tip leaf width within each environment (Table 5). The range of tip leaf width for medium maturity was 13–24 cm across all environments and treatments. Within the medium maturity TN 90, the GS had significantly wider tip leaves compared to all chemically topped application timings, except 10% bloom at Lexington in 2016. The range in tip leaf width for the late maturing cultivars was 15–28 cm across all environments and treatments. Within the late maturing cultivars, the GS had significantly wider leaves than all chemically topped application timings with the exception of 50% button at Princeton in 2016. The 10% button application timing was grouped with the significantly narrowest leaf in all environments for each maturity, except for late maturing cultivars at Lexington in 2016.

Generally, chemically topped plants resulted in shorter, narrower leaves in the tip stalk position compared to treatments that were manually topped, which is comparable to other previous results (7,10). It would be expected that tip leaf length in chemically topped burley tobacco would be equal to or less than manually topped. Thus, the marketable cured tip leaf stalk position would be expected to have a higher likelihood to meet the leaf length requirement for tip grade in chemically topped burley tobacco.

Total Yield. There was a significant application timing effect on total yield in each year and location combination except in the late maturing KT 215 at Murray in 2015 (Table 6). As expected, the UTC resulted in the lowest total yield within each environment, maturity, and application timing as there was no sucker control applied to these plots. There were no significant differences between the GS and chemically topped application timings in the medium maturity TN 90 at either location in any year. Within chemically topped treatments, the 10% bloom application timing resulted in significantly higher total yield compared to chemically topped at 10% button timing at Murray in 2015 (P = 0.0040). Tobacco that was chemically topped at the 50% button application timing resulted in significantly higher total yield compared to the 10% bloom timing at Lexington in 2015 within the medium maturity (P = 0.0026). Each location in 2016 and 2017 for the medium maturity TN 90 followed the same trend with the GS not significantly different than any chemically topped application timing, which is similar to sucker control effectiveness data.

Within the late maturing cultivars, there were no significant differences between the GS, 10% button, 50% button, and 10% bloom at Lexington in 2015 and 2017 or Princeton in 2016. The GS resulted in significantly higher total yield than the 50% button and 10% bloom application timings at Lexington in 2016, but was not different than the 10% button (P = 0.0206). The 10% button application timing at Princeton in 2017 had significantly lower total yield compared to the GS and 10% bloom application timing (P = 0.0059). Sucker control effectiveness data does not exclusively explain differences in total yield for the late maturing cultivars, as sucker control across all treated plots ranged from 89 to 100%, especially considering the excellent sucker control with all treatments at Princeton in 2017 (Table 2). It should be noted that later

Table 6. Total yield following manual topping and chemical topping application timings for medium and late maturing cultivars.

		2015[a]		2016		2017	
		Murray	Lexington	Princeton	Lexington	Princeton	Lexington
Maturity	Timing[b]	kg ha^{-1}					
Medium	UTC[c]	1340 C	1803 B	1788 B	2291 B	1965 B	2155 B
	GS	2068 AB	2094 AB	2692 A	2751 A	2614 A	2456 A
	10% button	1810 B	2122 AB	2566 A	2799 A	2475 A	2513 A
	50% button	2149 AB	2326 A	2580 A	2796 A	2516 A	2579 A
	10% bloom	2246 A	1896 B	2555 A	2680 A	2676 A	2494 A
	P value	*0.0040*	*0.0026*	*0.0019*	*0.0003*	*0.0417*	*0.0246*
Late	UTC	1688	2033 b	1737 b	2552 c	2223 c	2413 c
	GS	2154	2190 ab	2318 a	3439 a	2878 a	2924 ab
	10% button	2447	2263 ab	2492 a	3057 ab	2516 b	3090 a
	50% button	2244	2561 a	2145 a	2849 bc	2683 ab	2728 bc
	10% bloom	2378	2235 ab	2187 a	2976 b	2826 a	2720 bc
	P value	*0.4036*	*0.0032*	*0.0182*	*0.0206*	*0.0059*	*0.0070*

[a]Means within a column followed by the same uppercase or lowercase letter are not significantly different according to Fisher's Protected LSD at P = 0.10.
[b]Maleic hydrazide (2.52 kg a.i. ha^{-1}) and butralin (1.68 kg a.i. ha^{-1}) were used in the 10% button, 50% button, and 10% bloom chemically topped treatments.
[c]UTC = untreated control; GS = grower standard.

maturing/flowering cultivars might be better suited for adopting chemical topping methods, as the transition between reproductive growth stages is slower than in earlier maturing cultivars. To summarize, there were no significant differences in total yield when comparing the GS to tobacco that was chemically topped at 10% button, 50% button, and 10% bloom across all environments in the medium maturity TN 90. With the exception of 2 environments, total yield was not significantly different between the GS and any chemically topped application timing in the later maturing cultivars; however, at least 1 chemical topping timing was equivalent to the GS in all environments.

Quality Grade Index. There was no significant effect of treatment across all environments and maturities on quality grade index (Table 7). Quality grade index data were not collected at Lexington in 2015. There was a difference of 11 grade index points between all treatments within the medium maturity TN 90 at Murray; however, there was only 2 grade index points difference between the GS and all chemically topped application timings for quality grade index. Within TN 90, there was a difference of 3 and 13 grade index points across all treatments in 2016 and 3 and 9 grade index points in 2017 at Princeton and Lexington, respectively. There was a difference of 12 grade index points across

Table 7. Quality grade index following manual topping and chemical topping application timings for medium and late maturing cultivars.

		2015[a]		2016		2017	
		Murray	Lexington[b]	Princeton	Lexington	Princeton	Lexington
Maturity	Timing[c]	0-100					
Medium	UTC[d]	40	–	65	66	64	75
	GS	51	–	65	73	64	74
	10% button	49	–	68	67	67	68
	50% button	49	–	65	57	67	70
	10% bloom	49	–	67	60	66	66
	P value	*0.0543*	–	*0.7255*	*0.4727*	*0.6089*	*0.7615*
Late	UTC	41	–	60	74	63	60
	GS	41	–	58	73	64	69
	10% button	49	–	60	68	64	66
	50% button	53	–	60	68	63	69
	10% bloom	47	–	63	69	62	70
	P value	*0.1317*	–	*0.1124*	*0.7864*	*0.9968*	*0.5473*

[a]Means within a column followed by the same uppercase or lowercase letter are not significantly different according to Fisher's Protected LSD at $P = 0.10$.
[b]Quality grade index data not collected at Lexington in 2015.
[c]Maleic hydrazide (2.52 kg a.i. ha^{-1}) and butralin (1.68 kg a.i. ha^{-1}) were used in the 10% button, 50% button, and 10% bloom chemically topped treatments.
[d]UTC = untreated control; GS = grower standard.

all treatments within the late maturing KT 215 at Murray. Within the late maturing cultivars, there was a difference of 5 and 6 grade index points across all treatments in 2016 and 2 and 10 grade index points in 2017 at Princeton and Lexington, respectively. Therefore, our data suggested that no application timing detrimentally influenced quality grade index, as there were no significant differences across manually or chemically topped treatments.

CONCLUSION

Chemical topping burley tobacco at 10% button (prebud) to 50% button (early bud) is ideal as application of suckercides at 10% bloom did not completely halt the development of reproductive growth. Most chemically topped application timings included in these experiments provided similar sucker control, total yield, and leaf quality compared to standard manual topping. Chemically topped treatments also appeared to have shorter tip leaves, which may contribute to an increased amount of marketable tip grades compared to manually topping. Although there were no outstanding differences in yield and quality between the medium and late maturing cultivars used in this experiment, later maturing cultivars tended to yield higher and may be better suited for chemical topping because of less rapid change from vegetative to reproductive growth, which would result in a wider window for making chemical topping applications at the most appropriate timings.

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