

NC STATE UNIVERSITY

The Evaluation of Various Potassium Rates, Application Methods, and Application Timing on the Yield and Quality of Flue-cured Tobacco

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 - Objectives
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Introduction

- Research Conducted
 - Potassium Application Rate Evaluation
 - Potassium Rate, Application Method, & Application Timing Evaluation
- Purpose for Research
 - Unique Role of Potassium in Tobacco Production
 - Rising Potassium Prices
 - High Phosphorus Indices
 - Decoupling of N, P, & K/Alternative Fertilizer Programs



The Effects of Various Potassium Rates on the Yield and Quality of Flue-cured Tobacco



Objectives

- Evaluate Current Potassium Recommendations
- Improve Fertilizer Efficiency
- Evaluate Crop Response Using Alternative Fertilizer Programs



Methods & Materials

- RCBD
- Tissue Samples Collected from Each Plot at Layby, at Topping, and After Curing
- Tissue Analysis for N, P, K, Mg, Alkaloids, and Reducing Sugars
- Yield, Quality, and Crop Value Data Collected Post-harvest
- Soil Samples Collected at Transplanting from Control Plots



Locations

- Upper Coastal Plain Research Station in Rocky Mount, NC (2009 & 2010)
 - Two Locations at UCPRS in 2010
- Oxford Tobacco Research Station in Oxford, NC (2009)
- Representative of Coastal Plain & Piedmont



Location Descriptions

<u>Location</u>	<u>Soil Series</u>	<u>Soil pH</u>	<u>Soil P</u> ----mg P/dm ³ ----	<u>Soil K</u> ----meq K/100cc----
UCPRS-09	Goldsboro loamy sand	6.2	45.6 (Medium)	0.25 (Medium)
OTRS-09	Helena sandy loam	5.8	49.2 (Medium)	0.19 (Medium)
UCPRS1-10	Norfolk loamy sand	5.8	162 (Very High)	0.30 (High)
UCPRS2-10	Goldsboro loamy sand	6.0	112.8 (High)	0.45 (High)



Treatments

- Variety: NC 71 & NC 297
- Potassium Source: K-Mag (0-0-22)
- Rates: 0, 84, 112, 140, 168, 196, 224, & 252 kg K₂O/ha
- Additional Treatment: Complete Fertilizer
 - 747 kg/ha 6-6-18 (134 kg K₂O)-UCPRS
 - 560 kg/ha 8-8-24 (134 kg K₂O)-OTRS
- Nitrogen Source: 206 L 30% UAN/ha at UCPRS
 - 434 kg 15.5-0-0/ha at OTRS



P Values for Yield, Quality, Value, Total Alkaloids, Reducing Sugars, and Elemental Leaf Content

<u>Variable</u>	<u>P>F Env*K₂O Rate</u>	<u>P>F K₂O Rate</u>
Yield	0.4033	0.0923
Quality Index	0.3581	0.3391
Value	0.0159*	0.0257*
Value-UCPRS-2009	----	0.0679
Value-OTS-2009	----	0.3589
Value-UCPRS1-2010	----	0.0393*
Value-UCPRS2-2010	----	0.0224*
Total Alkaloids	0.5316	0.1639
Reducing Sugars	0.6457	0.3941
Nitrogen-Layby	0.8998	0.0004*
Nitrogen-Topping	0.6391	0.3827
Nitrogen-After Curing	0.4171	0.0054*
Phosphorus-Layby	0.8510	0.0119*
Phosphorus-Topping	0.3925	0.1402
Phosphorus-After Curing	0.3353	0.9368
Phosphorus-Without P-Layby	0.7564	0.1176
Phosphorus-Without P-Topping	0.5944	0.1148
Phosphorus-Without P-After Curing	0.2076	0.8992
Potassium-Layby	0.6610	0.0356*
Potassium-Topping	0.3208	0.0033*
Potassium-After Curing	0.8228	<.0001*
Magnesium-Layby	0.2778	0.0024*
Magnesium-Topping	0.0860	0.2939
Magnesium-After Curing	0.8735	0.4169

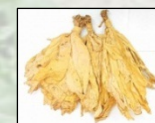


Yield, Quality, Alkaloid Content, and Sugar Content Response to Increasing Rates of K₂O

<u>K₂O Rate</u>	<u>Yield</u>	<u>Quality Index</u>	<u>Total Alkaloids</u>	<u>Reducing Sugars</u>
----kg/ha----	----kg/ha----		----%----	----%----
0	3077	81	4.20	11.89
84	3449	83	4.25	12.37
112	3408	82	4.20	11.60
134	3403	80	4.40	10.70
140	3335	81	4.28	11.89
168	3407	81	4.17	12.27
196	3353	81	4.14	12.26
224	3400	81	4.00	12.38
252	3466	79	4.18	11.75
LSD	NS	NS	NS	NS

Total Alkaloid Range: 0.20-7.87%¹

Reducing Sugar Range: 0.80-22.20%¹



Crop Value Response to Increasing Rates of K_2O at Individual Locations

<u>K_2O Rate</u>	<u>UCPRS-2009</u>	<u>OTRS-2009</u>	<u>UCPRS1-2010</u>	<u>UCPRS2-2010</u>
----kg/ha----	----\$/ha----	----\$/ha----	----\$/ha----	----\$/ha----
0	8811	12743	8602	10787
84	10154	15585	12092	10767
112	11179	14780	12172	9885
134	7155	12757	12408	12000
140	8711	14679	11712	9658
168	8862	13573	11259	11896
196	8560	14553	11487	9028
224	10131	14623	11907	10056
252	8091	14600	11688	10495
LSD	NS	NS	2097	1756

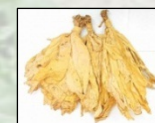


Elemental Nitrogen (N₂) Content at Layby, at Topping, and After Curing

<u>K₂O Rate</u> ----kg/ha----	<u>Layby</u> ----%----	<u>Topping</u> ----%----	<u>Cured Leaf</u> ----%----
0	5.92	4.93	2.69
84	5.74	4.87	2.49
112	5.84	4.76	2.53
134	6.12	4.69	2.70
140	5.63	4.71	2.51
168	6.05	4.80	2.58
196	5.72	5.07	2.50
224	5.76	4.68	2.43
252	5.71	4.56	2.65
LSD	0.23	NS	0.16

Nitrogen Sufficiency Range: 1.30-2.25%²

Nitrogen Deficiency Range: <1.50%³



Elemental Phosphorus Content at Layby, at Topping, and After Curing

<u>K₂O Rate</u> ----kg/ha----	<u>Layby</u> ----%----	<u>Topping</u> ----%----	<u>Cured Leaf</u> ----%----
0	0.56	0.39	0.22
84	0.52	0.42	0.20
112	0.55	0.39	0.22
134	0.61	0.39	0.22
140	0.52	0.39	0.21
168	0.58	0.42	0.22
196	0.52	0.45	0.21
224	0.57	0.41	0.22
252	0.51	0.38	0.22
LSD	0.06	NS	NS

Phosphorus Sufficiency Range: 0.12-0.30%²

Phosphorus Deficiency Range: <0.12%³



Elemental Phosphorus Content at Layby, at Topping, and After Curing (Without Complete Fertilizer)

<u>K₂O Rate</u> ----kg/ha----	<u>Layby</u> ----%----	<u>Topping</u> ----%----	<u>Cured Leaf</u> ----%----
0	0.56	0.39	0.22
84	0.52	0.42	0.20
112	0.55	0.39	0.22
140	0.52	0.39	0.21
168	0.58	0.42	0.21
196	0.52	0.45	0.21
224	0.57	0.41	0.22
252	0.51	0.38	0.22
LSD	NS	NS	NS

Phosphorus Sufficiency Range: 0.12-0.30%²

Phosphorus Deficiency Range: <0.12%²

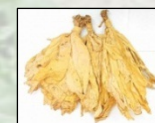


Elemental Potassium Content at Layby, at Topping, and After Curing

<u>K₂O Rate</u> ----kg/ha----	<u>Layby</u> ----%----	<u>Topping</u> ----%----	<u>Cured Leaf</u> ----%----
0	3.76	2.47	1.85
84	4.14	2.93	2.18
112	3.99	2.75	2.41
134	4.13	3.31	2.55
140	4.13	2.96	2.28
168	4.07	2.90	2.24
196	4.15	2.93	2.26
224	4.04	2.94	2.50
252	3.87	3.01	2.58
LSD	0.25	0.34	0.22

Potassium Sufficiency Range: 1.30-2.50%²

Potassium Deficiency Range: <1.00%⁴



Elemental Magnesium Content at Layby, at Topping, and After Curing

<u>K₂O Rate</u> ----kg/ha----	<u>Layby</u> ----%----	<u>Topping</u> ----%----	<u>Cured Leaf</u> ----%----
0	0.52	0.52	0.68
84	0.55	0.52	0.65
112	0.55	0.52	0.65
134	0.50	0.59	0.64
140	0.55	0.55	0.67
168	0.55	0.58	0.69
196	0.56	0.58	0.67
224	0.57	0.57	0.66
252	0.53	0.57	0.71
LSD	0.03	NS	NS

Magnesium Sufficiency Range: 0.18-0.60%²

Magnesium Deficiency Range: <0.15%⁵



Conclusion

- Rates above 84 kg K₂O/ha did not significantly improve any measured parameters.
 - Current recommendations are correct.
- Applying potassium from K-Mag independent of nitrogen and phosphorus was acceptable.
- Residual soil potassium, soil texture, and depth to clay must be considered.



The Effects of Various Potassium Rates,
Application Methods, and Application Timing
on the Yield and Quality of Flue-cured Tobacco



Objectives

- Evaluate Alternative Application Methods
 - Evaluate Potassium Application Rates from Previous Study Utilizing Alternative Methods and Timing
- Evaluate Alternative Fertilizer Programs



Methods & Materials

- Factorial Design with Appropriate Control
- Tissue Samples Collected from Each Plot at Layby, at Topping, and After Curing
- Tissue Analysis for N, P, K, Mg, Alkaloids, and Reducing Sugars
- Yield, Quality, and Crop Value Data Collected Post-harvest
- Soil Samples Collected from Control Plots Each Time Potassium Application Occurred



Locations

- Upper Coastal Plain Research Station in Rocky Mount, NC (2009 & 2010)
 - Two Locations at UCPRS in 2010
- Oxford Tobacco Research Station in Oxford, NC (2009)
- Representative of Coastal Plain & Piedmont



Location Descriptions

<u>Location</u>	<u>Soil Series</u>	<u>Soil pH</u>	<u>Soil P</u> ----mg P/dm ³ ----	<u>Soil K</u> ----meq K/100cc----
UCPRS-09	Goldsboro loamy sand	6.2	45.6 (Medium)	0.25 (Medium)
OTRS-09	Helena sandy loam	5.8	49.2 (Medium)	0.19 (Medium)
UCPRS1-10	Norfolk loamy sand	5.8	162 (Very High)	0.30 (High)
UCPRS2-10	Goldsboro loamy sand	6.0	112.8 (High)	0.45 (High)



Treatments

- Variety: NC 71 & NC 297
- Potassium Source: K-Mag (0-0-22)
- Rates: 84, 140, 196, 252 kg K₂O/ha
- Method: One Month before Transplanting, One Week before Transplanting, At Transplant, and Split Application
- Control: 0 kg K₂O/ha
- Nitrogen Source: 206 L 30% UAN/ha at UCPRS
434 kg 15.5-0-0/ha at OTRS



P Values for Yield, Quality, Value, Total Alkaloids, Reducing Sugars, and Elemental Leaf Content

<u>Variable</u>	<u>Env*Rate*Appl</u>	<u>Rate*App</u>	<u>Env*Rate</u>	<u>Env*App</u>	<u>Rate</u>	<u>App</u>
Yield	0.8211	0.8304	0.0226*	0.9799	0.0385*	0.9902
Quality Index	0.5767	0.5937	0.7826	0.6930	0.5629	0.5972
Value	0.9437	0.8980	0.2387	0.9075	0.4595	0.6347
Total Alkaloids	0.5567	0.4561	0.0669	0.1223	0.9226	0.6890
Reducing Sugars	0.3668	0.8070	0.2756	0.0905	0.0216	0.4227
Nitrogen-Layby	0.8917	0.1248	0.4251	0.4899	0.1499	0.5744
Nitrogen-Topping	0.9739	0.9819	0.4025	0.3904	0.9583	0.0678
Nitrogen-After Curing	0.7716	0.5382	0.3177	0.5562	0.0961	0.9101
Phosphorus-Layby	0.5516	0.6587	0.2092	0.9233	0.1369	0.1111
Phosphorus-Topping	0.3678	0.2215	0.7722	0.0270	0.5213	0.1405
Phosphorus-After Curing	0.9525	0.5640	0.5456	0.6059	0.3254	0.0361
Potassium-Layby	0.7551	0.1071	0.5835	0.0011*	0.0518	0.2884
Potassium-Topping	0.4633	0.5977	0.6622	0.0439*	0.4991	0.2013
Potassium-After Curing	0.4649	0.7530	0.0334*	0.3953	<.0001*	0.1873
Magnesium-Layby	0.3119	0.3707	0.1869	0.1567	0.0038	0.0073
Magnesium-Topping	0.4212	0.4885	0.6442	0.1367	0.6237	0.2331
Magnesium-After Curing	0.2080	0.5925	0.5374	0.2086	0.0114	0.1437



Yield Response to Increasing Rates of K_2O at Individual Environments

<u>K_2O Rate</u>	<u>UCPRS-09</u>	<u>OTRS-09</u>	<u>UCPRS1-10</u>	<u>UCPRS2-10</u>
--kg/ha--	--kg/ha--	--kg/ha--	--kg/ha--	--kg/ha--
84	3331	3252	3411	3405
140	3239	3385	3387	3404
196	3183	3234	3514	3206
252	3126	3644	3627	3422
LSD	NS	266	NS	NS



Elemental Potassium Content by Application Method at Layby

<u>Application Method</u>	<u>UCPRS-09</u>	<u>OTRS-09</u>	<u>UCPRS1-10</u>	<u>UCPRS2-10</u>
	--%--	--%--	--%--	--%--
Broadcast-One Month	4.69	3.65	4.02	4.08
Broadcast-One Week	4.72	3.79	4.08	4.15
Banded-At Planting	4.65	3.59	4.14	4.38
Banded-Split Applied	4.67	3.53	4.03	4.45
LSD	NS	0.18	NS	0.23

Potassium Sufficiency Range: 1.30-2.50%²

Potassium Deficiency Range: <1.00⁴



Elemental Potassium Content by Application Method at Topping

<u>Application Method</u>	<u>UCPRS-09</u>	<u>OTRS-09</u>	<u>UCPRS1-10</u>	<u>UCPRS2-10</u>
	--%--	--%--	--%--	--%--
Broadcast-One Month	2.41	3.90	2.67	2.77
Broadcast-One Week	2.60	2.97	2.54	2.87
Banded-At Planting	2.60	3.25	2.99	3.28
Banded-Split Applied	2.59	3.15	2.67	3.22
LSD	NS	NS	NS	0.24

Potassium Sufficiency Range: 1.30-2.50%²

Potassium Deficiency Range: <1.00%⁴

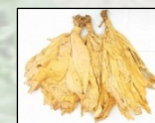


Elemental Potassium Content Response to Increasing Rates of K₂O After Curing

<u>K₂O Rate</u>	<u>UCPRS-09</u>	<u>OTRS-09</u>	<u>UCPRS1-10</u>	<u>UCPRS2-10</u>
--kg/ha--	--%--	--%--	--%--	--%--
84	2.37	2.13	2.13	2.40
140	2.53	2.36	2.32	2.37
196	2.80	2.29	2.63	3.43
252	2.59	2.48	2.39	3.47
LSD	0.23	NS	0.30	NS

Potassium Sufficiency Range: 1.30-2.50%²

Potassium Deficiency Range: <1.00%⁴



Conclusion

- Application method & timing had no effect on yield and quality, under research conditions.
- Early broadcast applications are acceptable, as long as soil and environmental conditions are considered.
- Rates above 84 kg K₂O/ha were not required regardless of application method.



Conclusions From Both Studies

- Rates above 84 kg K₂O/ha did not significantly improve any measured parameter.
- Early broadcast application of lower rates is acceptable.
- Residual potassium, soil texture, and depth to clay must be considered.



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Questions?

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