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The effect of source and rate of sidedress nitrogen on yield and quality of burley tobacco

Ahmed Azhar Jaafar

To the Graduate Council:

I am submitting herewith a thesis written by Ahmed Azhar Jaafar entitled "The effect of source and rate of sidedress nitrogen on yield and quality of burley tobacco." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant, Soil and Environmental Sciences.

William L. Park, Major Professor

We have read this thesis and recommend its acceptance:

Gary M. Lessman, John H. Reynolds

Accepted for the Council:
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Vice Provost and Dean of the Graduate School

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Date Jan. 30, 1986

THE EFFECT OF SOURCE AND RATE OF SIDEDRESS NITROGEN ON YIELD AND QUALITY OF BURLEY TOBACCO

A Thesis

Presented for the

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Degree

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Ahmed Azhar Jaafar

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ABSTRACT

Two field experiments were conducted during the growing seasons of 1983 and 1984 at the University of Tennessee Tobacco Experiment Station, Greeneville, Tennessee, to study the effect of source and rate of sidedress nitrogen on yield and quality of burley tobacco (Nicotiana tabacum L.). The 1983 experiment consisted of two tests, namely sod tobacco (tobacco following sod) and continuous tobacco (tobacco following tobacco). Only sod tobacco was planted in the 1984 season. Three rates of sidedress nitrogen at 33, 100, and 165 pounds per acre, and nitrogen sources in the forms of sodium nitrate, ammonium nitrate, and urea were used. All treatments received a preplant broadcast application of 450 pounds of 9-18-27 per acre.

No significant differences were found for yield, grade index, and crop index among the nitrogen rates and sources. Notably higher values were obtained for the sod tobacco over the continuous tobacco.

There were significant differences among rates of nitrogen for percent contents of nitrogen, potassium, and calcium in the cured leaves. Percent nitrogen and calcium contents increased with increasing nitrogen rates. While percent potassium showed inconsistent response, percent phosphorus and magnesium contents were not significantly affected by the treatments. Nitrogen sources had no significant effect on the percent contents of nitrogen, phosphorus, calcium, and magnesium. However, sodium nitrate produced significantly higher percent potassium content than either ammonium nitrate or urea.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

TABLE PAGE

TABLE PAGE

TABLE PAGE

TABLE PAGE

CHAPTER I

INTRODUCTION

A deep, well-drained soil, high in organic matter is most desirable for a successful burley tobacco production. Commonly, very good tobacco soils are limited in distribution so that related soils capable of producing leaf of only fair quality must be used to obtain the desired acreage. In such cases, thorough soil preparation is essential for the production of good yields of high quality tobacco.

One of the most important factors in fertilizing burley tobacco is to provide the proper amount of nutrients, especially nitrogen. Lack of nitrogen will result in poor yields and poor quality. On the other hand, too much nitrogen will cause the crop to mature late and be of low quality. An ideal nitrogen fertilizer is one which furnishes the nitrate form of nitrogen very slowly in the early season, increasing the supply more rapidly as the season progresses. Towards the end of the growing season, demand should be in excess of supply in order to ripen the leaves and give the best quality tobacco. Thus, it is a matter of supply and demand that ultimately measures the value of any fertilizer. The material that most nearly matches the plant's nutritional demands is the most efficient fertilizer.

Generally, increasing the rate of nitrogen fertilization of tobacco will result in increased yields. However, the method of

fertilizer application is important for the survival and subsequent growth of the tobacco plant. Burley tobacco is usually fertilized by broadcasting and disking prior to transplanting. Some farmers also sidedress portions of the nitrogen fertilizer after the plants have been established in the field.

Experiments with rates and sources of nitrogen for burley tobacco show that the amount rather than the form in which it is applied is more important. In general, results obtained indicate that the common sources of nitrogen are about equally effective. When properly used, nitrogen from any of the common fertilizers is satisfactory.

The purpose of this study was to determine the effect of source and rate of sidedress nitrogen on yield and quality of burley tobacco.

CHAPTER II

LITERATURE REVIEW

The objective of applying fertilizer is to supply the optimum amount of plant nutrients within easy reach of plant roots. Nutrient requirements of tobacco are higher and more extensive than for most other crops. Special attention must be given to nitrogen as it is very important in tobacco nutrition. Oversupply of nitrogen delays maturity and lowers tobacco quality whereas no harm is caused by excess phosphorus, and high potassium levels greatly improve the quality of tobacco.

Nitrogen is one of the integral chemical constituents of protoplasm which is the most important part of the green plant. Without protoplasm there can be no life or growth. Nitrogen is the essential component of proteins and related amino acids of the plant (10). It is also contained in nicotine, an alkaloid present only in tobacco. Finally, chlorophyll is composed partly of nitrogen; breakdown of chlorophyll and subsequent fading of leaves is due to nitrogen deprivation (48, 51).

Effects of Source and Rate on Yield and Quality

Differences in sources and rates of fertilizers are among the many factors influencing the yield, quality, and chemical composition of tobacco. Probably no other phase in the fertilization of tobacco has been studied more extensively than the response to

various forms of nitrogen. Experiments with sources of N show that results from the nitrogen applied have not always been consistent. Mahadik (23) proved that three carriers of N, calcium ammonium nitrate, ammonium sulfate and urea, had similar effects on growth and yield of tobacco. According to Vickery et al. (52), nitrogen responses were subtle and difficult to interpret upon application of different forms of nitrogen.

Similar results concerning tobacco yield were obtained by several other researchers. Nichols et al. (32) used sodium nitrate, ammonium sulfate, urea, and ammonium nitrate as sources of N and found no significant differences in yield at the Tobacco Experiment Station, Greeneville, Tennessee. Shaw (44) discovered no significant differences in yield among various sources and methods of applying N fertilizer in North Carolina. Samuels et al. (43) used combinations of ammonium sulfate and urea as sources of N for cigar filler tobacco in Puerto Rico, and found no significant differences in the yield obtained. In an experiment with flue-cured tobacco, Tisdale (50) found no significant difference in yield or value resulting from the use of urea or ammonium nitrate. Several other reports (13, 24, 26, 27) also discussed the same effect of sources and methods of nitrogen fertilization.

While burley tobacco has a fairly high nitrogen requirement, it should be noted here that it is easy to provide too much nitrogen for this crop. Thus, the rate rather than the source of fertilizer

is more important in making fertilization decisions. Studies done on field-grown tobacco have shown that N fertilization increased yield (6, 22, 27, 31, 36, 44, 46, 53). Significant improvements were obtained in yield and quality of tobacco by using up to 120 lbs N/A (31). Atkinson et al. (4) concluded that the mean dry weight of leaves increased with the increase of N fertilization from 100 to 200 lbs/A. Higher N did not affect mean weights of leaves. Paterson (38) reported that tobacco yield showed a positive response to added N up to the 150 lbs/A level. Parks et al. (35) obtained significant increases in average yield of dark tobacco by using up to 200 lbs N/A.

Added N also increased growth (2, 41, 42) and dry matter content of burley tobacco (4, 8, 19). However, Atkinson et al. (6) found that burley tobacco yields were not increased further when more than 200 lbs N/A were applied. Several workers found that increasing the rates of N fertilization delayed the maturity period of the tobacco plant (1, 23). Andersen et al. (1) stated that this delay reduced the levels of phenolic constituents in the tobacco leaves. This in turn lowered the quality of cured tobacco leaves.

Economically, an increase in yield does not mean very much if it is not accompanied by an increase in quality. Tobacco quality can be evaluated by the terms crop index and grade index which are the average monetary returns per acre and the average price per 100 pounds, respectively. Results showed N applications significantly increased crop index (34) and grade index (32) over no-nitrogen

treatments. Parks et al. (36) found that applications of N above 40 lbs/A increased crop index and N applications up to 120 lbs/A were still profitable.

Meanwhile, Nichols et al. (31) discovered that on the average, crop index and grade index were significantly higher when using up to 160 lbs N/A. Further increases in the amount of N fertilizer failed to bring about significant increases in either. Atkinson et al. (6) working with burley tobacco reported that price was generally lower when more than 100 lbs N/A were applied.

Nitrogen and Nicotine

The concentration of each chemical constituent in the tobacco leaf varies considerably; it is dependent on many factors, including variety, fertilization practices, plant population, rainfall, and other environmental factors. Atkinson et al. (7) reported that the concentrations of total N, total alkaloids, and nitrate N in burley tobacco increased when N rates were increased. Sims et al. (45) found that total plant contents of K, Ca, Mg, and Mn increased as N rate was increased from 100 to 200 lbs/A. Nichols et al. (31) reported that N and K fertilization influenced the concentrations of P, K, and Ca in cured burley tobacco.

Nitrogen has a more pronounced effect on the growth and development of tobacco than any other nutrient (5, 6, 18, 25, 45). Growth is slow and the plants become stunted with narrow and light yellow leaves when the nitrogen supply in the soil is low. Nitrogen is an

integral part of the nicotine molecule, and thus nitrogen is an important factor in nicotine synthesis. Data generally show that the nicotine content of field grown plants increases with the increase in the amount of available N (9, 11, 22, 25, 47). The nicotine content of tobacco plants is also influenced by the method of fertilizer application and topping practices. Crockford (12) found that split N applications, with the second portion being applied between 34 to 36 days after planting subsequently increased leaf nicotine levels. Kroontje et al. (19) reported that highest nicotine accumulation occurred at 70 to 100 days after topping.

It is an established fact that within the plant's ability to absorb nitrogen, the concentration of total nitrogen in the tobacco leaf bears a direct relationship to the amount of nitrogen available to the plant during the growing season. Miller et al. (29) reported that N uptake was much higher with the higher N treatment than with the low N treatment. Works by Zartman et al. (55) revealed that both leaf N concentration and leaf weight were consistently greater at 180 kg N/ha than at 90 kg N/ha. Other results also showed that increasing N rate increased total N content of the cured leaves (5, 9, 22, 32, 39, 55).

Phosphorus, Potassium, Calcium, and Magnesium

Phosphorus is essential in the formation of many protein substances in plants and important in reproductive organs and for maintenance of life. The relationship between nitrogen and phosphorus

mainfest itself in governing the maturity of plants in general and particularly of the leaf with respect to tobacco. Whitty et al. (54) found that P application stimulated more early growth of the tobacco plant.

Although P application increased the leaf P content, the rate or placement of P fertilizer did not influence yield and quality of cured tobacco (5, 54). This effect was assumed to be due to the residual level of P in the soil. According to Parups et al. (37), P appeared to be the most important and beneficial nutrient element for growth at lower soil temperatures. Paterson et al. (40) reported that P had a direct effect on Ca, Mg, and B and an inverse effect on Zn and Cu. Leaf phosphorus decreased as the nitrogen in the fertilizer was increased (31, 33).

The importance of potassium in the nutrition of tobacco can be illustrated by its univeral application in all production areas. The total uptake of K is the highest of the chemical elements. Grizzard et al. (16) reported that K uptake was highest during the active vegatative growth phase of tobacco. An ample supply of K imparts general vigor to the plant and improves the quality and usability of tobacco. Gopalachari (15) indicated that inclusion of potassium at optimum levels in the fertilizers would improve yield and quality of bidi tobacco. Nichols et al. (32) observed a dilution effect on the K content of burley tobacco when N supply was increased. Such effect was most pronounced when substantial yield increases were realized with each addition of nitrogen.

Similar results from potassium were obtained by Atkinson et al. (7) and Link et al. (22). Nichols et al. (30) reported that addition of K reduced the Ca content of the cured leaf. In their experiment with 'Havana 501' cigar binder tobacco, Paterson et al. (40) discovered that K had an inverse effect on the leaf concentrations of Ca, Mg, B, Zn, and Cu.

Plants require calcium for cell elongation and cell division. There is evidence that Ca is of fundamental importance for membrane permeability and the maintenance of cell integrity (28). Calcium may also activate enzymes and particularly those which are membrane bound. Overall, the calcium content of burley tobacco tended to increase with an increase in the nitrogen supplied in the fertilizer (31). Similar observations were made by Atkinson et al. (7) and Bowman (9).

Even though the requirement for Ca is relatively high, special attention is seldom given to this element in tobacco fertilization. This is because deficiencies are rarely observed in normal production and fertilization programs. However, lack of Ca may cause an adverse effect on terminal bud growth and thickening of the leaf resulting in extremely poor leaf quality. Calcium deficiency can be corrected by application of lime which supplies Ca and increases soil pH. McCants et al. (24) recommended that a soil pH of 5.0 to 5.5 would produce best quality tobacco. Link (21) suggested that liming increased both soil pH and tobacco yield.

The most well known role of magnesium is its occurrence at the center of the chlorophyll molecule. Besides its function in the other physiological processes, Mg is also a cofactor in almost all enzymes activating phosphorylation processes. Magnesium deficiency is shown by interveinal yellowing or chlorosis of the leaves (24). As development proceeded and deficiency symptoms become more pronounced, the content of Mg increased as N fertilizer rate was increased (45). Paterson et al. (40) reported that nitrogen and phosphorus had a direct effect on Mg and potassium had an inverse effect on this element.

The weather and cultural practices during the growing season also have an important bearing on results of fertilizer experiments. Temperature and soil moisture conditions can influence the release of nitrogen from the fertilizer mixtures. The quantity and distribution of rainfall may create leaching problems especially in coarse to medium textured soils. Irrigation greatly increased yield and value per 100 pounds tobacco (6, 7). Atkinson et al. (4) reported that good sucker control increased the weight of tobacco leaves.

CHAPTER III

MATERIALS AND METHODS

Field Procedures

This study was conducted during the summer months of 1983 and 1984 at the Tobacco Experiment Station, Greeneville, Tennessee. Soil samples were taken for testing prior to fertilization. The burley tobacco variety used in the experiments was Virginia 509.

During the summer of 1983, the experiment was divided into two separate experimental blocks; one following sod (sod tobacco) and one following tobacco (continuous tobacco). The soil type for sod tobacco was Pace silt loam at 2 to 5 percent slope. Soil pH was 6.3 and P and K contents were 85 and 125 lbs/A, respectively. The continuous tobacco was planted on Elk and Holston silt loam soil having 2 to 5 percent slope with 68 and 140 lbs/A of P and K, respectively. The soil pH was 5.7.

For the 1984 season, only sod tobacco was planted on Cumberland silt loam soil at 2 to 5 percent slope. The soil test values for P and K were 40 and 240 lbs/A, respectively. The pH was 6.6. Results of the soil tests are listed in Table 1.

A randomized complete block design with a split-plot arrangement of treatments with four replications was used. The main plots were nitrogen rates at three levels and the sub-plots were nitrogen sources. Each sub-plot consisted of 4 rows 42 inches wide and 36

Table 1. Soil test results of samples taken before fertilization in each block of the burley tobacco experiments at Greeneville, Tennessee.

Year and Tobacco Type	Percent Slope	pH	Available Nutrients P	Available Nutrients K
1983				
Sod Tobacco	2-5	6.3	85	125
Continuous Tobacco	2-5	5.7	68	140
1984				
Sod Tobacco	2-5	6.6	40	240

feet long with plants spaced 20 inches apart. The two center rows were harvested for yield, quality evaluations, and chemical analysis. Sidedress nitrogen rates used were 33, 100, and 165 lbs/A. The sources of nitrogen were sodium nitrate, ammonium nitrate, and urea.

After plowing, 450 lbs/A of 9-19-27 fertilizer was broadcast over the overall area. The fertilizer was disked into the soil. Tobacco plants were transplanted on June 6 for sod tobacco and June 8 for continuous tobacco of the 1983 season. The 1984 sod tobacco was transplanted on June 1. Four weeks after transplanting, nitrogen fertilizer in the forms of sodium nitrate, ammonium nitrate, and urea were sidedressed to the plots at rates of 33, 100, and 165 lbs N/A for the respective treatments (Table 2). This resulted in a total of 73, 140, and 205 lbs N/A.

Conventional cultivation methods were conducted during the course of the tobacco growing seasons. The plants were harvested at maturity and hung in the barns for curing.

When cured, the tobacco was stripped and separated into farm grades. Grades for each plot were determined by the Federal Tobacco Grading Service. Values per 100 pounds (grade index) and per acre (crop index) were calculated on the basis of average prices paid by grade on all burley markets during each year of the test period.

Ten plants were selected at random from each plot for chemical analyses. Each plot was made up of three leaf samples designated by top, middle, and bottom. The top sample was composed of red leaf

Table 2. Source and rate of sidedress nitrogen used in the burley tobacco experiments at Greeneville, Tennessee.

Tmt. No.	Amount and Source of N	Lbs of N Per Acre	Lbs Fertilizer Per Plot		
			Sodium Nitrate	Am. Nitrate	Urea
1	200 lbs Sod Nitrate/A	33	2.31	-	-
2	100 lbs Am. Nitrate/A	33	-	1.16	-
3	75 lbs Urea/A	33	-	-	0.87
4	600 lbs Sod. Nitrate/A	100	6.94	-	-
5	300 lbs Am. Nitrate/A	100	-	3.47	-
6	225 lbs Urea/A	100	-	-	2.60
7	1000 lbs Sod. Nitrate/A	165	11.57	-	-
8	500 lbs Am. Nitrate/A	165	-	5.79	-
9	375 lbs Urea/A	165	-	-	4.34

and tips, the middle sample of lugs and bright leaf, and the bottom sample of dark and light flyings. They were dried at 70°C for 48 hours, ground, and stored in air-tight plastic bags. Determinations for total nitrogen, phosphorus, potassium, calcium, and magnesium were made on these samples at the Plant and Soil Science Laboratory, University of Tennessee, Knoxville.

Laboratory Procedures

The determination for total nitrogen was conducted using the phenol-hypochlorite color reaction as described by Thomas et al. (49). The procedure is outlined in Appendix A. Phosphorus, potassium, calcium, and magnesium were determined by the procedures described by Johnson et al. (17) as outlined in Appendix B. These chemical analyses were made for all test of both years.

Statistical Analyses

Analyses of variance were calculated on the data for each test of both years. Procedures of the split-plot design described by Little et al. (20) were used.

CHAPTER IV

RESULTS AND DISCUSSION

Yield

The burley tobacco yields in pounds per acre are shown in Tables 3, 4, and 5. No significant differences in yields were observed among the nitrogen rates and sources during both years. Source x rate interactions were not significant in all the three tests indicating that the plants responded to all treatments in the same way.

Nitrogen fertilization did not significantly affect total tobacco yields. However, the mean yields increased with increasing rates of nitrogen. In all tests, treatments receiving ammonium nitrate and urea tended to produce higher yields than those receiving sodium nitrate although the differences were not significant. The mean yields for rates and sources of nitrogen on sod tobacco were much higher than for continuous tobacco.

Grade Index

Nitrogen rates and sources did not cause any significant effect on the grade index of tobacco in all tests (Tables 6, 7, and 8). There were no significant source x rate interactions showing that different nitrogen fertilizers at different levels used in the experiment produced similar tobacco grades. The means of grade index were noticeably higher for the sod tobacco than for the continuous tobacco.

Table 3. Effect of source and rate of sidedress nitrogen on the 1983 lbs/A yield of continuous burley tobacco.

Sources of N	lbs N/A	Replication 1	2	3	4	Average
Sod. Nitrate	33	2251	1476	1755	1927	1852
Am. Nitrate	33	1834	2431	1789	1716	1943
Urea	33	1558	2304	1626	1683	1793
Sod. Nitrate	100	1535	1957	1547	1436	1619
Am. Nitrate	100	1983	1752	2310	2799	2211
Urea	100	2211	2543	2558	2159	2368
Sod. Nitrate	165	1952	2461	1604	1541	1890
Am. Nitrate	165	2088	2529	2356	1956	2230
Urea	165	2730	1698	2170	2155	2188

Source of Variation	df	SS	MS	F
Rates of N	2	401,340.02	200,670.01	3.09
Replications	3	199,041.60	66,347.20	1.02
Error a	6	389,641.98	64,940.33	
Sources of N	2	899,722.02	449,861.01	3.02
Sources x Rates	4	670,113.81	167,525.45	1.13
Error b	18	2,588,856.17	148,825.34	

Means for Rates of N

33 lbs N/A = 1863
100 lbs N/A = 2066
165 lbs N/A = 2103
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 1787
Am. Nitrate = 2128
Urea = 2166
LSD (.05) = NS

Table 4. Effect of source and rate of sidedress nitrogen on the 1983 lbs/A yield of burley tobacco grown after sod.

Sources of N	lbs N/A	Replication 1	2	3	4	Average
Sod. Nitrate	33	1908	2801	2950	2781	2610
Am. Nitrate	33	2253	2662	2963	3214	2773
Urea	33	2134	2614	2888	2970	2652
Sod. Nitrate	100	2321	2970	3087	2634	2753
Am. Nitrate	100	2412	2781	3329	2490	2753
Urea	100	2252	3661	2420	2862	2799
Sod. Nitrate	165	2784	2632	2951	2406	2693
Am. Nitrate	165	2729	3002	3688	2718	3034
Urea	165	3140	3030	2835	2186	2798

Source of Variation	df	SS	MS	F
Rates of N	2	161,107.03	80,553.52	0.29
Replications	3	1,740,544.31	580,181.44	2.08
Error a	6	1,674,495.86	279,082.64	
Sources of N	2	172,570.70	86,285.35	0.97
Sources x Rates	4	134,593.47	33,648.37	0.38
Error b	18	1,595,533.83	88,640.77	

Means for Rates of N

33 lbs N/A = 2678
100 lbs N/A = 2768
165 lbs N/A = 2842
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 2685
Am. Nitrate = 2853
Urea = 2749
LSD (.05) = NS

Table 5. Effect of source and rate of sidedress nitrogen on the 1984 lbs/A yield of burley tobacco grown after sod.

Sources of N	lbs N/A	Replication 1	2	3	4	Average
Sod. Nitrate	33	2176	1849	1924	2294	2061
Am. Nitrate	33	2978	2131	1953	2985	2511
Urea	33	3736	2945	3773	2567	3255
Sod. Nitrate	100	1921	1826	3639	1626	2253
Am. Nitrate	100	2754	1726	2295	2012	2197
Urea	100	3207	2750	3360	1230	2637
Sod. Nitrate	165	1720	2106	3083	2190	2274
Am. Nitrate	165	2265	3163	2449	2570	2612
Urea	165	2987	3093	1732	1712	2381

Source of Variation	df	SS	MS	F
Rates of N	2	402,903.25	201,451.63	0.38
Replications	3	1,766,705.33	588,901.78	1.10
Error a	6	3,212,218.75	535,369.79	
Sources of N	2	1,908,160.80	954,080.40	2.71
Sources x Rates	4	1,698,717.20	424,679.30	1.21
Error b	18	6,328,081.67	351,560.09	

Means for Rates of N

33 lbs N/A = 2609
100 lbs N/A = 2362
165 lbs N/A = 2422
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 2196
Am. Nitrate = 2440
Urea = 2758
LSD (.05) = NS

Table 6. Effect of source and rate of sidedress nitrogen on the 1983 grade index of continuous burley tobacco.

Sources of N	lbs N/A	Replication 1	2	3	4	Average
Sod. Nitrate	33	.319	.347	.218	.381	.316
Am. Nitrate	33	.307	.449	.329	.455	.385
Urea	33	.427	.363	.246	.327	.341
Sod. Nitrate	100	.294	.418	.330	.301	.336
Am. Nitrate	100	.319	.390	.247	.573	.382
Urea	100	.318	.469	.410	.405	.401
Sod. Nitrate	165	.445	.354	.345	.380	.381
Am. Nitrate	165	.228	.308	.418	.302	.314
Urea	165	.464	.464	.423	.309	.415

Source of Variation	df	SS	MS	F
Rates of N	2	4,688.23	2,344.11	0.30
Replications	3	25,161.00	8,387.00	1.08
Error a	6	46,407.33	7,734.56	
Sources of N	2	10,286.06	5,143.03	0.93
Sources x Rates	4	29,472.27	7,368.07	1.34
Error b	18	99,259.67	5,514.43	

Means for Rates of N

33 lbs N/A = .347
100 lbs N/A = .373
165 lbs N/A = .370
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = .344
Am. Nitrate = .360
Urea = .385
LSD (.05) = NS

Table 7. Effect of source and rate of sidedress nitrogen on the 1983 grade index of burley tobacco grown after sod.

Sources of N	lbs N/A	Replication 1	2	3	4	Average
Sod. Nitrate	33	.329	.466	.503	.542	.460
Am. Nitrate	33	.428	.498	.452	.480	.465
Urea	33	.459	.472	.523	.452	.477
Sod. Nitrate	100	.386	.517	.514	.511	.482
Am. Nitrate	100	.461	.450	.488	.391	.448
Urea	100	.372	.388	.459	.474	.423
Sod. Nitrate	165	.402	.438	.390	.475	.426
Am. Nitrate	165	.453	.461	.457	.495	.467
Urea	165	.463	.453	.485	.455	.464

Source of Variation	df	SS	MS	F
Rates of N	2	1,912.05	956.03	0.75
Replications	3	20,186.99	6,728.99	5.24
Error a	6	7,698.18	1,283.03	
Sources of N	2	152.39	76.20	0.04
Sources x Rates	4	11,471.28	2,867.82	1.47
Error b	18	35,050.33	1,947.24	

Means for Rates of N

33 lbs N/A = .467
100 lbs N/A = .451
165 lbs N/A = .452
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = .456
Am. Nitrate = .460
Urea = .455
LSD (.05) = NS

Table 8. Effect of source and rate of sidedress nitrogen on the 1984 grade index of burley tobacco grown after sod.

Sources of N	lbs N/A	Replication 1	2	3	4	Average
Sod. Nitrate	33	.415	.272	.139	.420	.312
Am. Nitrate	33	.693	.438	.302	.671	.526
Urea	33	.587	.476	.483	.419	.491
Sod. Nitrate	100	.412	.454	.683	.330	.470
Am. Nitrate	100	.557	.260	.506	.289	.403
Urea	100	.676	.467	.672	.362	.544
Sod. Nitrate	165	.302	.377	.563	.403	.411
Am. Nitrate	165	.426	.474	.467	.523	.473
Urea	165	.588	.703	.254	.248	.448

Source of Variation	df	SS	MS	F
Rates of N	2	6,677.17	3,338.59	0.08
Replications	3	58,820.30	19,606.76	0.47
Error a	6	248,816.61	41,469.44	
Sources of N	2	60,121.17	30,060.58	1.93
Sources x Rates	4	93,470.67	23,367.67	1.51
Error b	18	280,116.83	15,562.05	

Means for Rates of N

33 lbs N/A = .443
100 lbs N/A = .472
165 lbs N/A = .444
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = .398
Am. Nitrate = .467
Urea = .494
LSD (.05) = NS

Crop Index

The values of the crop index for each test are shown in Tables 9, 10, and 11. There were no significant differences among the various nitrogen rates and sources used. The interactions of sources x rates did not produce any significant effect. Crop index tended to increase from 33 to 100 lbs N/A in the continuous tobacco but not in the sod tobacco. The average values for crop index of the sod tobacco were higher than the continuous tobacco.

Chemical Analysis

A partial chemical analysis of the top, middle, and bottom leaves of 10-plant samples was made each year. The percent contents of nitrogen, phosphorus, potassium, calcium, and magnesium are reported in Appendix C, Tables 12-56.

Percent Nitrogen

Results for percent nitrogen are given in Tables 12 through 20. No significant differences were found among rates of nitrogen for the 1983 continuous tobacco and the 1983 sod tobacco. However, the top leaves of both tests produced highly significant source x rate interactions. For the 1984 sod tobacco, rates of nitrogen caused significant increases in all leaves.

Results for means of nitrogen indicated that percent nitrogen tended to increase with increasing amount of nitrogen supplied to the

Table 9. Effect of source and rate of sidedress nitrogen on the 1983 crop index of continuous burley tobacco.

Sources of N	lbs N/A	Replication 1	2	3	4	Average
Sod. Nitrate	33	718	512	383	734	587
Am. Nitrate	33	563	1092	589	781	756
Urea	33	665	836	400	550	613
Sod. Nitrate	100	451	816	511	432	553
Am. Nitrate	100	633	683	571	1604	873
Urea	100	703	1193	1045	875	955
Sod. Nitrate	165	869	871	553	586	720
Am. Nitrate	165	476	779	981	591	707
Urea	165	1267	788	918	666	910

Source of Variation	df	SS	MS	F
Rates of N	2	145,504.67	72,752.33	1.06
Replications	3	161,402.75	53,800.92	0.78
Error a	6	413,458.00	68,909.67	
Sources of N	2	279,480.50	139,740.25	2.13
Sources x Rates	4	251,300.33	62,825.08	0.96
Error b	18	1,183,118.50	65,728.81	

Means for Rates of N

33 lbs N/A = 652
100 lbs N/A = 795
165 lbs N/A = 779
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 620
Am. Nitrate = 779
Urea = 826
LSD (.05) = NS

Table 10. Effect of source and rate of sidedress nitrogen on the 1983 crop index of burley tobacco grown after sod.

Sources of N	lbs N/A	Replication 1	2	3	4	Average
Sod. Nitrate	33	628	1305	1484	1507	1231
Am. Nitrate	33	964	1326	1339	1543	1293
Urea	33	979	1234	1511	1343	1267
Sod. Nitrate	100	896	1535	1587	1346	1341
Am. Nitrate	100	1112	1252	1625	974	1241
Urea	100	838	1420	1111	1357	1182
Sod. Nitrate	165	1119	1153	1151	1143	1142
Am. Nitrate	165	1236	1384	1685	1345	1413
Urea	165	1454	1373	1375	995	1299

Source of Variation	df	SS	MS	F
Rates of N	2	5,672.22	2,836.11	0.04
Replications	3	804,802.53	268,267.51	3.54
Error a	6	455,330.22	75,888.37	
Sources of N	2	42,146.72	21,073.36	0.68
Sources x Rates	4	165,804.78	41,451.20	1.35
Error b	18	553,982.50	30,776.81	

Means for Rates of N		Means for Sources of N	
33 lbs N/A	= 1264	Sodium Nitrate	= 1238
100 lbs N/A	= 1254	Am. Nitrate	= 1315
165 lbs N/A	= 1284	Urea	= 1249
LSD (.05)	= NS	LSD (.05)	= NS

Table 11. Effect of source and rate of sidedress nitrogen on the 1984 crop index of burley tobacco grown after sod.

Sources of N	lbs N/A	Replication 1	2	3	4	Average
Sod. Nitrate	33	904	502	267	963	659
Am. Nitrate	33	2063	934	589	2004	1398
Urea	33	2194	1403	1823	1076	1624
Sod. Nitrate	100	791	829	2486	537	1161
Am. Nitrate	100	1533	449	1161	581	931
Urea	100	2166	1284	2258	445	1538
Sod. Nitrate	165	519	794	1735	882	983
Am. Nitrate	165	964	1499	1144	1343	1238
Urea	165	1755	2174	440	425	1199

Source of Variation	df	SS	MS	F
Rates of N	2	51,522.89	25,761.44	0.04
Replications	3	1,433,436.22	477,812.07	0.67
Error a	6	4,264,955.11	710,825.85	
Sources of N	2	1,619,495.06	809,747.53	2.52
Sources x Rates	4	1,320,712.11	330,178.03	1.03
Error b	18	5,784,142.17	321,341.23	

Means for Rates of N

33 lbs N/A = 1227
100 lbs N/A = 1210
165 lbs N/A = 1140
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 934
Am. Nitrate = 1189
Urea = 1454
LSD (.05) = NS

plants except for the 1983 continuous tobacco. Each increment of fertilizer nitrogen gave larger percent nitrogen values than the next lower increment. Sources of nitrogen showed no significant differences in the percent nitrogen except for the bottom leaves of the 1983 continuous tobacco and the middle and bottom leaves of the 1984 sod tobacco. The percent nitrogen contents were relatively higher in the upper than the lower leaves.

Percent Phosphorus

The data in Tables 21 through 29 illustrated the influence of nitrogen fertilizers on percent phosphorus of the cured burley tobacco. Variations in the phosphorus content of tobacco grown with different fertilizer treatments were comparatively small. No significant differences in the leaf phosphorus caused by rates of nitrogen were obtained except for the middle leaves of the 1983 continuous tobacco. There were no significant differences among sources of nitrogen indicating that different nitrogen fertilizers had no significant effect on the leaf phosphorus content.

Percent Potassium

The values for percent potassium in the cured tobacco during the two growing seasons are given in Tables 30 through 38. The 1983 continuous tobacco showed that rates of nitrogen significantly increased percent potassium in the top leaves and significantly decreased percent

potassium in the bottom leaves. For the 1983 sod tobacco, means for rates of nitrogen showed significant increase in percent potassium from 100 to 165 lbs N/A in the middle leaves and significant decrease in percent potassium from 33 to 100 lbs N/A in the bottom leaves. In the 1984 sod tobacco, rates of nitrogen significantly increased percent potassium in the top and middle leaves. Interactions of sources x rates of nitrogen were highly significant for all leaves.

A relatively high potassium content is usually associated with desirable quality in burley tobacco. The concentration of leaf potassium tends to decrease with an increase fertilizer nitrogen. This is explained on the basis of dilution, since larger yields are obtained with higher rates of nitrogen. Results from these experiments were not consistent. The bottom leaves of the 1983 continuous tobacco and the 1983 sod tobacco (Tables 32 and 35) indicated that percent potassium decreased with higher rates of nitrogen. Meanwhile, other leaf positions indicated that percent potassium increased with the increase of nitrogen rates.

Significant source x rate interactions indicated that different nitrogen treatments influenced percent potassium of the cured tobacco leaves. The results also revealed significant differences among the sources of nitrogen except the middle leaves of the 1983 continuous tobacco and the top leaves of the 1983 sod tobacco. Plants receiving sodium nitrate produced significantly higher percent potassium in leaves than plants receiving ammonium nitrate or urea nitrogen.

Percent Calcium

Results for percent calcium are given in Tables 39 through 47. As in the case of percent nitrogen, the calcium content in the tobacco leaves increased with increasing rates of nitrogen fertilization. In this experiment, however, only the 1984 sod tobacco was significant for rates of nitrogen in all leaves. Average results showed that percent calcium tended to increase with increasing nitrogen rates. Since the effect of increasing the nitrogen application was to lower the potassium content in the leaves, the competing calcium ion was more efficiently absorbed at higher nitrogen levels.

Highly significant source x rate interactions indicated that there were differences in the comparative response of the tobacco to the sources of nitrogen at the different fertility levels. The percent calcium contents were notably higher in the lower than in the upper leaves.

Percent Magnesium

No significant differences were found among rates of nitrogen except for the bottom leaves of the 1984 sod tobacco where significant increase in percent magnesium was obtained when nitrogen rates were increased (Tables 48 through 56). Source x rate interactions were significant for the bottom leaves of the 1983 continuous tobacco, top leaves of the 1983 sod tobacco, and all leaves of the 1984 sod tobacco.

Overall, the magnesium content of burley tobacco tended to increase with the increase in the nitrogen supplied in the fertilizer. Results also showed that percent magnesium increased from the upper to the lower leaves.

CHAPTER V

SUMMARY

The main objective of this study was to determine the effect of source and rate of sidedress nitrogen on yield and quality of burley tobacco. Evaluations of yield, grade index, and crop index were made. Leaf samples were analyzed for contents of major elements.

No significant differences were found among the sources and rates of nitrogen for yield, grade index, and crop index in all the three tests of both years. Results showed that the mean values of the sod tobacco were notably higher than the continuous tobacco.

The chemical analyses produced varied results. However, it was observed that there were significant differences among rates of nitrogen for percent contents of nitrogen, potassium, and calcium in the cured tobacco leaves. This investigation revealed that nitrogen and calcium contents increased as the rates of nitrogen fertilizer were increased. The potassium content was somewhat inconsistent while the phosphorus and magnesium contents did not show any significant effects.

It was found that the different nitrogen sources had no significant effect on the contents of nitrogen, phosphorus, calcium, and magnesium. Nitrogen sources, however, had highly significant effect on the content of potassium. By comparing the average results it was concluded that sodium nitrate caused significantly higher leaf potassium than either ammonium nitrate or urea.

Average results also indicated that the percent nitrogen content was higher in the upper than the lower leaves. The case was reversed for the percent calcium and magnesium contents. No specific trend was found in the percent contents of phosphorus and potassium.

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LIST OF REFERENCES

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APPENDIXES

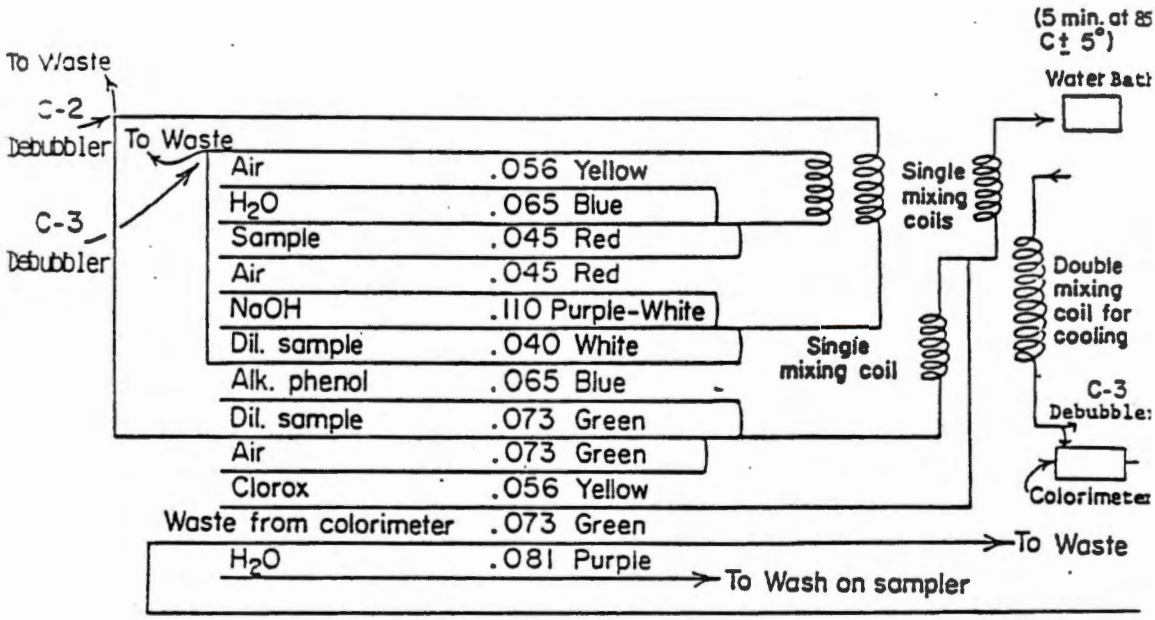
APPENDIX A

APPENDIX A

NITROGEN DIGESTION PROCEDURE

1. Weigh 0.20 g sample of finely ground leaf tissue and place in a 125 ml Erlenmeyer flask.
2. Add 10 ml concentrated H_2SO_4 to each flask and allow to predigest overnight.
3. Set the flasks on a hot plate and heat to 220°C for 2 hours or until the volume is reduced by about 50 percent.
4. Remove the flasks from the hot plate and allow to cool.
5. Add 20 ml of 35% H_2O_2 to each flask and place back on the hot plate and heat at 220°C for about 45 minutes until clearing or bubbling stops.
6. Transfer the cool samples to 250 ml volumetric flasks and bring to volume with distilled water.
7. Shake well, allow samples to equilibrate overnight and run on Auto Analyzer.*

*The flow diagram for this analysis in the Auto Analyzer is presented in Figure 1.



COLOR	I. D.	CC/MIN.
White	.040	.60
Red	.045	.80
Yellow	.056	1.20
Blue	.065	1.60
Green	.073	2.00
Purple	.081	2.50
Purple-White	.110	3.90

Figure 1. Manifold for nitrogen determinations.

APPENDIX B

APPENDIX B

WET ASHING DIGESTION PROCEDURE FOR PHOSPHORUS, POTASSIUM, CALCIUM AND MAGNESIUM

1. Weigh 0.50 g of finely ground leaf tissue and place in digestion tube in aluminum digestion block.
2. Add 4 ml concentrated HNO_3 and let predigest overnight.
3. Heat at 150°C for 1 hour and allow to cool.
4. Add 3 ml concentrated $HClO_4$ and heat at 235°C for 2 hours.
5. Set off the hot plate and allow the samples to cool.
6. Add 1 ml concentrated HCl and heat to 150°C for 15 minutes and let cool.
7. Transfer to 100 ml volumetric flasks and bring to volume with distilled water.
8. Shake thoroughly and let set overnight to equilibrate.
9. Analyze with Auto Analyzer* for P and Atomic Absorption Spectrophotometer for K, Ca, and Mg.

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*The flow diagram for P analysis in the Auto Analyzer is presented in Figure 2.

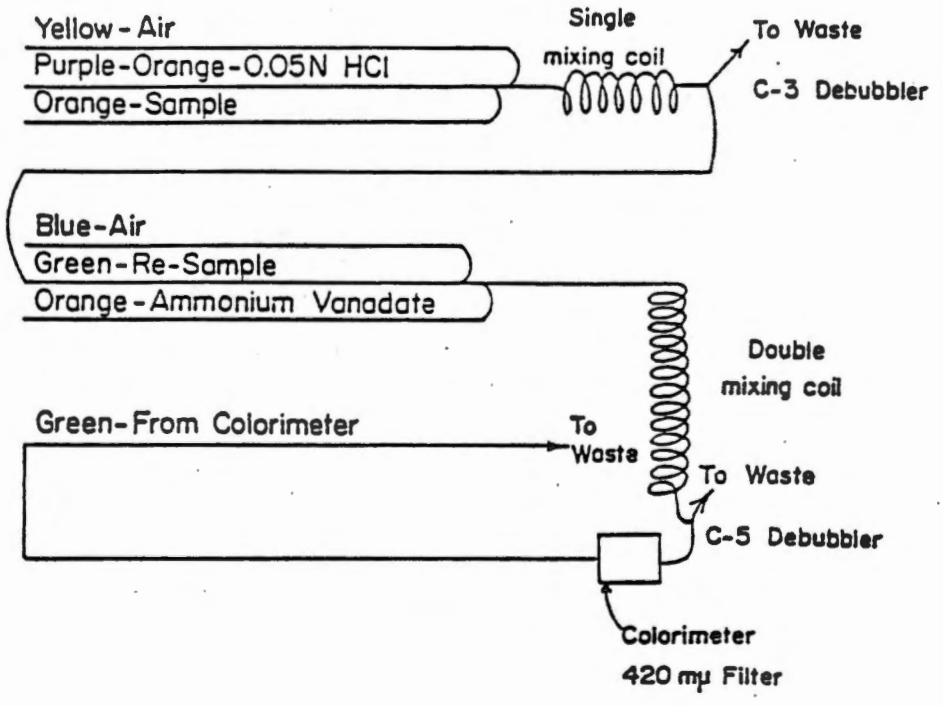

Figure 2. Manifold for phosphorus determinations.

APPENDIX C

Table 12. Percent nitrogen in top leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	3.76	3.43	3.60
Am. Nitrate	33	3.23	3.12	3.18
Urea	33	3.22	2.96	3.09
Sod. Nitrate	100	3.16	3.33	3.25
Am. Nitrate	100	3.56	3.45	3.51
Urea	100	3.37	3.45	3.41
Sod. Nitrate	165	3.40	3.59	3.50
Am. Nitrate	165	3.44	3.63	3.54
Urea	165	3.91	3.84	3.88

Source of Variation	df	SS	MS	F
Rates of N	2	0.3860	0.1930	3.96
Replications	1	0.0035	0.0035	0.07
Error a	2	0.0975	0.0487	
Sources of N	2	0.0092	0.0046	0.50
Sources x Rates	4	0.5268	0.1317	14.21**
Error b	6	0.0556	0.0093	

Means for Rates of N

33 lbs N/A = 3.29
100 lbs N/A = 3.39
165 lbs N/A = 3.64
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 3.45
Am. Nitrate = 3.41
Urea = 3.46
LSD (.05) = NS

**Significant at the 1% level of probability.

Table 13. Percent nitrogen in middle leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	4.78	3.04	3.91
Am. Nitrate	33	2.96	2.71	2.84
Urea	33	3.08	2.73	2.91
Sod. Nitrate	100	2.73	2.58	2.66
Am. Nitrate	100	3.45	3.08	3.27
Urea	100	3.04	2.85	2.95
Sod. Nitrate	165	2.83	3.03	2.93
Am. Nitrate	165	3.34	3.23	3.29
Urea	165	3.15	3.02	3.09

Source of Variation	df	SS	MS	F
Rates of N	2	0.2062	0.1031	0.44
Replications	1	0.5304	0.5304	2.27
Error a	2	0.4665	0.2332	
Sources of N	2	0.1174	0.0587	0.47
Sources x Rates	4	1.8288	0.4572	3.70
Error b	6	0.7416	0.1236	

Means for Rates of N

33 lbs N/A = 3.22
100 lbs N/A = 3.96
165 lbs N/A = 3.10
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 3.17
Am. Nitrate = 3.13
Urea = 2.98
LSD (.05) = NS

Table 14. Percent nitrogen in bottom leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	1.96	1.95	1.96
Am. Nitrate	33	2.13	2.00	2.06
Urea	33	2.13	2.05	2.09
Sod. Nitrate	100	2.07	2.34	2.21
Am. Nitrate	100	2.36	2.27	2.32
Urea	100	2.23	2.28	2.26
Sod. Nitrate	165	2.13	2.34	2.24
Am. Nitrate	165	2.33	2.54	2.45
Urea	165	2.48	2.66	2.57

Source of Variation	df	SS	MS	F
Rates of N	2	0.4444	0.2222	11.38
Replications	1	0.0235	0.0235	1.20
Error a	2	0.0391	0.0195	
Sources of N	2	0.1045	0.0523	9.06*
Sources x Rates	4	0.0441	0.0110	1.91
Error b	6	0.0346	0.0058	

Means for Rates of N

33 lbs N/A = 2.03
100 lbs N/A = 2.26
165 lbs N/A = 2.42
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 2.13
Am. Nitrate = 2.28
Urea = 2.31
LSD (.05) = 0.15

*Significant at the 5% level of probability.

Table 15. Percent nitrogen in top leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	3.56	3.23	3.40
Am. Nitrate	33	3.56	3.56	3.56
Urea	33	3.24	3.32	3.28
Sod. Nitrate	100	3.45	3.38	3.42
Am. Nitrate	100	3.27	3.20	3.24
Urea	100	3.96	3.85	3.91
Sod. Nitrate	165	3.51	3.85	3.68
Am. Nitrate	165	3.73	3.85	3.79
Urea	165	3.63	3.55	3.59

Source of Variation	df	SS	MS	F
Rates of N	2	0.2307	0.1154	5.22
Replications	1	0.0008	0.0008	0.04
Error a	2	0.0441	0.0221	
Sources of N	2	0.0281	0.0141	0.92
Sources x Rates	4	0.5722	0.1431	9.35**
Error b	6	0.0919	0.0153	

Means for Rates of N		Means for Sources of N	
33 lbs N/A	= 3.41	Sodium Nitrate	= 3.50
100 lbs N/A	= 3.52	Am. Nitrate	= 3.53
165 lbs N/A	= 3.69	Urea	= 3.59
LSD (.05)	= NS	LSD (.05)	= NS

**Significant at the 1% level of probability.

Table 16. Percent nitrogen in middle leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	3.16	3.12	3.14
Am. Nitrate	33	2.86	3.08	2.97
Urea	33	2.83	2.99	2.93
Sod. Nitrate	100	3.03	3.15	3.09
Am. Nitrate	100	3.05	2.85	2.95
Urea	100	3.02	2.91	2.97
Sod. Nitrate	165	3.08	3.28	3.18
Am. Nitrate	165	3.16	3.38	3.27
Urea	165	3.23	3.38	3.31

Source of Variation	df	SS	MS	F
Rates of N	2	0.2451	0.1226	4.85
Replications	1	0.0289	0.0289	1.14
Error a	2	0.0505	0.0253	
Sources of N	2	0.0225	0.0113	1.44
Sources x Rates	4	0.0747	0.0187	2.38
Error b	6	0.0471	0.0079	

Means for Rates of N

33 lbs N/A = 3.01
100 lbs N/A = 3.00
165 lbs N/A = 3.25
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 3.14
Am. Nitrate = 3.06
Urea = 3.07
LSD (.05) = NS

Table 17. Percent nitrogen in bottom leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	1.75	1.90	1.83
Am. Nitrate	33	1.90	2.13	2.02
Urea	33	2.07	2.33	2.20
Sod. Nitrate	100	2.28	2.33	2.31
Am. Nitrate	100	2.35	2.34	2.35
Urea	100	2.13	2.33	2.23
Sod. Nitrate	165	2.13	2.27	2.20
Am. Nitrate	165	2.54	2.24	2.39
Urea	165	2.24	2.42	2.33

Source of Variation	df	SS	MS	F
Rates of N	2	0.3292	0.1646	9.98
Replications	1	0.0450	0.0450	2.73
Error a	2	0.0330	0.0165	
Sources of N	2	0.0803	0.0402	2.81
Sources x Rates	4	0.1117	0.0279	1.95
Error b	6	0.0858	0.0143	

Means for Rates of N

33 lbs N/A = 2.02
100 lbs N/A = 2.30
165 lbs N/A = 2.31
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 2.11
Am. Nitrate = 2.25
Urea = 2.25
LSD (.05) = NS

Table 18. Percent nitrogen in top leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	3.52	3.36	3.44
Am. Nitrate	33	3.36	3.26	3.31
Urea	33	3.13	3.07	3.10
Sod. Nitrate	100	3.29	3.23	3.26
Am. Nitrate	100	3.41	3.35	3.38
Urea	100	3.56	3.49	3.53
Sod. Nitrate	165	3.67	3.74	3.71
Am. Nitrate	165	3.71	3.54	3.63
Urea	165	3.76	3.63	3.70

Source of Variation	df	SS	MS	F
Rates of N	2	0.4932	0.2466	326.38**
Replications	1	0.0304	0.0304	40.24*
Error a	2	0.0015	0.0008	
Sources of N	2	0.0034	0.0017	0.53
Sources x Rates	4	0.1924	0.0481	15.13**
Error b	6	0.0191	0.0032	

Means for Rates of N

33 lbs N/A = 3.28
100 lbs N/A = 3.39
165 lbs N/A = 3.68
LSD (.05) = 0.07
LSD (.01) = 0.16

Means for Sources of N

Sodium Nitrate = 3.47
Am. Nitrate = 3.44
Urea = 3.44
LSD (.05) = NS

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 19. Percent nitrogen in middle leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.91	2.92	2.92
Am. Nitrate	33	2.95	2.96	2.96
Urea	33	2.89	2.92	2.91
Sod. Nitrate	100	2.83	2.78	2.83
Am. Nitrate	100	3.17	3.14	3.16
Urea	100	2.93	2.94	2.94
Sod. Nitrate	165	3.03	3.13	3.08
Am. Nitrate	165	3.27	3.07	3.17
Urea	165	3.22	3.12	3.17

Source of Variation	df	SS	MS	F
Rates of N	2	0.1569	0.0785	30.19*
Replications	1	0.0027	0.0027	1.04
Error a	2	0.0052	0.0026	
Sources of N	2	0.0772	0.0386	9.49*
Sources x Rates	4	0.0616	0.0154	3.79
Error b	6	0.0244	0.0041	

Means for Rates of N

33 lbs N/A = 2.93
100 lbs N/A = 2.98
165 lbs N/A = 3.14
LSD (.05) = 0.13

Means for Sources of N

Sodium Nitrate = 2.94
Am. Nitrate = 3.10
Urea = 3.01
LSD (.05) = 0.09

*Significant at the 5% level of probability.

Table 20. Percent nitrogen in bottom leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	1.88	1.96	1.92
Am. Nitrate	33	2.04	2.15	2.10
Urea	33	2.16	2.14	2.15
Sod. Nitrate	100	2.17	2.10	2.14
Am. Nitrate	100	2.33	2.36	2.35
Urea	100	2.21	2.14	2.18
Sod. Nitrate	165	2.26	2.19	2.23
Am. Nitrate	165	2.44	2.51	2.48
Urea	165	2.54	2.74	2.64

Source of Variation	df	SS	MS	F
Rates of N	2	0.4644	0.2422	47.71*
Replications	1	0.0038	0.0038	0.78
Error a	2	0.0097	0.0049	
Sources of N	2	0.1944	0.0972	22.17**
Sources x Rates	4	0.0876	0.0219	5.00
Error b	6	0.0263	0.0044	

Means for Rates of N

33 lbs N/A = 2.06
100 lbs N/A = 2.22
165 lbs N/A = 2.45
LSD (.05) = 0.17

Means for Sources of N

Sodium Nitrate = 2.10
Am. Nitrate = 2.31
Urea = 2.32
LSD (.05) = 0.09
LSD (.01) = 0.14

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 21. Percent phosphorus in top leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.22	0.22	0.22
Am. Nitrate	33	0.22	0.23	0.23
Urea	33	0.22	0.22	0.22
Sod. Nitrate	100	0.28	0.22	0.25
Am. Nitrate	100	0.22	0.21	0.22
Urea	100	0.21	0.22	0.22
Sod. Nitrate	165	0.19	0.18	0.19
Am. Nitrate	165	0.20	0.21	0.21
Urea	165	0.21	0.21	0.21

Source of Variation	df	SS	MS	F
Rates of N	2	0.0024	0.0012	5.05
Replications	1	0.0001	0.0001	0.58
Error a	2	0.0005	0.0002	
Sources of N	2	0.0000	0.0000	0.16
Sources x Rates	4	0.0023	0.0006	2.36
Error b	6	0.0015	0.0003	

Means for Rates of N

33 lbs N/A = 0.22
100 lbs N/A = 0.23
165 lbs N/A = 0.20
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.22
Am. Nitrate = 0.22
Urea = 0.22
LSD (.05) = NS

Table 22. Percent phosphorus in middle leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.20	0.21	0.21
Am. Nitrate	33	0.20	0.21	0.21
Urea	33	0.20	0.20	0.20
Sod. Nitrate	100	0.18	0.19	0.19
Am. Nitrate	100	0.20	0.20	0.20
Urea	100	0.17	0.18	0.18
Sod. Nitrate	165	0.17	0.18	0.18
Am. Nitrate	165	0.17	0.18	0.18
Urea	165	0.19	0.20	0.20

Source of Variation	df	SS	MS	F
Rates of N	2	0.0015	0.0008	57.60*
Replications	1	0.0003	0.0003	21.60*
Error a	2	0.0003	0.0001	
Sources of N	2	0.0001	0.0000	4.00
Sources x Rates	4	0.0011	0.0003	28.86**
Error b	6	0.0001	0.0000	

Means for Rates of N

33 lbs N/A = 0.21
100 lbs N/A = 0.19
165 lbs N/A = 0.19
LSD (.05) = 0.02

Means for Sources of N

Sodium Nitrate = 0.19
Am. Nitrate = 0.20
Urea = 0.19
LSD (.05) = NS

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 23. Percent phosphorus in bottom leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.14	0.15	0.15
Am. Nitrate	33	0.18	0.16	0.17
Urea	33	0.22	0.18	0.20
Sod. Nitrate	100	0.14	0.18	0.16
Am. Nitrate	100	0.18	0.15	0.17
Urea	100	0.15	0.18	0.17
Sod. Nitrate	165	0.17	0.16	0.17
Am. Nitrate	165	0.14	0.14	0.14
Urea	165	0.14	0.18	0.16

Source of Variation	df	SS	MS	F
Rates of N	2	0.0008	0.0004	0.93
Replications	1	0.0000	0.0000	0.05
Error a	2	0.0009	0.0005	
Sources of N	2	0.0012	0.0006	1.38
Sources x Rates	4	0.0025	0.0006	1.42
Error b	6	0.0027	0.0005	

Means for Rates of N

33 lbs N/A = 0.17
100 lbs N/A = 0.17
165 lbs N/A = 0.16
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.16
Am. Nitrate = 0.16
Urea = 0.18
LSD (.05) = NS

Table 24. Percent phosphorus in top leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.22	0.23	0.23
Am. Nitrate	33	0.21	0.25	0.23
Urea	33	0.25	0.25	0.25
Sod. Nitrate	100	0.26	0.25	0.26
Am. Nitrate	100	0.25	0.26	0.26
Urea	100	0.25	0.24	0.25
Sod. Nitrate	165	0.25	0.24	0.25
Am. Nitrate	165	0.22	0.25	0.24
Urea	165	0.23	0.21	0.22

Source of Variation	df	SS	MS	F
Rates of N	2	0.0012	0.0006	3.06
Replications	1	0.0001	0.0001	0.44
Error a	2	0.0004	0.0002	
Sources of N	2	0.0000	0.0000	0.08
Sources x Rates	4	0.0014	0.0004	1.78
Error b	6	0.0013	0.0002	

Means for Rates of N

33 lbs N/A = 0.24
100 lbs N/A = 0.26
165 lbs N/A = 0.24
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.24
Am. Nitrate = 0.24
Urea = 0.24
LSD (.05) = NS

Table 25. Percent phosphorus in middle leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.20	0.24	0.22
Am. Nitrate	33	0.22	0.22	0.22
Urea	33	0.18	0.24	0.21
Sod. Nitrate	100	0.22	0.25	0.23
Am. Nitrate	100	0.22	0.23	0.23
Urea	100	0.21	0.19	0.20
Sod. Nitrate	165	0.25	0.23	0.24
Am. Nitrate	165	0.18	0.25	0.22
Urea	165	0.22	0.25	0.24

Source of Variation	df	SS	MS	F
Rates of N	2	0.0006	0.0003	1.04
Replications	1	0.0022	0.0022	7.62
Error a	2	0.0006	0.0003	
Sources of N	2	0.0009	0.0005	0.85
Sources x Rates	4	0.0013	0.0003	0.51
Error b	6	0.0035	0.0006	

Means for Rates of N

33 lbs N/A = 0.22
100 lbs N/A = 0.22
165 lbs N/A = 0.23
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.23
Am. Nitrate = 0.22
Urea = 0.22
LSD (.05) = NS

Table 26. Percent phosphorus in bottom leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.19	0.23	0.21
Am. Nitrate	33	0.17	0.21	0.19
Urea	33	0.15	0.23	0.19
Sod. Nitrate	100	0.19	0.24	0.22
Am. Nitrate	100	0.18	0.21	0.20
Urea	100	0.19	0.17	0.18
Sod. Nitrate	165	0.19	0.16	0.18
Am. Nitrate	165	0.19	0.19	0.19
Urea	165	0.21	0.19	0.20

Source of Variation	df	SS	MS	F
Rates of N	2	0.0002	0.0001	0.05
Replications	1	0.0011	0.0011	0.52
Error a	2	0.0043	0.0021	
Sources of N	2	0.0006	0.0003	1.11
Sources x Rates	4	0.0022	0.0006	2.21
Error b	6	0.0016	0.0003	

Means for Rates of N

33 lbs N/A = 0.20
100 lbs N/A = 0.20
165 lbs N/A = 0.19
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.20
Am. Nitrate = 0.19
Urea = 0.19
LSD (.05) = NS

Table 27. Percent phosphorus in top leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.23	0.23	0.23
Am. Nitrate	33	0.20	0.22	0.21
Urea	33	0.20	0.28	0.24
Sod. Nitrate	100	0.21	0.19	0.20
Am. Nitrate	100	0.18	0.20	0.19
Urea	100	0.18	0.19	0.19
Sod. Nitrate	165	0.22	0.18	0.20
Am. Nitrate	165	0.20	0.20	0.20
Urea	165	0.20	0.19	0.20

Source of Variation	df	SS	MS	F
Rates of N	2	0.0041	0.0021	2.16
Replications	1	0.0002	0.0002	0.21
Error a	2	0.0019	0.0010	
Sources of N	2	0.0003	0.0002	0.45
Sources x Rates	4	0.0009	0.0002	0.45
Error b	6	0.0026	0.0004	

Means for Rates of N

33 lbs N/A = 0.23
100 lbs N/A = 0.19
165 lbs N/A = 0.20
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.21
Am. Nitrate = 0.20
Urea = 0.21
LSD (.05) = NS

Table 28. Percent phosphorus in middle leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.27	0.22	0.25
Am. Nitrate	33	0.21	0.23	0.22
Urea	33	0.22	0.24	0.23
Sod. Nitrate	100	0.23	0.20	0.22
Am. Nitrate	100	0.20	0.26	0.23
Urea	100	0.19	0.20	0.20
Sod. Nitrate	165	0.28	0.22	0.25
Am. Nitrate	165	0.20	0.23	0.22
Urea	165	0.22	0.20	0.21

Source of Variation	df	SS	MS	F
Rates of N	2	0.0010	0.0005	1.88
Replications	1	0.0002	0.0002	0.75
Error a	2	0.0005	0.0003	
Sources of N	2	0.0019	0.0010	1.05
Sources x Rates	4	0.0019	0.0005	0.53
Error b	6	0.0057	0.0010	

Means for Rates of N

33 lbs N/A = 0.23
100 lbs N/A = 0.22
165 lbs N/A = 0.23
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.24
Am. Nitrate = 0.22
Urea = 0.21
LSD (.05) = NS

Table 29. Percent phosphorus in bottom leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.29	0.21	0.25
Am. Nitrate	33	0.22	0.24	0.23
Urea	33	0.19	0.27	0.23
Sod. Nitrate	100	0.26	0.20	0.23
Am. Nitrate	100	0.22	0.28	0.25
Urea	100	0.22	0.24	0.23
Sod. Nitrate	165	0.26	0.23	0.25
Am. Nitrate	165	0.22	0.24	0.23
Urea	165	0.24	0.24	0.24

Source of Variation	df	SS	MS	F
Rates of N	2	0.0000	0.0000	0.20
Replications	1	0.0001	0.0001	3.91
Error a	2	0.0001	0.0000	
Sources of N	2	0.0002	0.0001	0.05
Sources x Rates	4	0.0011	0.0003	0.16
Error b	6	0.0109	0.0018	

Means for Rates of N		Means for Sources of N	
33 lbs N/A	= 0.24	Sodium Nitrate	= 0.24
100 lbs N/A	= 0.24	Am. Nitrate	= 0.24
165 lbs N/A	= 0.24	Urea	= 0.23
LSD (.05)	= NS	LSD (.05)	= NS

Table 30. Percent potassium in top leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidesdress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.55	2.12	2.34
Am. Nitrate	33	3.07	2.97	3.02
Urea	33	2.12	2.16	2.14
Sod. Nitrate	100	2.81	2.65	2.73
Am. Nitrate	100	2.88	2.47	2.68
Urea	100	3.06	2.88	2.97
Sod. Nitrate	165	3.04	2.95	3.00
Am. Nitrate	165	3.34	2.94	3.14
Urea	165	2.92	2.80	2.86

Source of Variation	df	SS	MS	F
Rates of N	2	0.7575	0.3788	133.04**
Replications	1	0.1901	0.1901	66.77*
Error a	2	0.0057	0.0028	
Sources of N	2	0.3015	0.1508	8.47*
Sources x Rates	4	0.7298	0.1825	10.26**
Error b	6	0.1068	0.0178	

Means for Rates of N

33 lbs N/A = 2.49
100 lbs N/A = 2.80
165 lbs N/A = 3.00
LSD (.05) = 0.13
LSD (.01) = 0.30

Means for Sources of N

Sodium Nitrate = 2.69
Am. Nitrate = 2.95
Urea = 2.66
LSD (.05) = 0.19

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 31. Percent potassium in middle leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.83	2.83	2.83
Am. Nitrate	33	2.82	3.03	2.93
Urea	33	2.68	2.40	2.54
Sod. Nitrate	100	3.09	2.91	3.00
Am. Nitrate	100	2.25	2.59	2.42
Urea	100	2.84	2.95	2.90
Sod. Nitrate	165	2.91	3.14	3.03
Am. Nitrate	165	3.11	2.85	2.98
Urea	165	3.08	2.88	2.98

Source of Variation	df	SS	MS	F
Rates of N	2	0.2056	0.1028	9.46
Replications	1	0.0001	0.0001	0.01
Error a	2	0.0217	0.0109	
Sources of N	2	0.1072	0.0536	1.61
Sources x Rates	4	0.4384	0.1096	3.29
Error b	6	0.1998	0.0333	

Means for Rates of N

33 lbs N/A = 2.77
100 lbs N/A = 2.77
165 lbs N/A = 3.00
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 2.95
Am. Nitrate = 2.78
Urea = 2.81
LSD (.05) = NS

Table 32. Percent potassium in bottom leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	3.85	3.80	3.83
Am. Nitrate	33	4.01	4.04	4.03
Urea	33	2.64	2.95	2.80
Sod. Nitrate	100	3.22	3.45	3.34
Am. Nitrate	100	2.21	2.26	2.24
Urea	100	3.28	3.25	3.27
Sod. Nitrate	165	2.65	2.78	2.72
Am. Nitrate	165	3.03	2.86	2.95
Urea	165	2.88	2.94	2.91

Source of Variation	df	SS	MS	F
Rates of N	2	1.7004	0.8502	238.37**
Replications	1	0.0174	0.0174	4.88
Error a	2	0.0071	0.0036	
Sources of N	2	0.2940	0.1470	11.29**
Sources x Rates	4	3.0271	0.7568	58.14**
Error b	6	0.0781	0.0130	

Means for Rates of N

33 lbs N/A = 3.55
100 lbs N/A = 2.95
165 lbs N/A = 2.86
LSD (.05) = 0.15
LSD (.01) = 0.34

Means for Sources of N

Sodium Nitrate = 3.30
Am. Nitrate = 3.07
Urea = 2.99
LSD (.05) = 0.16
LSD (.01) = 0.24

**Significant at the 1% level of probability.

Table 33. Percent potassium in top leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.89	2.64	2.77
Am. Nitrate	33	2.85	2.64	2.75
Urea	33	2.57	2.55	2.56
Sod. Nitrate	100	2.93	3.04	2.99
Am. Nitrate	100	2.08	2.47	2.28
Urea	100	2.85	2.79	2.82
Sod. Nitrate	165	3.39	3.15	3.27
Am. Nitrate	165	2.75	2.94	2.85
Urea	165	2.85	3.05	2.95

Source of Variation	df	SS	MS	F
Rates of N	2	0.4356	0.2178	5.91
Replications	1	0.0007	0.0007	0.09
Error a	2	0.0074	0.0369	
Sources of N	2	0.4503	0.2252	6.89*
Sources x Rates	4	0.3491	0.0873	2.67
Error b	6	0.1962	0.0327	

Means for Rates of N

33 lbs N/A = 2.69
100 lbs N/A = 2.70
165 lbs N/A = 3.01
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 3.01
Am. Nitrate = 2.63
Urea = 2.78
LSD (.05) = 0.26

*Significant at the 5% level of probability.

Table 34. Percent potassium in middle leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	3.15	3.03	3.09
Am. Nitrate	33	2.83	3.03	2.93
Urea	33	2.84	2.95	2.90
Sod. Nitrate	100	3.37	3.52	3.45
Am. Nitrate	100	2.61	2.33	2.47
Urea	100	2.40	2.53	2.47
Sod. Nitrate	165	3.01	2.94	2.98
Am. Nitrate	165	3.11	2.96	3.04
Urea	165	2.93	3.15	3.04

Source of Variation	df	SS	MS	F
Rates of N	2	0.1674	0.0857	42.55*
Replications	1	0.0020	0.0020	0.13
Error a	2	0.0040	0.0020	
Sources of N	2	0.5309	0.2654	12.84**
Sources x Rates	4	0.7916	0.1979	9.58**
Error b	6	0.1240	0.0017	

Means for Rates of N

33 lbs N/A = 2.97
100 lbs N/A = 2.80
165 lbs N/A = 3.02
LSD (.05) = 0.11

Means for Sources of N

Sodium Nitrate = 3.17
Am. Nitrate = 2.81
Urea = 2.80
LSD (.05) = 0.19
LSD (.01) = 0.28

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 35. Percent potassium in bottom leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	4.09	3.84	3.97
Am. Nitrate	33	3.96	3.84	3.90
Urea	33	2.73	2.61	2.67
Sod. Nitrate	100	3.14	3.14	3.14
Am. Nitrate	100	2.48	2.16	2.32
Urea	100	2.93	3.08	3.01
Sod. Nitrate	165	3.21	2.90	3.06
Am. Nitrate	165	2.68	2.93	2.81
Urea	165	2.97	3.08	3.03

Source of Variation	df	SS	MS	F
Rates of N	2	1.5964	0.7982	65.03*
Replications	1	0.0207	0.0207	1.69
Error a	2	0.0245	0.0123	
Sources of N	2	0.7834	0.3917	15.85**
Sources x Rates	4	2.1938	0.5484	22.19**
Error b	6	0.1483	0.0247	

Means for Rates of N

33 lbs N/A = 3.51
100 lbs N/A = 2.82
165 lbs N/A = 2.97
LSD (.05) = 0.28

Means for Sources of N

Sodium Nitrate = 3.39
Am. Nitrate = 3.01
Urea = 2.90
LSD (.05) = 0.22
LSD (.01) = 0.34

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 36. Percent potassium in top leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.37	2.31	2.34
Am. Nitrate	33	2.94	2.82	2.82
Urea	33	2.26	2.40	2.33
Sod. Nitrate	100	2.95	3.00	2.98
Am. Nitrate	100	2.56	2.47	2.52
Urea	100	2.84	2.92	2.88
Sod. Nitrate	165	3.13	3.14	3.14
Am. Nitrate	165	3.07	3.06	3.07
Urea	165	2.84	2.88	2.86

Source of Variation	df	SS	MS	F
Rates of N	2	0.7570	0.3785	134.91**
Replications	1	0.0001	0.0001	0.04
Error a	2	0.0056	0.0028	
Sources of N	2	0.0651	0.0326	8.65*
Sources x Rates	4	0.6464	0.1616	42.90**
Error b	6	0.0226	0.0038	

Means for Rates of N

33 lbs N/A = 2.50
100 lbs N/A = 2.79
165 lbs N/A = 3.02
LSD (.05) = 0.13
LSD (.01) = 0.30

Means for Sources of N

Sodium Nitrate = 2.82
Am. Nitrate = 2.80
Urea = 2.69
LSD (.05) = 0.09

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 37. Percent potassium in middle leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	3.03	3.18	3.11
Am. Nitrate	33	2.97	2.93	2.95
Urea	33	2.69	2.77	2.73
Sod. Nitrate	100	3.15	3.13	3.14
Am. Nitrate	100	2.45	2.46	2.46
Urea	100	2.67	2.64	2.66
Sod. Nitrate	165	3.02	3.08	3.05
Am. Nitrate	165	3.13	3.17	3.15
Urea	165	3.07	3.04	3.06

Source of Variation	df	SS	MS	F
Rates of N	2	0.3371	0.1686	75.87*
Replications	1	0.0027	0.0027	1.22
Error a	2	0.0044	0.0022	
Sources of N	2	0.2871	0.1435	72.62**
Sources x Rates	4	0.3640	0.0910	46.05**
Error b	6	0.0119	0.0020	

Means for Rates of N

33 lbs N/A = 2.93
100 lbs N/A = 2.75
165 lbs N/A = 3.09
LSD (.05) = 0.12

Means for Sources of N

Sodium Nitrate = 3.10
Am. Nitrate = 2.52
Urea = 2.82
LSD (.05) = 0.06
LSD (.01) = 0.10

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 38. Percent potassium in bottom leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.95	3.86	3.41
Am. Nitrate	33	3.95	3.81	3.88
Urea	33	2.85	2.83	2.84
Sod. Nitrate	100	3.46	3.35	3.41
Am. Nitrate	100	2.23	2.23	2.23
Urea	100	3.15	3.05	3.10
Sod. Nitrate	165	2.83	2.93	2.88
Am. Nitrate	165	2.93	2.97	2.95
Urea	165	2.94	2.97	2.96

Source of Variation	df	SS	MS	F
Rates of N	2	0.8289	0.4144	10.63
Replications	1	0.0280	0.0280	0.72
Error a	2	0.0780	0.0390	
Sources of N	2	0.2347	0.1174	2.10
Sources x Rates	4	2.3437	0.5859	10.48**
Error b	6	0.3353	0.0559	

Means for Rates of N

33 lbs N/A = 3.38
100 lbs N/A = 2.91
165 lbs N/A = 2.93
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 3.23
Am. Nitrate = 3.02
Urea = 2.97
LSD (.05) = NS

**Significant at the 1% level of probability.

Table 39. Percent calcium in top leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	1.88	2.02	1.95
Am. Nitrate	33	2.31	1.89	2.10
Urea	33	2.20	2.38	2.29
Sod. Nitrate	100	2.01	1.98	2.00
Am. Nitrate	100	2.02	2.45	2.24
Urea	100	2.78	3.04	2.91
Sod. Nitrate	165	2.27	1.96	2.12
Am. Nitrate	165	2.19	2.45	2.32
Urea	165	2.70	2.94	2.82

Source of Variation	df	SS	MS	F
Rates of N	2	0.3312	0.1656	6.76
Replications	1	0.0313	0.0313	1.28
Error a	2	0.0490	0.0245	
Sources of N	2	1.3464	0.6732	14.89**
Sources x Rates	4	0.1961	0.0490	1.08
Error b	6	0.2713	0.0452	

Means for Rates of N

33 lbs N/A = 2.11
100 lbs N/A = 2.38
165 lbs N/A = 2.42
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 2.02
Am. Nitrate = 2.22
Urea = 2.67
LSD (.05) = 0.30
LSD (.01) = 0.46

** Significant at the 1% level of probability.

Table 40. Percent calcium in middle leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.89	3.04	2.97
Am. Nitrate	33	2.93	2.84	2.89
Urea	33	3.06	3.37	3.22
Sod. Nitrate	100	3.01	3.22	3.12
Am. Nitrate	100	2.95	3.25	3.10
Urea	100	3.35	3.18	3.27
Sod. Nitrate	165	2.89	3.13	3.01
Am. Nitrate	165	2.93	3.64	3.29
Urea	165	2.97	3.14	3.06

Source of Variation	df	SS	MS	F
Rates of N	2	0.0601	0.0300	9.29
Replications	1	0.1861	0.1861	57.61*
Error a	2	0.0065	0.0033	
Sources of N	2	0.0668	0.0334	0.81
Sources x Rates	4	0.1721	0.0430	1.04
Error b	6	0.2476	0.0413	

Means for Rates of N

33 lbs N/A = 3.03
100 lbs N/A = 3.16
165 lbs N/A = 3.12
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 3.03
Am. Nitrate = 3.09
Urea = 3.18
LSD (.05) = NS

*Significant at the 5% level of probability.

Table 41. Percent calcium in bottom leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	4.55	4.27	4.41
Am. Nitrate	33	4.76	4.29	4.53
Urea	33	4.30	3.94	4.12
Sod. Nitrate	100	4.60	4.45	4.53
Am. Nitrate	100	4.86	4.54	4.70
Urea	100	4.74	4.32	4.53
Sod. Nitrate	165	4.33	4.42	4.38
Am. Nitrate	165	4.83	4.60	4.72
Urea	165	4.56	4.28	4.42

Source of Variation	df	SS	MS	F
Rates of N	2	0.1746	0.0873	6.49
Replications	1	0.3335	0.3335	24.80*
Error a	2	0.0269	0.0135	
Sources of N	2	0.2667	0.1334	10.08*
Sources x Rates	4	0.0804	0.0201	1.52
Error b	6	0.0794	0.0132	

Means for Rates of N

33 lbs N/A = 4.35
100 lbs N/A = 4.59
165 lbs N/A = 4.51
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 4.44
Am. Nitrate = 2.65
Urea = 4.36
LSD (.05) = 0.16

*Significant at the 5% level of probability.

Table 42. Percent calcium in top leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	1.86	2.15	2.01
Am. Nitrate	33	1.96	1.68	1.82
Urea	33	2.27	2.04	2.16
Sod. Nitrate	100	2.09	1.84	1.97
Am. Nitrate	100	2.04	1.95	2.00
Urea	100	2.81	2.75	2.78
Sod. Nitrate	165	2.12	2.15	2.14
Am. Nitrate	165	2.11	2.28	2.20
Urea	165	1.94	2.26	2.10

Source of Variation	df	SS	MS	F
Rates of N	2	0.0320	0.0160	0.16
Replications	1	0.0411	0.0411	0.41
Error a	2	0.2014	0.1007	
Sources of N	2	0.3019	0.1510	4.55
Sources x Rates	4	0.6839	0.1710	5.15
Error b	6	0.1992	0.0332	

Means for Rates of N

33 lbs N/A = 2.00
100 lbs N/A = 2.25
165 lbs N/A = 2.15
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 2.04
Am. Nitrate = 2.01
Urea = 2.35
LSD (.05) = NS

Table 43. Percent calcium in middle leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.84	3.12	2.98
Am. Nitrate	33	2.83	2.86	2.85
Urea	33	3.22	2.94	3.08
Sod. Nitrate	100	3.02	3.38	3.20
Am. Nitrate	100	3.02	2.79	2.91
Urea	100	2.84	3.08	2.96
Sod. Nitrate	165	2.96	3.28	3.12
Am. Nitrate	165	3.04	3.30	3.17
Urea	165	2.75	3.19	2.97

Source of Variation	df	SS	MS	F
Rates of N	2	0.0421	0.0211	0.50
Replications	1	0.1120	0.1120	2.65
Error a	2	0.0844	0.0422	
Sources of N	2	0.0526	0.0263	0.86
Sources x Rates	4	0.1448	0.0362	1.18
Error b	6	0.1843	0.0307	

Means for Rates of N

33 lbs N/A = 2.97
100 lbs N/A = 3.02
165 lbs N/A = 3.09
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 3.10
Am. Nitrate = 2.98
Urea = 3.00
LSD (.05) = NS

Table 44. Percent calcium in bottom leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	4.13	4.12	4.13
Am. Nitrate	33	4.14	4.01	4.08
Urea	33	4.10	4.05	4.08
Sod. Nitrate	100	3.83	3.89	3.86
Am. Nitrate	100	4.06	4.03	4.05
Urea	100	4.02	4.34	4.18
Sod. Nitrate	165	4.33	4.05	4.19
Am. Nitrate	165	4.35	4.00	4.18
Urea	165	4.41	4.45	4.43

Source of Variation	df	SS	MS	F
Rates of N	2	0.1801	0.0901	2.43
Replications	1	0.0103	0.0103	0.28
Error a	2	0.0742	0.0371	
Sources of N	2	0.0948	0.0474	3.56
Sources x Rates	4	0.0937	0.0234	1.76
Error b	6	0.0800	0.0133	

Means for Rates of N

33 lbs N/A = 4.10
100 lbs N/A = 4.03
165 lbs N/A = 4.27
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 4.06
Am. Nitrate = 4.10
Urea = 4.23
LSD (.05) = NS

Table 45. Percent calcium in top leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.02	2.10	2.06
Am. Nitrate	33	1.93	1.93	1.93
Urea	33	2.16	2.13	2.15
Sod. Nitrate	100	1.95	2.04	2.00
Am. Nitrate	100	2.14	2.26	2.20
Urea	100	2.85	2.84	2.85
Sod. Nitrate	165	2.09	2.21	2.15
Am. Nitrate	165	2.38	2.43	2.41
Urea	165	2.43	2.55	2.49

Source of Variation	df	SS	MS	F
Rates of N	2	0.3660	0.1830	74.19*
Replications	1	0.0162	0.0162	6.57
Error a	2	0.0049	0.0025	
Sources of N	2	0.5839	0.2920	185.70**
Sources x Rates	4	0.3753	0.0938	59.45**
Error b	6	0.0095	0.0016	

Means for Rates of N

33 lbs N/A = 2.05
100 lbs N/A = 2.35
165 lbs N/A = 2.35
LSD (.05) = 0.12

Means for Sources of N

Sodium Nitrate = 2.07
Am. Nitrate = 2.18
Urea = 2.50
LSD (.05) = 0.06
LSD (.01) = 0.09

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 46. Percent calcium in middle leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	2.92	2.85	2.89
Am. Nitrate	33	2.91	2.84	2.88
Urea	33	3.23	3.23	3.23
Sod. Nitrate	100	3.13	3.13	3.13
Am. Nitrate	100	2.94	2.94	2.94
Urea	100	3.26	3.25	3.26
Sod. Nitrate	165	3.12	3.07	3.10
Am. Nitrate	165	3.34	3.33	3.34
Urea	165	3.02	2.92	2.97

Source of Variation	df	SS	MS	F
Rates of N	2	0.0658	0.0329	394.80**
Replications	1	0.0057	0.0057	68.40*
Error a	2	0.0002	0.0001	
Sources of N	2	0.0458	0.0229	24.78**
Sources x Rates	4	0.3533	0.0883	95.55**
Error b	6	0.0055	0.0009	

Means for Rates of N

33 lbs N/A = 3.00
100 lbs N/A = 3.11
165 lbs N/A = 3.14
LSD (.05) = 0.02
LSD (.01) = 0.06

Means for Sources of N

Sodium Nitrate = 3.04
Am. Nitrate = 3.05
Urea = 3.15
LSD (.05) = 0.04
LSD (.01) = 0.06

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

Table 47. Percent calcium in bottom leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	4.34	4.24	4.29
Am. Nitrate	33	4.21	4.15	4.18
Urea	33	4.11	4.12	4.12
Sod. Nitrate	100	4.30	4.16	4.23
Am. Nitrate	100	4.37	4.33	4.35
Urea	100	4.41	4.54	4.48
Sod. Nitrate	165	4.25	4.16	4.21
Am. Nitrate	165	4.44	4.44	4.44
Urea	165	4.35	4.49	4.42

Source of Variation	df	SS	MS	F
Rates of N	2	0.1003	0.0502	30.48*
Replications	1	0.0013	0.0013	0.79
Error a	2	0.0033	0.0016	
Sources of N	2	0.0317	0.0159	2.71
Sources x Rates	4	0.1275	0.0319	5.44*
Error b	6	0.0352	0.0059	

Means for Rates of N

33 lbs N/A = 4.20
100 lbs N/A = 4.35
165 lbs N/A = 4.36
LSD (.05) = 0.10

Means for Sources of N

Sodium Nitrate = 4.24
Am. Nitrate = 4.32
Urea = 4.34
LSD (.05) = NS

*Significant at the 5% level of probability.

Table 48. Percent magnesium in top leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.61	0.58	0.60
Am. Nitrate	33	0.80	0.78	0.79
Urea	33	0.79	0.93	0.86
Sod. Nitrate	100	0.80	0.80	0.80
Am. Nitrate	100	0.79	0.71	0.75
Urea	100	0.81	0.86	0.83
Sod. Nitrate	165	0.83	0.84	0.84
Am. Nitrate	165	0.75	0.82	0.79
Urea	165	0.93	0.84	0.89

Source of Variation	df	SS	MS	F
Rates of N	2	0.0226	0.0113	16.21
Replications	1	0.0001	0.0001	0.14
Error a	2	0.0014	0.0007	
Sources of N	2	0.0436	0.0218	6.57*
Sources x Rates	4	0.0491	0.0123	3.71
Error b	6	0.0199	0.0033	

Means for Rates of N

33 lbs N/A = 0.75
100 lbs N/A = 0.79
165 lbs N/A = 0.84
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.75
Am. Nitrate = 0.78
Urea = 0.86
LSD (.05) = 0.08

*Significant at the 5% level of probability.

Table 49. Percent magnesium in middle leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.93	0.93	0.93
Am. Nitrate	33	0.89	0.80	0.85
Urea	33	1.03	0.96	0.99
Sod. Nitrate	100	1.04	0.97	1.01
Am. Nitrate	100	1.04	0.93	0.99
Urea	100	1.10	0.96	1.03
Sod. Nitrate	165	1.05	0.96	1.01
Am. Nitrate	165	0.95	1.10	1.03
Urea	165	1.11	0.92	1.02

Source of Variation	df	SS	MS	F
Rates of N	2	0.0308	0.0154	8.84
Replications	1	0.0207	0.0207	11.89
Error a	2	0.0035	0.0017	
Sources of N	2	0.0114	0.0057	1.01
Sources x Rates	4	0.0136	0.0034	0.60
Error b	6	0.0340	0.0057	

Means for Rates of N

33 lbs N/A = 0.92
100 lbs N/A = 1.01
165 lbs N/A = 1.02
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.98
Am. Nitrate = 0.95
Urea = 1.01
LSD (.05) = NS

Table 50. Percent magnesium in bottom leaves and analysis of variance for 1983 continuous burley tobacco when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	1.29	1.06	1.18
Am. Nitrate	33	1.35	1.21	1.28
Urea	33	0.90	0.89	0.90
Sod. Nitrate	100	1.36	1.25	1.31
Am. Nitrate	100	1.64	1.48	1.56
Urea	100	1.14	1.05	1.10
Sod. Nitrate	165	1.11	1.06	1.09
Am. Nitrate	165	1.38	1.50	1.44
Urea	165	1.33	1.26	1.30

Source of Variation	df	SS	MS	F
Rates of N	2	0.1361	0.0681	8.90
Replications	1	0.0304	0.0304	3.97
Error a	2	0.0153	0.0077	
Sources of N	2	0.3510	0.1755	43.20**
Sources x Rates	4	0.1517	0.0379	9.33**
Error b	6	0.0244	0.0041	

Means for Rates of N

33 lbs N/A = 1.12
100 lbs N/A = 1.32
165 lbs N/A = 1.28
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 1.19
Am. Nitrate = 1.43
Urea = 1.10
LSD (.05) = 0.09
LSD (.01) = 0.14

**Significant at the 1% level of probability.

Table 51. Percent magnesium in top leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.78	0.84	0.81
Am. Nitrate	33	0.95	0.83	0.89
Urea	33	0.91	0.86	0.89
Sod. Nitrate	100	1.02	0.89	0.96
Am. Nitrate	100	0.81	0.65	0.73
Urea	100	0.80	0.64	0.72
Sod. Nitrate	165	0.54	0.68	0.61
Am. Nitrate	165	0.83	0.75	0.76
Urea	165	0.87	0.71	0.79

Source of Variation	df	SS	MS	F
Rates of N	2	0.0549	0.0275	4.63
Replications	1	0.0228	0.0228	3.84
Error a	2	0.0119	0.0059	
Sources of N	2	0.0007	0.0004	0.06
Sources x Rates	4	0.1261	0.0315	4.91*
Error b	6	0.0385	0.0064	

Means for Rates of N		Means for Sources of N	
33 lbs N/A	= 0.86	Sodium Nitrate	= 0.79
100 lbs N/A	= 0.80	Am. Nitrate	= 0.79
165 lbs N/A	= 0.72	Urea	= 0.80
LSD (.05)	= NS	LSD (.05)	= NS

*Significant at the 5% level of probability.

Table 52. Percent magnesium in middle leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.95	0.94	0.95
Am. Nitrate	33	1.05	0.84	0.95
Urea	33	1.04	0.90	0.97
Sod. Nitrate	100	1.14	0.96	1.05
Am, Nitrate	100	1.04	0.85	0.95
Urea	100	0.81	0.96	0.89
Sod. Nitrate	165	0.84	0.82	0.83
Am. Nitrate	165	0.96	1.40	1.18
Urea	165	0.91	0.87	0.89

Source of Variation	df	SS	MS	F
Rates of N	2	0.0101	0.0051	0.38
Replications	1	0.0174	0.0174	1.30
Error a	2	0.0268	0.0134	
Sources of N	2	0.0070	0.0035	0.56
Sources x Rates	4	0.0514	0.0129	2.07
Error b	6	0.0374	0.0062	

Means for Rates of N

33 lbs N/A = 0.96
100 lbs N/A = 0.96
165 lbs N/A = 0.97
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.94
Am. Nitrate = 1.03
Urea = 0.92
LSD (.05) = NS

Table 53. Percent magnesium in bottom leaves and analysis of variance for 1983 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	1.35	1.05	1.20
Am. Nitrate	33	1.65	1.23	1.44
Urea	33	1.16	0.93	1.05
Sod. Nitrate	100	1.46	1.38	1.42
Am. Nitrate	100	1.73	1.55	1.64
Urea	100	0.94	1.05	1.00
Sod. Nitrate	165	0.92	1.06	0.99
Am. Nitrate	165	1.43	1.28	1.36
Urea	165	1.28	1.24	1.26

Source of Variation	df	SS	MS	F
Rates of N	2	0.0768	0.0384	0.95
Replications	1	0.0735	0.0735	1.81
Error a	2	0.0811	0.0406	
Sources of N	2	0.4589	0.2294	26.29**
Sources x Rates	4	0.2730	0.0429	4.92
Error b	6	0.0523	0.0087	

Means for Rates of N

33 lbs N/A = 1.23
100 lbs N/A = 1.35
165 lbs N/A = 1.20
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 1.20
Am. Nitrate = 1.48
Urea = 1.10
LSD (.05) = 0.13
LSD (.01) = 0.20

**Significant at the 1% level of probability.

Table 54. Percent magnesium in top leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.68	0.73	0.71
Am. Nitrate	33	0.84	0.81	0.83
Urea	33	0.92	0.93	0.93
Sod. Nitrate	100	0.91	0.97	0.94
Am. Nitrate	100	0.76	0.82	0.79
Urea	100	0.77	0.75	0.76
Sod. Nitrate	165	0.76	0.82	0.79
Am. Nitrate	165	0.79	0.83	0.81
Urea	165	0.84	0.79	0.82

Source of Variation	df	SS	MS	F
Rates of N	2	0.0019	0.0009	4.38
Replications	1	0.0018	0.0018	8.76
Error a	2	0.0004	0.0002	
Sources of N	2	0.0022	0.0011	0.92
Sources x Rates	4	0.0842	0.0211	17.61**
Error b	6	0.0072	0.0012	

Means for Rates of N

33 lbs N/A = 0.82
100 lbs N/A = 0.83
165 lbs N/A = 0.81
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 0.81
Am. Nitrate = 0.86
Urea = 0.84
LSD (.05) = NS

**Significant at the 1% level of probability.

Table 55. Percent magnesium in middle leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	0.92	0.96	0.94
Am. Nitrate	33	0.97	0.95	0.96
Urea	33	0.96	0.97	0.97
Sod. Nitrate	100	1.06	1.13	1.10
Am. Nitrate	100	0.97	0.93	0.95
Urea	100	0.92	0.97	0.95
Sod. Nitrate	165	0.94	0.95	0.95
Am. Nitrate	165	1.03	1.05	1.04
Urea	165	0.96	0.95	0.96

Source of Variation	df	SS	MS	F
Rates of N	2	0.0053	0.0026	14.40
Replications	1	0.0009	0.0009	4.98
Error a	2	0.0004	0.0002	
Sources of N	2	0.0047	0.0024	3.16
Sources x Rates	4	0.0359	0.0090	11.87**
Error b	6	0.0045	0.0008	

Means for Rates of N

33 lbs N/A = 0.96
100 lbs N/A = 1.00
165 lbs N/A = 0.98
LSD (.05) = NS

Means for Sources of N

Sodium Nitrate = 1.00
Am. Nitrate = 0.98
Urea = 0.96
LSD (.05) = NS

**Significant at the 1% level of probability.

Table 56. Percent magnesium in bottom leaves and analysis of variance for 1984 burley tobacco grown after sod when fertilized with different sources and rates of sidedress nitrogen.

Sources of N	lbs N/A	Replication 1	Replication 2	Average
Sod. Nitrate	33	1.21	1.13	1.17
Am. Nitrate	33	1.35	1.28	1.32
Urea	33	1.03	1.05	1.04
Sod. Nitrate	100	1.27	1.26	1.27
Am. Nitrate	100	1.55	1.52	1.54
Urea	100	1.03	1.05	1.04
Sod. Nitrate	165	1.02	1.12	1.07
Am. Nitrate	165	1.36	1.34	1.35
Urea	165	1.24	1.15	1.20

Source of Variation	df	SS	MS	F
Rates of N	2	0.0351	0.0176	23.47*
Replications	1	0.0014	0.0014	1.87
Error a	2	0.0015	0.0008	
Sources of N	2	0.3092	0.1546	70.07**
Sources x Rates	4	0.0909	0.0227	10.29**
Error b	6	0.0132	0.0022	

Means for Rates of N

33 lbs N/A = 1.18
100 lbs N/A = 1.28
165 lbs N/A = 1.21
LSD (.05) = 0.07

Means for Sources of N

Sodium Nitrate = 1.17
Am. Nitrate = 1.40
Urea = 1.09
LSD (.05) = 0.07
LSD (.01) = 0.10

*Significant at the 5% level of probability.

**Significant at the 1% level of probability.

VITA

Ahmed Azhar Jaafar was born in Kelantan, Malaysia, on February 5, 1955. He attended primary and high school in Kota Bharu, Kelantan. In 1976, he graduated from the University of Agriculture, Malaysia with a Diploma of Agriculture. He was employed with the Malaysian Agricultural Research and Development Institute (MARDI).

He attended Iowa State University in January 1982 and received his Bachelor of Science degree in Agronomy in December 1983. In January 1984, he entered The University of Tennessee, Knoxville and in March 1986 received his Master of Science degree with a major in Plant and Soil Science.

He is married to Maziah Abdullah of Kota Bharu, Kelantan. They have one daughter, Nadia Azura Ahmed Azhar.