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To the Graduate Council:

I am submitting herewith a thesis written by Billy M. Greene entitled "The Effect of Nitrogen Fertilization on Yield, HCN Potential, and Nitrate Nitrogen Content of Three Varieties of Sorghum." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

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Major Professor

We have read this thesis and recommend its acceptance:

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THE EFFECT OF NITROGEN FERTILIZATION ON YIELD, HCN POTENTIAL, AND NITRATE NITROGEN CONTENT OF THREE VARIETIES OF SORGHUM

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Billy M. Greene

August 1968

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To the following people I wish to express my gratitude and appreciation:

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ABSTRACT

The effect of nitrogen fertilization on yield, hydrocyanic acid potential (HCN-p), and nitrate nitrogen accumulation was studied in three varieties of sorghum in 1966. The five nitrogen treatments used in this field study at Knoxville were: N_0 which received no applied nitrogen, N_1 which received 54 kg. of nitrogen per ha. at planting, N_2 which received 27 kg. per ha. at planting and 27 kg. after the second harvest, N_3 which received 108 kg. per ha. at planting, and N_4 which received 27 kg. per ha. of nitrogen at planting and 27 kg. after each of the first three harvests. The plants were cut to a 20 cm. stubble height each time they reached a height of 75 cm. and analyzed for yield, HCN-p, and nitrate nitrogen content.

The sodium picrate method was used for determining HCN-p, and the official A.O.A.C. phenoldisulfonic acid method was used for nitrate nitrogen determinations.

Yield was attected more by the distribution of nitrogen application than by the total amount applied. However, plants receiving some nitrogen at any time during the growing season produced higher yields than plants receiving no applied

nitrogen. Suhi-1 produced significantly higher yields than Greenleaf or Piper in this study.

HCN-p was affected by nitrogen fertilization. In general, higher nitrogen rates produced higher levels of HCN in the plants. Split nitrogen applications produced higher season averages of HCN than the same total amounts applied only at planting; however, the highest harvest readings occurred in plants receiving all their nitrogen at planting. Suhi-1 was the only variety which consistently produced HCN levels that would be considered dangerous (above 800 ppm).

The data were inconclusive as to nitrate accumulations. The range of the readings was from 1475 to 3750 ppm. No trends or patterns were detected.

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CHAPTER I

INTRODUCTION

Sorghums are an important source of annual summer forage in Tennessee. Tolerance to drought and high productive capacity account for increased utilization of sorghums (14). Increased yields of sorghum have resulted from the development of high yielding sorghum and sudangrass hybrids and improved management practices. In order to obtain high yields it has been necessary to apply high levels of nitrogen. Experimental work has shown that increased nitrogen fertilization results not only in increased yields, but also in increased hydrocyanic acid (HCN) and nitrate nitrogen content of the plants. Research has also shown that sorghum x sudangrass varieties are higher in HCN than sudangrass. Both HCN and nitrate nitrogen are toxic to livestock under certain conditions. The objective of this study was to determine the effect of nitrogen fertilization on yield, HCN potential, and nitrate nitrogen accumulation in forage sorghums.

CHAPTER II

REVIEW OF LITERATURE

I. EFFECT OF NITROGEN FERTILIZATION ON YIELD

The literature relating to nitrogen fertilization of different grass species is extensive. However, literature directly related to nitrogen fertilization of sundangrass and forage sorghums is limited.

The application of nitrogen fertilizer to pure stands of grass has been shown to increase yields on most soils (5,25). Broyles and Fribourg (5) studied two varieties of sudangrass and found that increases in nitrogen fertilizer from zero to 120 pounds per acre resulted in a corresponding increase in dry matter yields of the harvested forage. Tucker *et al*. (24) produced forage sorghums at nitrogen fertilization rates of zero to 800 pounds per acre. Dry matter production increased up to the 400 pound per acre rate. More green forage material was produced at the 800 than at the 400 pounds per acre rate, but the 400 pounds per acre rate produced more dry matter. Jung and Reid (15) reported increased yields in sudangrass for each increment of nitrogen fertilization from zero to 300 pounds of nitrogen per acre.

They reported that the increased yields at the lower nitrogen levels were due to increased tillering; whereas, increased yields at the higher nitrogen levels resulted from increased tillering and also increased growth rate. Sumner, Martin, and Echegaray (21) grew Piper sudangrass at nitrogen levels of zero to 500 pounds per acre and found that increased nitrogen fertilization to 300 pounds per acre resulted in increased yields.

II. EFFECT OF NITROGEN FERTILIZATION ON HCN

The HCN potential of sorghum plants is affected by fertilization. Willaman and West (28) found that the addition of nitrogen fertilizer to soils low in natural fertility increased the HCN potential of plants grown on those soils. However, there was very little response when nitrogen was added to soils high in natural fertility. Boyd et al. (4) stated that the addition of nitrogen fertilizers to soils deficient in nitrogen increased the HCN content of sudangrass and sorghum plants grown on those soils. Similar treatment of soils well supplied with nitrogen had little effect on the HCN content of the plants. They also found that when adequate amounts of phosphorus were present in the soil the HCN potential of the sorghum plants was reduced. Franzke and

Hume (9) reported that the application of stall manure decreased the HCN potential of sorghum plants. They also found that the HCN content was invariably lower in plants from plots receiving acid phosphate than from corresponding plots receiving no acid phosphate.

Patel and Wright (20) grew sudangrass in nutrient solutions under greenhouse conditions to determine the effect of nitrogen, phosphorus, and potassium on HCN potential. They found that high levels of nitrogen (364 ppm), when associated with either low (15.5 ppm) or optimum (31 ppm) levels of phosphorus, resulted in significant increases in HCN potential. Potassium had no effect on the HCN potential of the sudangrass plants. Nelson (19) reported that, regardless of moisture level and stage of growth, HCN potential was always higher when associated with increased amounts of nitrogen. Jung and Reid (15) reported increased HCN potential as a result of increased nitrogen fertilization.

III. EFFECT OF NITROGEN FERTILIZATION ON NITRATE NITROGEN

Numerous investigators have established a direct relationship between nitrogen fertilization and nitrate nitrogen accumulation in forage crops (1,6,16,29,30); however, information relating to forage sorghums and sudangrass is less abundant.

Sumner *et al*. (21) reported increased nitrate nitrogen accumulation in Piper sudangrass as a result of nitrogen fertilization. Plants receiving 200 pounds of nitrogen per acre contained an average of 1.39 percent nitrate nitrogen. Gilbert *et al*. (12) stated that toxic amounts of nitrates in forage sorghums appeared only under certain conditions, such as early growth or high nitrate levels in the soil.

Murphy and Smith (18) investigated nitrate accumulations in nine forage species over a two year period. They stated that sudangrass was by far the most persistent accumulator of nitrate nitrogen of the species studied. Their work also revealed a direct relationship between the nitrate nitrogen accumulation of sudangrass and the rate of nitrogen fertilization. Burger and Hittle (7) grew three sorghum x sudangrass hybrids, one sudangrass hybrid, three pearl millet hybrids, and Piper sudangrass using 200 pounds of nitrogen per acre. During this two-year study, the nitrate nitrogen accumulation in these forages ranged from 1342 ppm to 4039 ppm.

CHAPTER III

MATERIALS AND METHODS

The sudangrass (Sorghum sudanense (Piper) Stapf.) and sorghum (Sorghum vulgare Pers.) x sudangrass varieties used in this study were grown at Knoxville on an Etowah silt loam soil in 1966. A split-plot design in which main-plots were nitrogen treatments, and split-plots were varieties was used. Main treatments were replicated four times. An experimental unit consisted of one 3.4 m. row.

The varieties used in this study were 'Greenleaf', 'Piper', and 'Suhi-1'. Descriptions of the varieties are given in Table I. These varieties were chosen because they represent a range of low to high HCN potential. Piper is generally considered low, Greenleaf intermediate, and Suhi-1 high in HCN potential.

The varieties were seeded during the third week of May at the rate of 28 kg. per ha. in rows spaced 1 m. apart. Prior to planting, 0-20-20 fertilizer was incorporated into the soil at the rate of 268 kg. per ha. Nitrogen applications of ammonium nitrate were applied as five treatments. Treatment one received no applied nitrogen. Treatment two

TABLE I

DESCRIPTIONS OF SUDANGRASS AND SORGHUM x SUDANGRASS VARIETIES

Variety	Origin	Apparent characteristic
Greenleaf	Kansas State Univ.	Sudangrass type
Piper	Univ. of Wisconsin	Sudangrass type
Suhi-1	Univ. of Georgia	Sorghum x Sudangrass type

Source: Benson, J. A. Estimating hydrocyanic acid potential of sorghum plants from leaf samples. Master's Thesis, University of Tennessee, 1964.

received 54 kg. per ha. nitrogen at planting. Treatment three also received 54 kg. per ha. of nitrogen--27 kg. per ha. at planting and 27 kg. per ha. after the second cutting. Treatment four received 108 kg. per ha. of nitrogen at planting. Treatment five received 108 kg. per ha. of nitrogen--27 kg. at planting and 27 kg. after each of the first three cuttings. Hereafter these treatments will be referred to as N_0, N_1, N_2, N_3, and N_4, respectively. Plants were cut to a height of 20 cm. each time they reached a height of 75 cm. during the test period.

When the average height of all the plants within a treatment was approximately 75 cm., five plants were selected at random from each row. The plants were immediately taken to the laboratory for analysis. The remaining plants were harvested and dried to obtain yield information.

I. ESTIMATION OF HCN POTENTIAL

Plants from the four cuttings were analyzed for HCN potential using a modified version of the method used by Anderson et al. (2) at Wisconsin. Each plant was chopped into sections smaller than 1x1 cm. with a paper cutter. The chopped material from each plant was mixed thoroughly, and two samples from each plant were weighed on a closed Torsion balance to the nearest hundredth of a gram. Sample weights were approximately 0.5g. Each sample was placed in a 150 x 15 mm. test tube, and chloroform was added with a medicine dropper until the plant tissue was thoroughly moistened (10 drops). A strip of filter paper saturated with sodium picrate solution was then suspended above the sample by a rubber stopper. The tubes were allowed to stand for approximately 24 hours at room temperature before the filter paper strips were removed and immersed in 25 ml. of distilled water in a colorimeter tube. The filter paper strips were allowed to soak for approximately 20 minutes and were stirred gently two or three times to aid extraction of the colored material. After the filter paper was removed the tubes were placed in a Fisher Electrophotometer with a 525 mμ filter and the light absorbance was read. Another strip of filter paper saturated with sodium picrate solution was placed in the tubes, and the entire process was repeated. This gave two readings for each sample. The two readings were added together to give the total HCN potential for each sample. The total readings were then substituted into the equation prepared from the standard curve to determine the HCN content of each sample.

The standard curve was developed using a mixture prepared by combining 50 ml. of a cyanide solution containing

0.241 g. KCN per liter of water with 50 ml. of an alkaline picrate solution containing 25 g. Na_2CO_3 and 5 g. of picric acid per liter of water. Aliquots of this mixture were then dispensed into tubes in increasing amounts to give increasing concentrations of HCN. Light absorption was read using a Fisher Electrophotometer with a 525 mμ filter. A linear regression was calculated for colorimeter readings and concentrations to give "a" and "b" values to be used in the regression equation, $Y = a + bx$. The "a" value was -.44 and the "b" value was 14.86 for the solution.

II. ESTIMATION OF NITRATE NITROGEN

The portion of each plant remaining after the two samples for HCN analysis were taken was dried for calculating dry matter percentages and to be used for nitrate nitrogen analysis. This dried material was ground into a fine powder using a Micro-Wiley mill. Due to the time and difficulty involved in the nitrate nitrogen analysis, the five plants from each row and the four replications of each treatment were grouped together. Two 0.1 g. samples from each variety at each nitrogen level and harvest were weighed on a closed torsion balance. The samples were then placed in 25 ml. of distilled, boiling water to extract the nitrate nitrogen.

The samples were analyzed for nitrate nitrogen using a modified version of the phenoldisulfonic acid method of analysis.[1]

The 25 ml. samples were filtered, and the filtrates were evaporated to dryness in evaporation dishes on a hot plate. Each sample was then treated with 2 ml. of phenoldisulfonic acid solution, diluted into 250 ml. of distilled water, and treated with ammonium hydroxide until the maximum color was developed. A portion of the diluted material was then transferred into a 25 ml. colorimeter tube, and light absorbency was read in a Fisher Electrophotometer using a 425 mμ filter. The readings were substituted into a standard curve to determine the nitrate nitrogen content of each sample.

The standard curve was developed using a mixture prepared by evaporating 50 ml. of a nitrate solution containing 0.607 g. of pure $NaNO_3$ per liter of water. The evaporated material was then treated with 2 ml. of phenoldisulfonic acid solution and diluted in 500 ml. of distilled water. One ml. of this solution contained 0.044 mg. of nitrate nitrogen. The standard was prepared by adding ammonium hydroxide to measured

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[1] Methods of Analysis. A.O.A.C. Tenth Edition. 1965.

volumes of the standard solution and reading the light absorbance on the Fisher Electrophotometer with a 425 mμ filter. A standard curve was plotted using colorimeter readings for known concentrations of nitrate nitrogen.

CHAPTER IV

RESULTS AND DISCUSSION

I. YIELD

Total yield was affected more by the distribution of nitrogen applications than by the total amounts of nitrogen applied. The N_4 treatment produced the highest yield of dry matter with 7.68 metric tons per ha. (Table II); however, this was not significantly higher than the N_2 yield of 7.04 tons per ha. The N_4 treatment was significantly higher in yield than the N_3, N_1, and N_0 treatments which produced yields of 6.35, 6.03, and 5.65 metric tons per ha., respectively. The N_2 yield was not significantly higher than the N_3, but it was significantly higher than the N_1 and N_0 yields. The N_3, N_1, and N_0 yields were not significantly different.

At the first two harvest dates, the rate of nitrogen fertilization appeared to have no influence upon yield of dry matter. This may have been due to residual nitrogen in the soil. At the later harvest dates, the response to nitrogen treatment was more apparent. The treatments which received nitrogen applications only at planting produced less

TABLE II

DRY MATTER PRODUCTION (METRIC TONS/HA.) OF THREE VARIETIES OF SORGHUM GROWN UNDER FIVE NITROGEN TREATMENTS IN 1966

Nitrogen Treatment	Harvest Number	Greenleaf	Piper	Suhi-1	Average	
		Harvest				
N_0*	1	1.70	2.18	1.80	1.89	
	2	1.47	1.86	1.86	1.73	
	3	.62	.72	.97	.77	
	4	1.01	.97	1.79	1.26	
Total		4.80	5.73	6.42	5.65	c**
N_1	1	1.88	1.94	1.75	1.86	
	2	1.60	2.11	2.00	1.90	
	3	.86	.97	1.37	1.07	
	4	1.07	.80	1.72	1.20	
Total		5.41	5.82	6.84	6.03	c
N_2	1	2.08	2.75	2.46	2.42	
	2	1.46	1.56	1.68	1.57	
	3	.90	.94	1.50	1.12	
	4	1.45	1.05	3.30	1.93	
Total		5.89	6.30	8.94	7.04	ab
N_3	1	1.87	2.04	2.18	2.03	
	2	.90	1.33	1.61	1.28	
	3	1.06	1.04	1.75	1.29	
	4	1.43	.93	2.90	1.75	
Total		5.26	5.34	8.44	6.35	bc
N_4	1	2.50	2.18	2.43	2.36	
	2	1.67	1.80	1.90	1.79	
	3	1.09	1.20	2.20	1.50	
	4	1.62	1.10	3.36	2.03	
Total		6.88	6.28	9.89	7.68	a
Variety Average		5.65 b**	5.89 b	8.11 a		

*N_0-no applied N. N_1-54 kg. of N at planting. N_2-27 kg. N after second harvest. N_3-108 kg. N at planting. N_4-27 kg. at planting, 27 kg. N after each of the first three harvests.

**Duncan's Multiple Range Test at .05 level of probability.

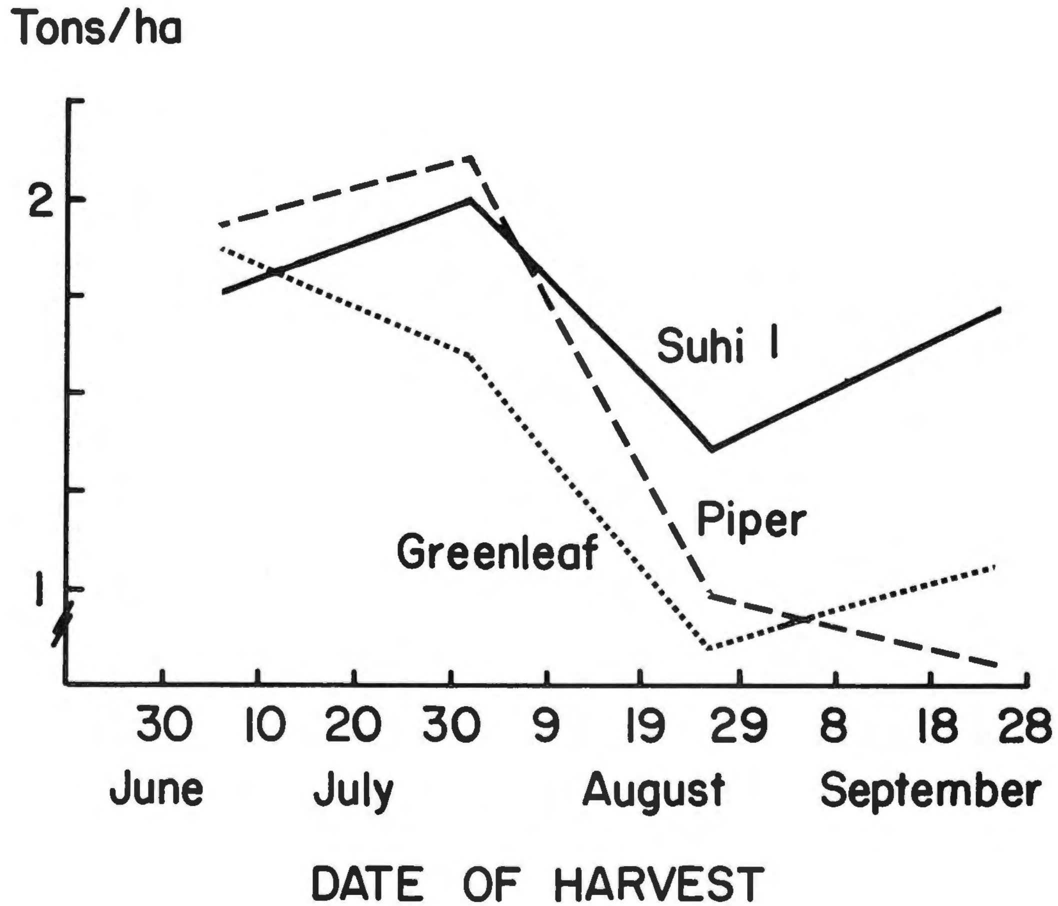

Figure 2. Dry matter production of three varieties of sorghum receiving 54 kg. of nitrogen per ha. at planting (N_1).

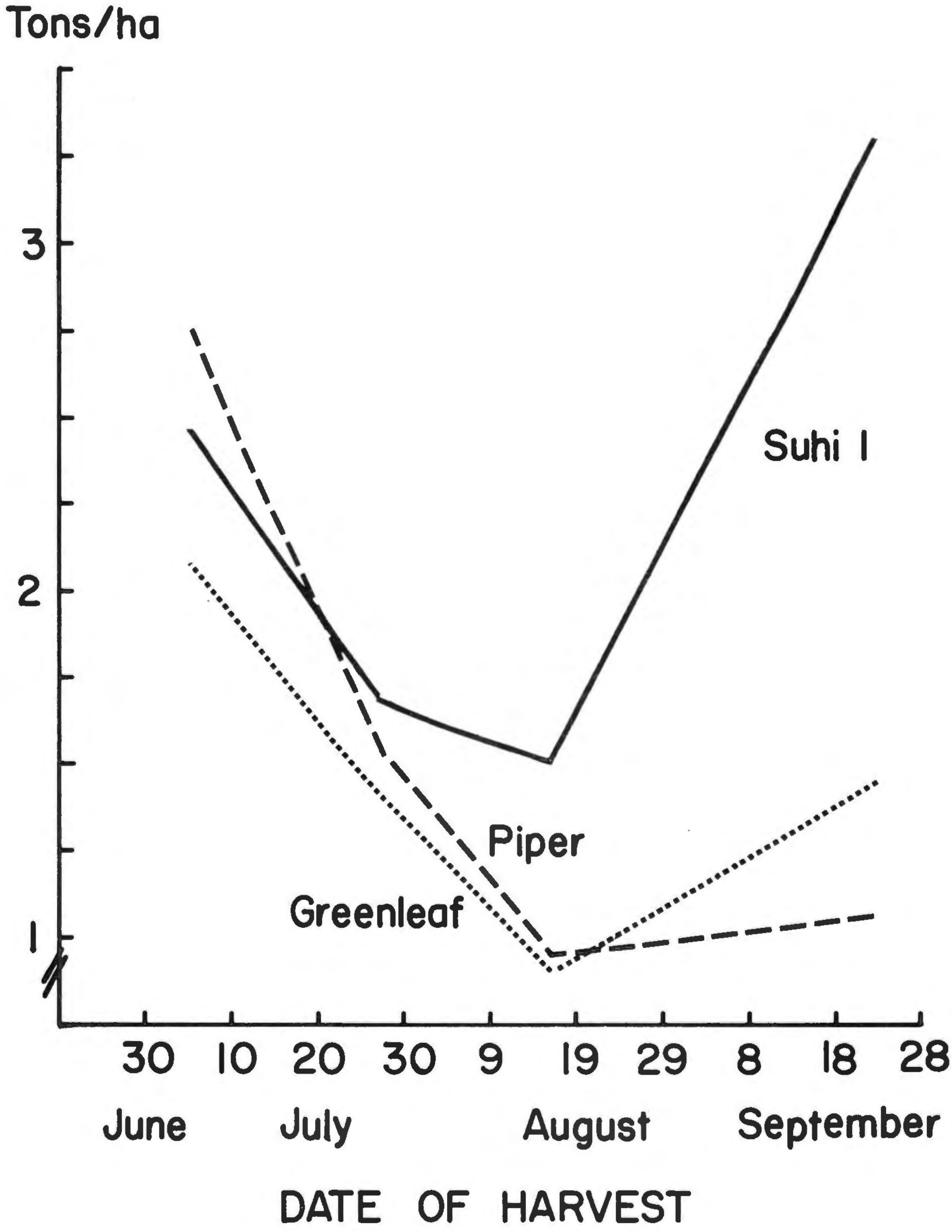

Figure 3. Dry matter production of three varieties of sorghum receiving 27 kg. of nitrogen per ha. at planting and 27 kg. after the second harvest (N_2).

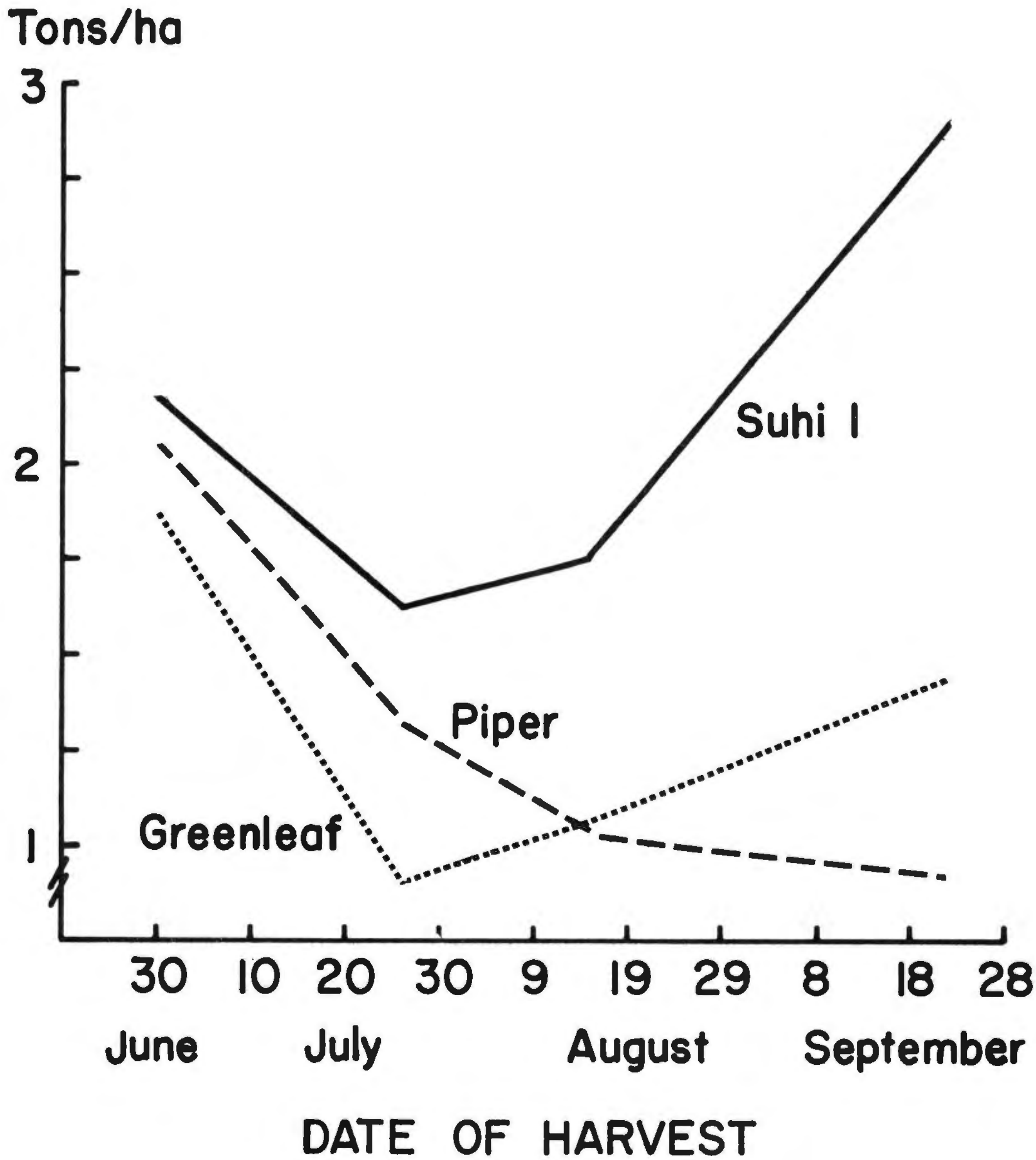

Figure 4. Dry matter production of three varieties of sorghum receiving 108 kg. of nitrogen per ha. at planting (N_3).

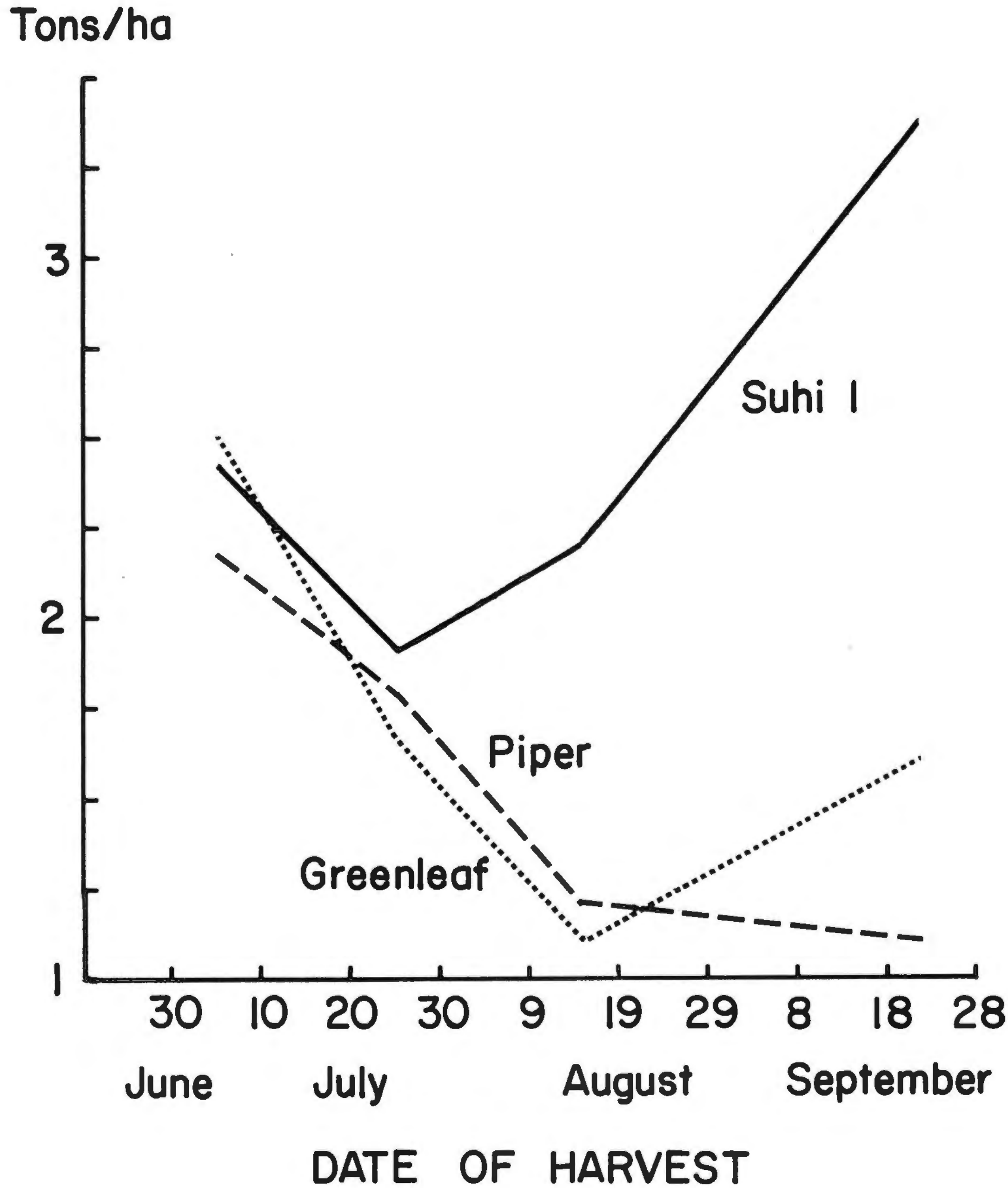

Figure 5. Dry matter production of three varieties of sorghum receiving 27 kg. of nitrogen per ha. at planting and 27 kg. after each of the first three harvests (N_4).

TABLE III

HCN-p (ppm DRY WEIGHT) OF THREE VARIETIES OF SORGHUM GROWN UNDER FIVE NITROGEN TREATMENTS IN 1966

Nitrogen Treatment	Harvest Number	Variety: Greenleaf	Variety: Piper	Variety: Suhi-1	Average
N_0*	1	414±81**	208±31	717±63	446±36
	2	496±75	215±51	1072±68	594±69
	3	383±16	69±6	717±22	390±42
	4	135±25	77±13	379±47	197±21
Average		356	142	721	407±28
N_1	1	325±27	210±31	751±69	428±41
	2	694±69	278±52	1387±113	786±83
	3	534±32	99±8	1052±38	562±60
	4	112±16	102±16	379±65	197±23
Average		416	172	892	493±35
N_2	1	743±67	295±48	1317±103	785±71
	2	681±52	438±70	1025±64	715±51
	3	759±69	389±103	1251±107	800±83
	4	175±24	92±10	456±57	241±25
Average		590	303	1012	635±36
N_3	1	807±75	453±72	1411±89	890±74
	2	692±73	478±65	1132±82	768±64
	3	728±46	359±33	1022±74	703±60
	4	132±23	131±26	407±58	224±33
Average		590	355	993	646±37
N_4	1	954±116	383±55	1198±150	870±92
	2	752±54	457±60	1268±104	826±64
	3	708±94	272±42	918±63	632±69
	4	228±32	102±20	750±87	360±50
Average		660	303	1033	666±40

*N_0-no applied N. N_1-54 kg. of N at planting. N_2-27 kg. N at planting, 27 kg. N after second harvest. N_3-108 kg. N at planting. N_4-27 kg. at planting, 27 kg. N after each of the first three harvests.

**$\bar{x} \pm t_{.05}\, s_{\bar{x}}$.

trend appeared in comparing the N_2 treatment with the N_1 treatment. This seems to indicate that high rates of nitrogen applied only at planting may cause higher levels of HCN than similar amounts applied in split applications.

Individual harvest-variety averages may also be seen in Table III. The season averages for Piper, Greenleaf, and Suhi-1 were 255.3, 522.6, and 930.5 ppm, respectively. These variety differences in HCN potential were consistent throughout the growing season. Comparisons of the three varieties at different nitrogen levels throughout the growing season are shown in Figures 6 through 10. HCN levels were much lower at the fourth harvest than at the other three. The highest levels occurred at the second cutting. In general, HCN levels decreased as the season progressed.

The importance of HCN levels is determined by their potential toxicity to livestock. The amount of HCN required to kill an animal depends upon several factors. Van der Walt (26) stated that HCN poisoning varied with quantity of the plant ingested, previous diet of the animal, pH of the stomach contents, percentage of HCN present in a free state in the plant, concentration of cyanide liberating enzyme, and total HCN content of the plant. Couch (8) stated that the minimum lethal dose for cattle is about 2.042 mg. per kg. of

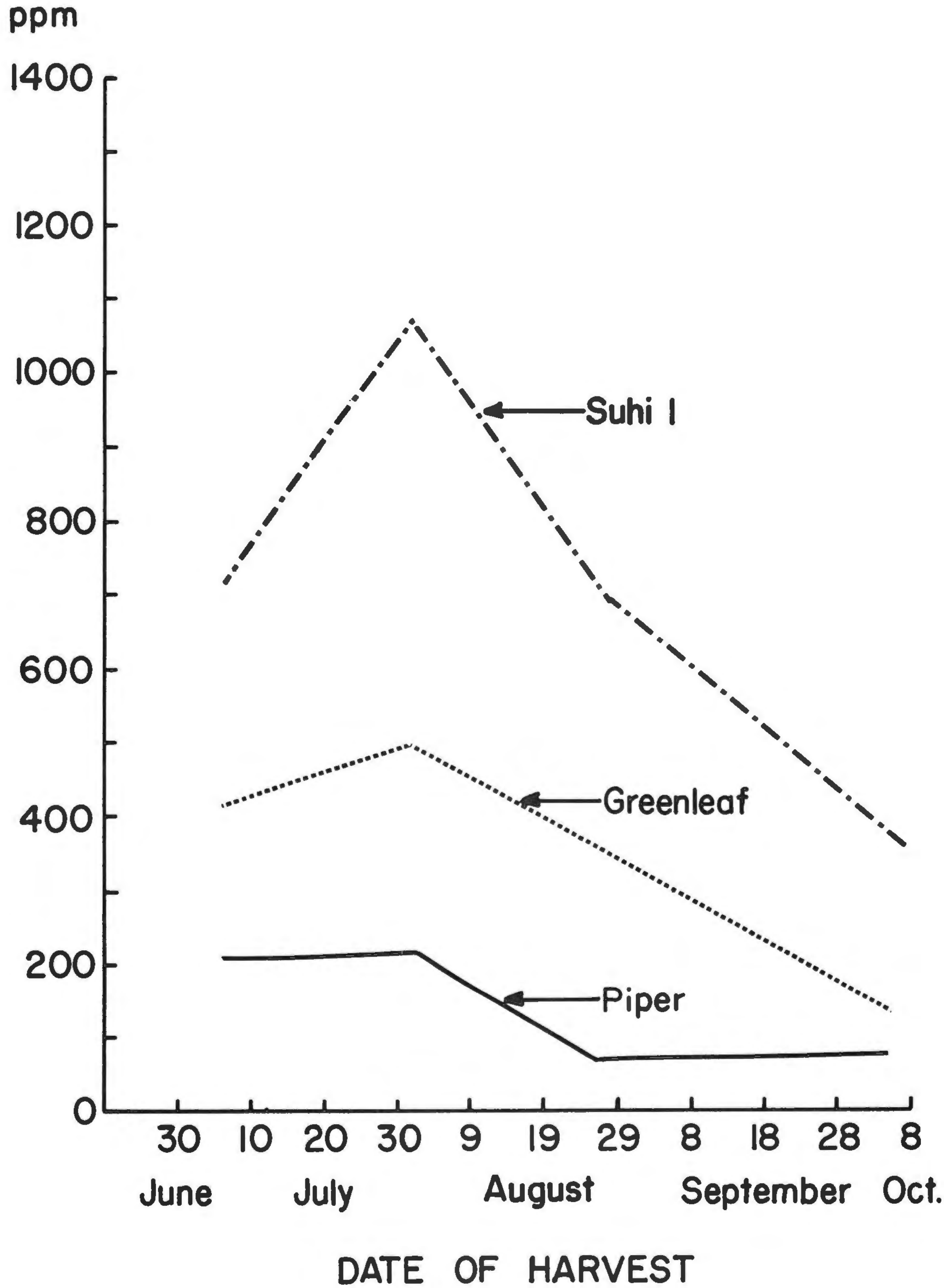

Figure 6. HCN-p of three varieties of sorghum receiving no applied nitrogen (N_o).

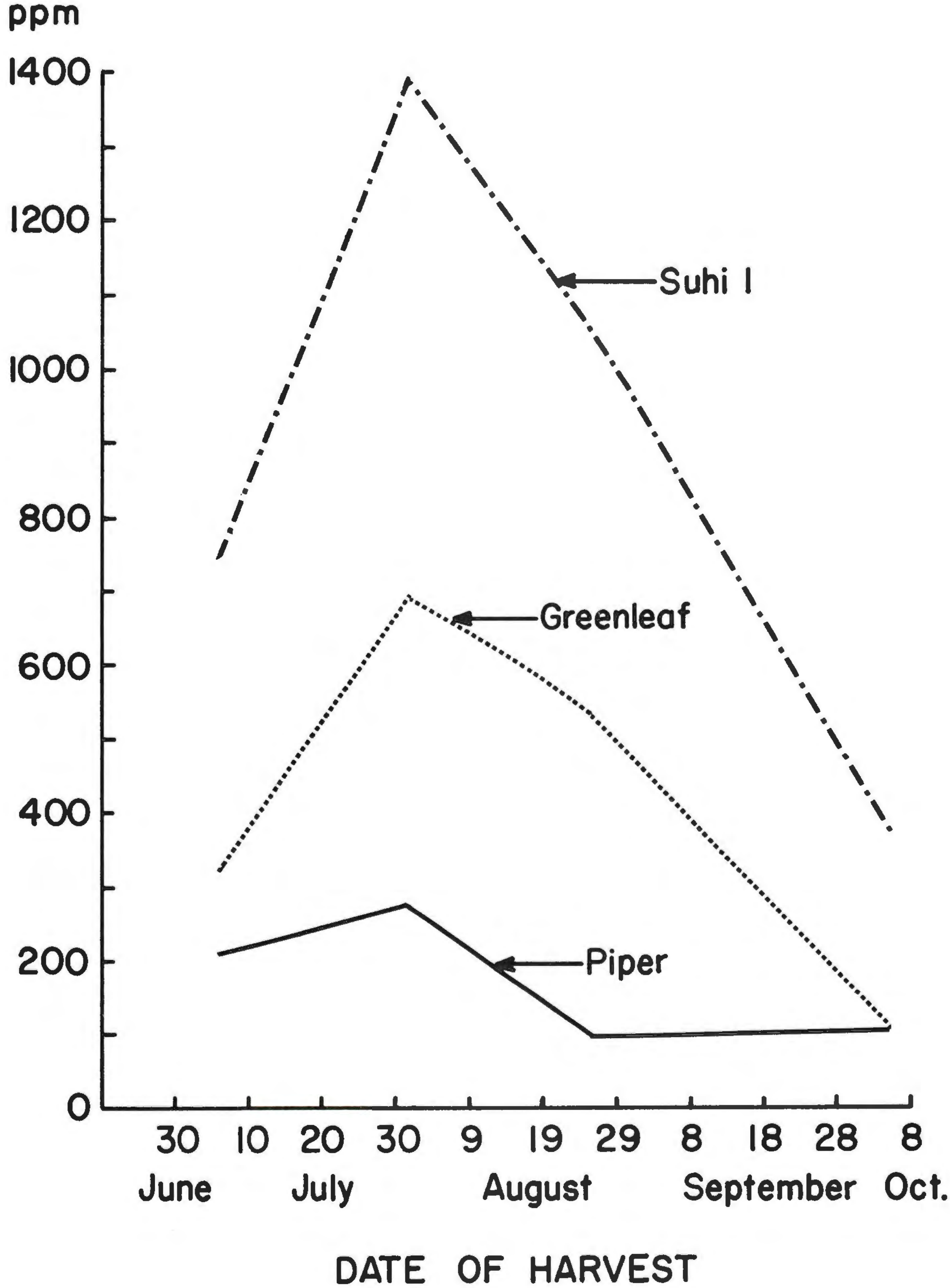

Figure 7. HCN-p of three varieties of sorghum receiving 54 kg. of nitrogen per ha. at planting (N_1).

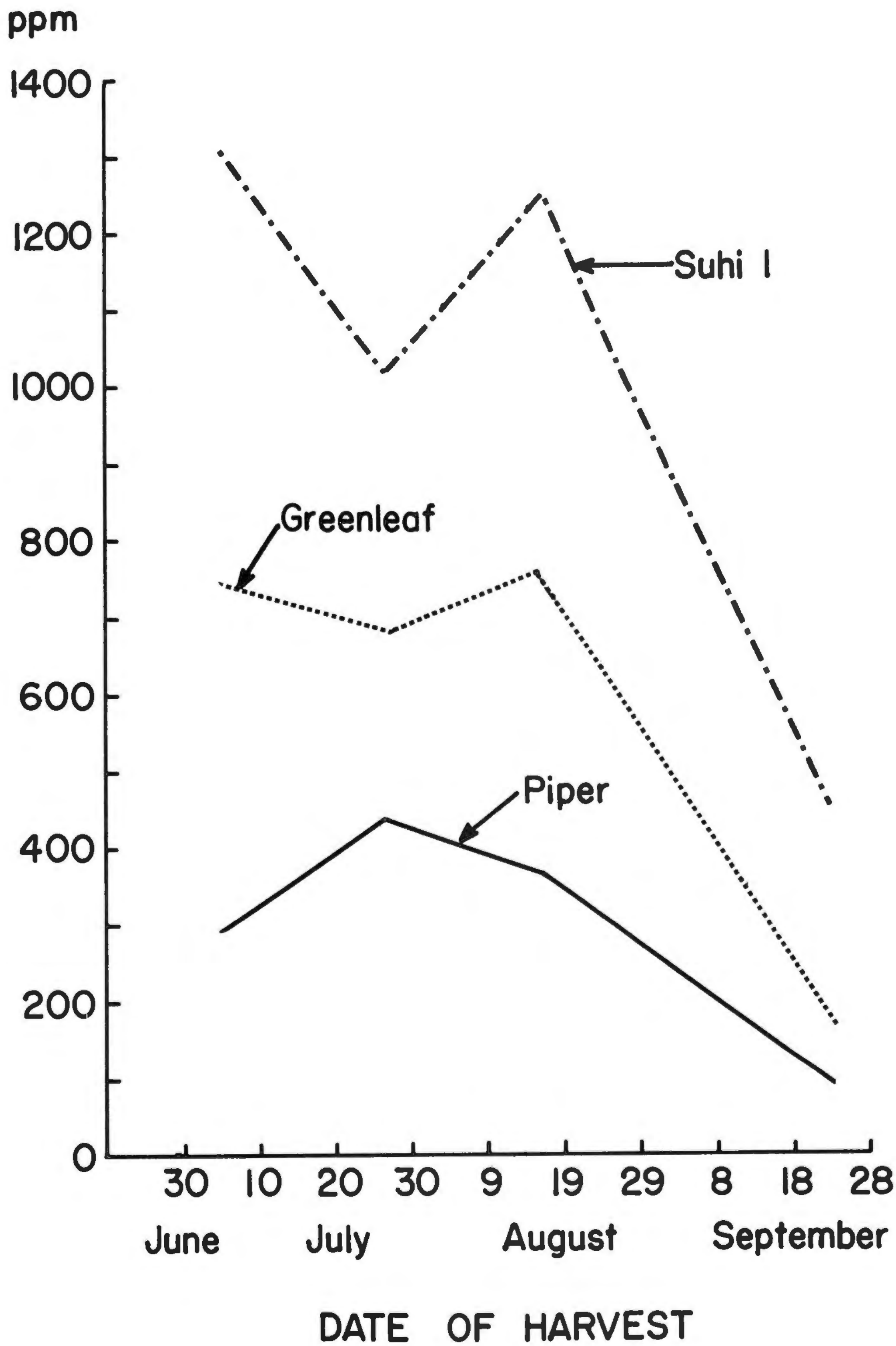

Figure 8. HCN-p of three varieties of sorghum receiving 27 kg. of nitrogen per ha. at planting and 27 kg. after the second harvest (N_2).

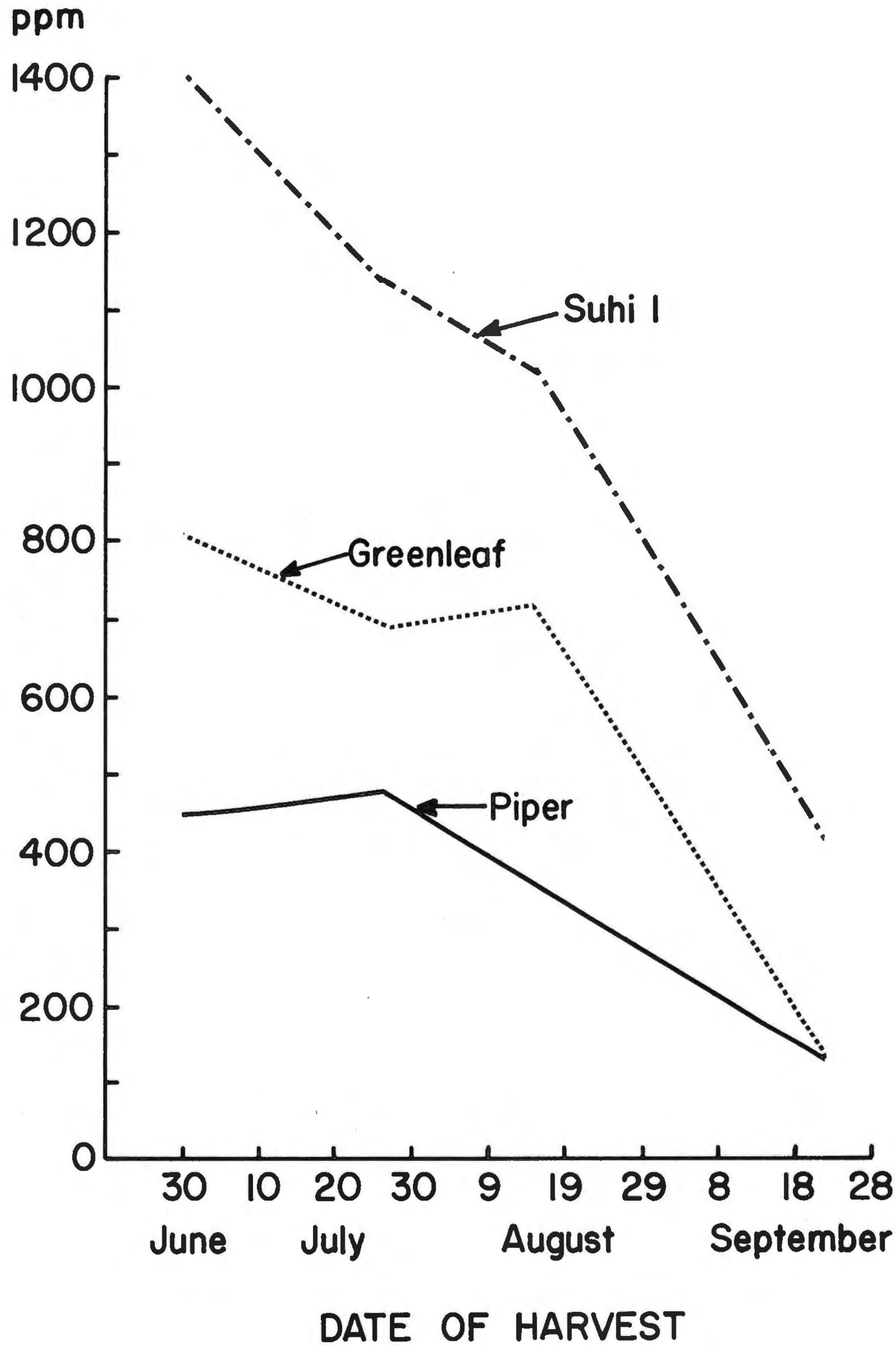

Figure 9. HCN-p of three varieties of sorghum receiving 108 kg. of nitrogen per ha. at planting (N_3).

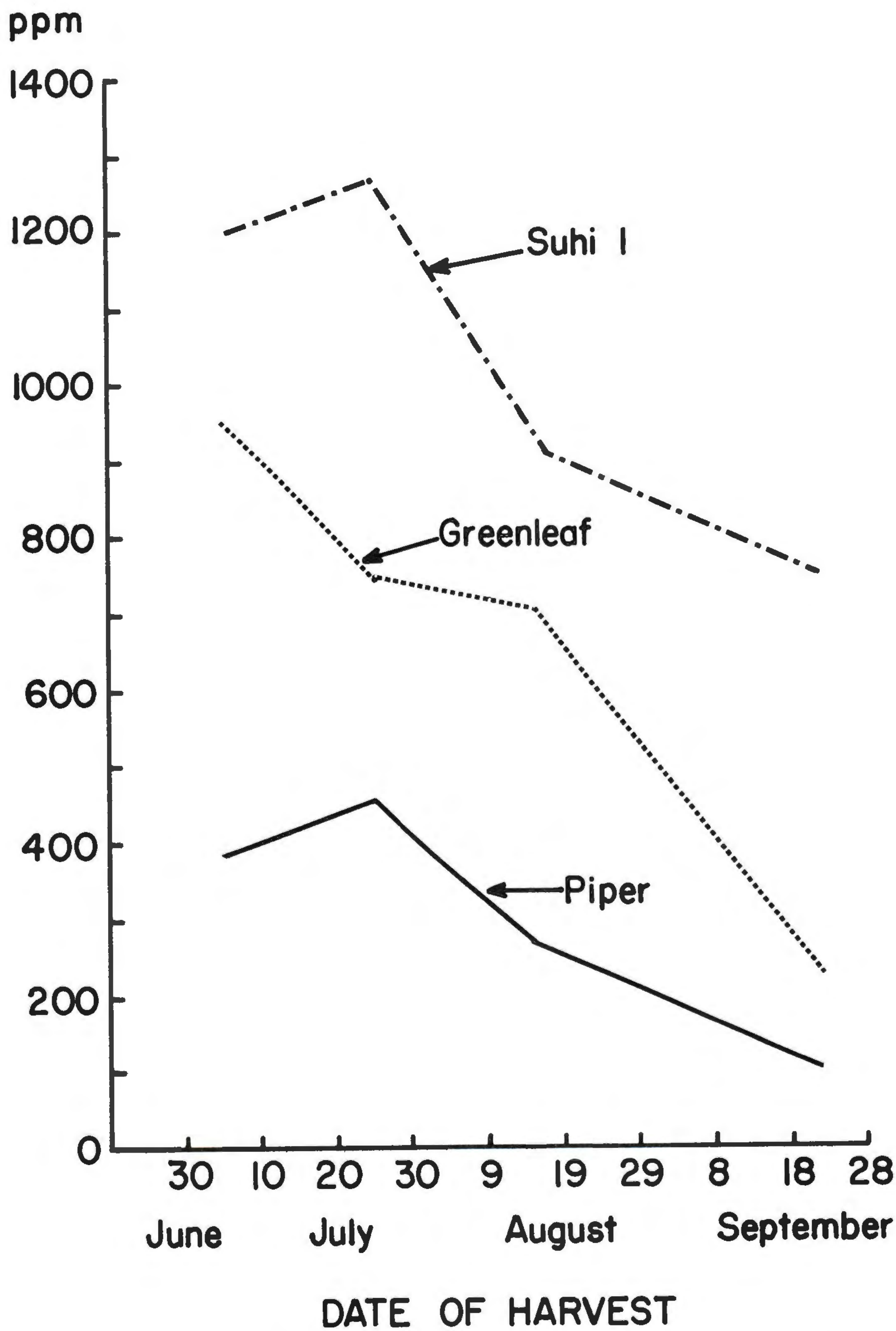

Figure 10. HCN-p of three varieties of sorghum receiving 27 kg. of nitrogen per ha. at planting and 27 kg. after each of the first three harvests (N_4).

body weight. Boyd (4) concluded that HCN potentials between 800 and 1000 ppm (dry matter) were dangerous, and those above 1000 ppm were very dangerous.

Only the N_3 and N_4 nitrogen treatments produced individual cutting averages of HCN which reached dangerous levels. Piper, Greenleaf, and Suhi-1 averaged 890.3 ppm at the first harvest of the N_3 nitrogen level. The varieties averaged 869.9 ppm for the first harvest and 825.7 ppm for the second harvest at the N_4 level. Suhi-1 was the only variety which consistently produced dangerous levels of HCN.

III. NITRATE NITROGEN CONTENT

The results were inconclusive as to the effect of nitrogen fertilization upon the nitrate content of the plants. The season averages for the different nitrogen treatments are shown in Table IV. There was no significant difference in nitrate content of the plants due to nitrogen fertilization or variety. The season distributions of nitrate content of the three varieties at different nitrogen treatments are shown in Figures 11 through 15.

The range in nitrate content in this study was from 1475 ppm to 3750 ppm. This range is similar to that reported by Burger and Hittle (7). The 1475 ppm reading was recorded

TABLE IV

NO_3-N CONTENT (ppm DRY WEIGHT) OF THREE VARIETIES OF SORGHUM GROWN UNDER FIVE NITROGEN TREATMENTS IN 1966

Nitrogen Treatment	Harvest Number	Variety: Greenleaf	Piper	Suhi-1	Average
N_0*	1	2575	2012	3025	2537
	2	2225	2475	2175	2292
	3	2300	2138	2662	2367
	4	2638	2412	2238	2429
Average		2434±322**	2259±350	2525±632	2406
N_1	1	2512	1562	3150	2408
	2	2325	2125	2375	2275
	3	2188	2150	2350	2229
	4	2562	2412	2562	2512
Average		2397±275	2062±569	2609±593	2356
N_2	1	3107	2087	3750	2981
	2	2650	2200	2475	2442
	3	2000	1888	2425	2104
	4	1938	2062	2188	2063
Average		2424±887	2059±205	2710±1122	2398
N_3	1	2650	3375	3352	3126
	2	2962	2375	2475	2604
	3	1788	1788	1750	1775
	4	2288	1475	2362	2042
Average		2422±803	2253±1330	2485±1050	2387
N_4	1	2875	2460	2645	2660
	2	2900	2588	2400	2629
	3	2162	2275	1625	2021
	4	2312	2775	2150	2412
Average		2562±606	2524±357	2205±694	2430

*N_0- no applied N. N_1-54 kg. of N at planting. N_2-27 kg. N at planting, 27 kg. N after second harvest. N_3-108 kg. N at planting. N_4-27 kg. at planting, 27 kg. N after each of the first three harvests.

**$\bar{x} \pm t_{.05} S_{\bar{x}}$.

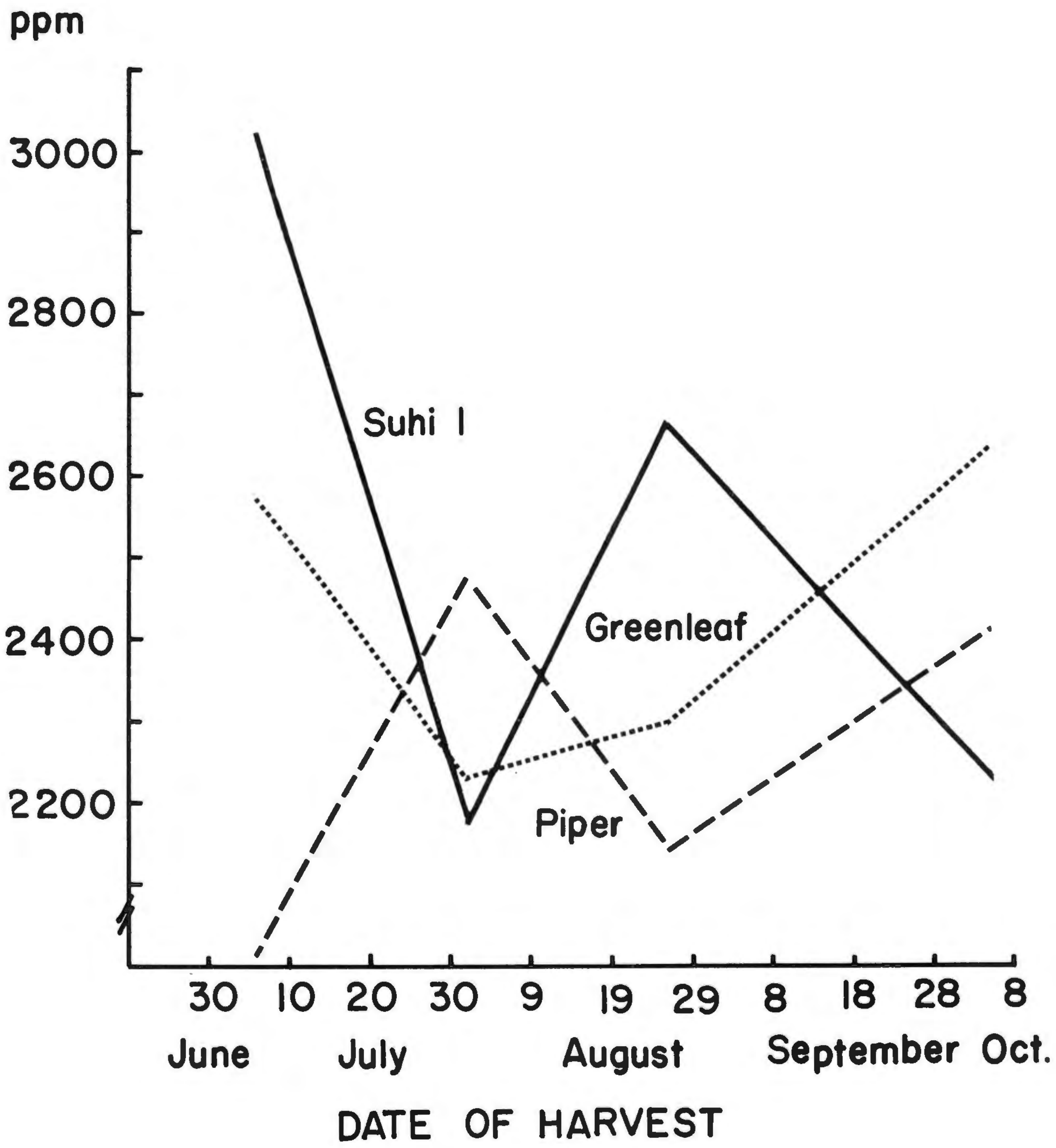

Figure 11. NO_3-N content of three varieties of sorghum receiving no applied nitrogen (N_o).

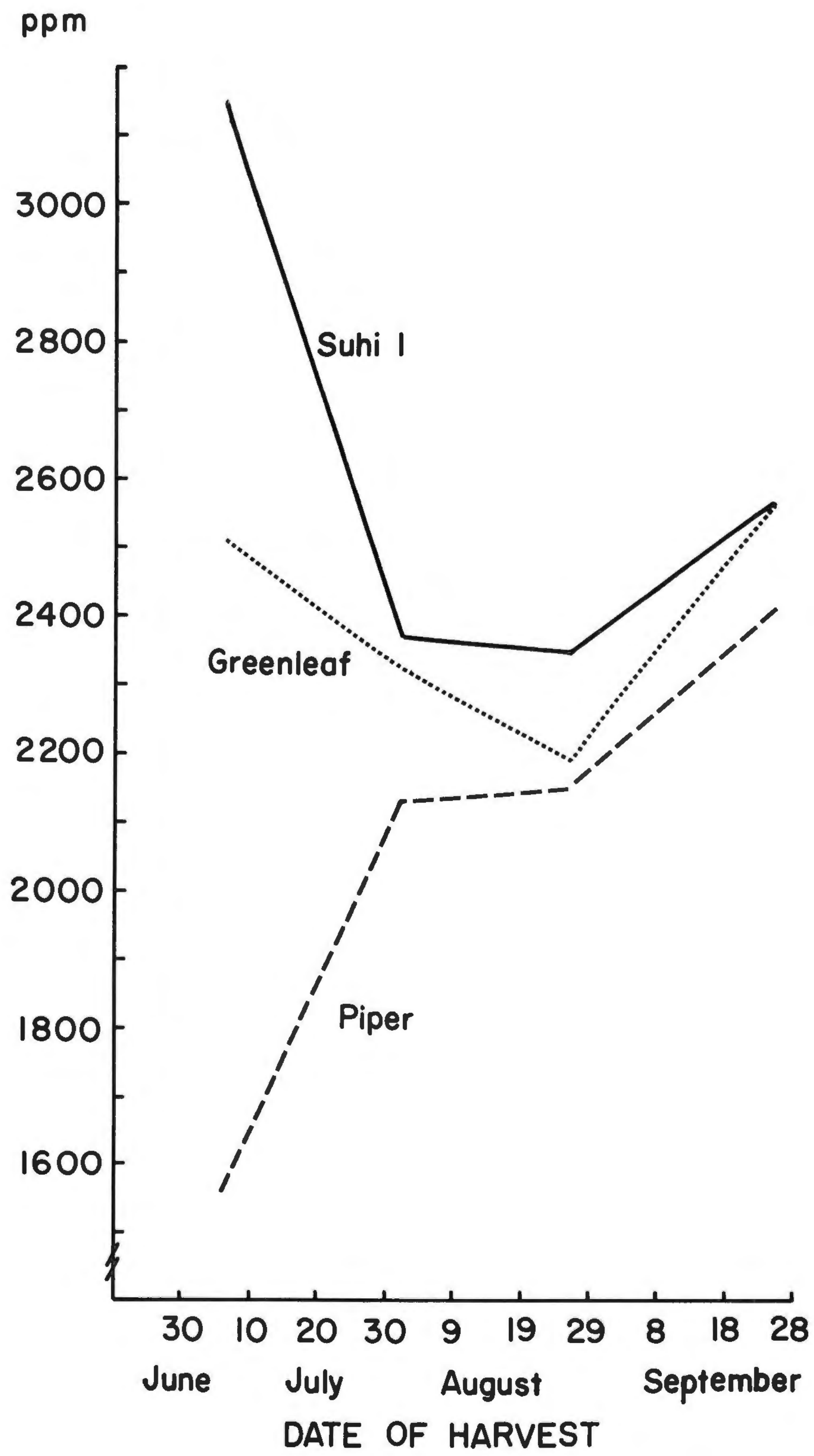

Figure 12. NO_3-N content of three varieties of sorghum receiving 54 kg. of nitrogen per ha. at planting (N_1).

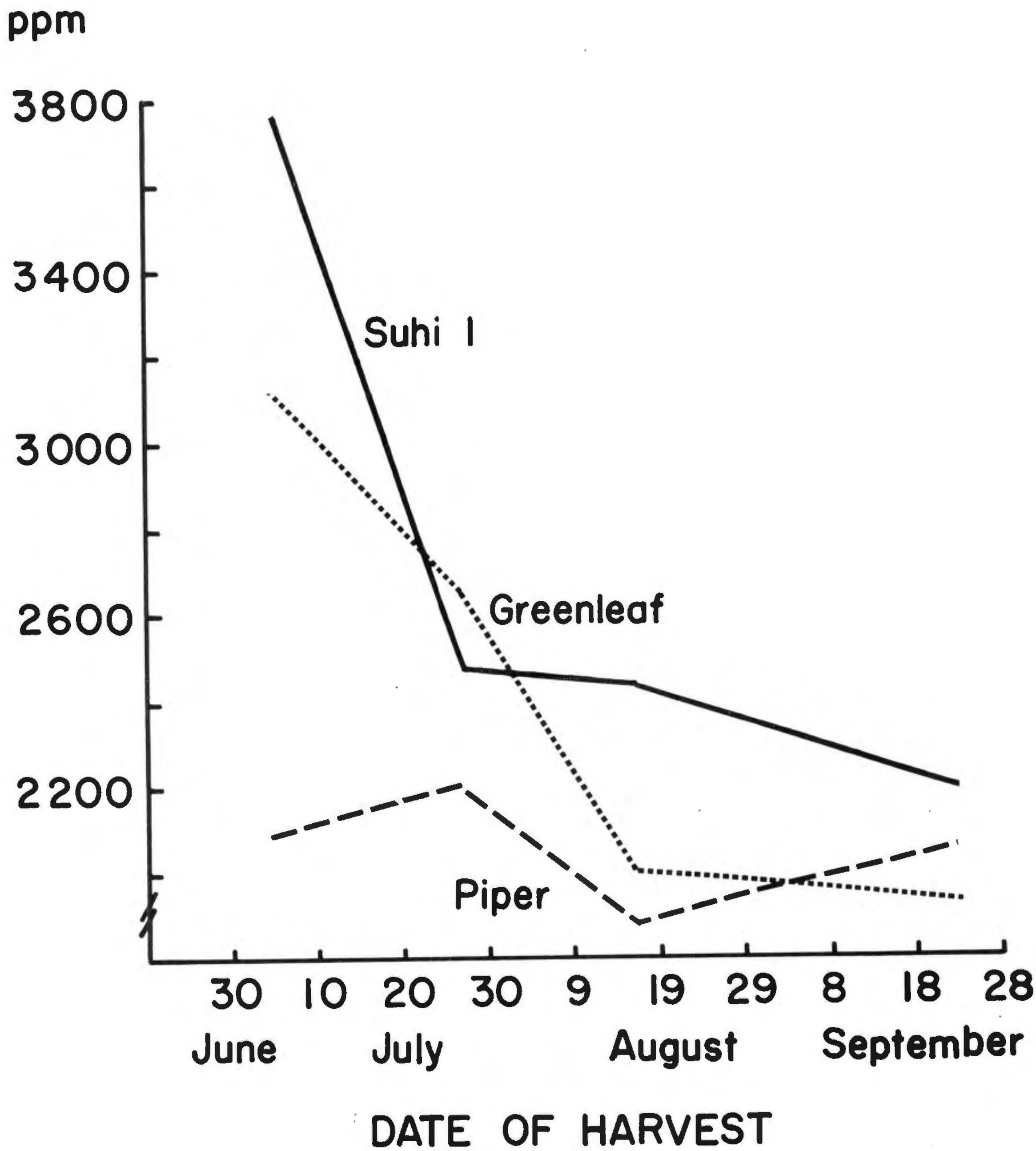

Figure 13. NO_3-N content of three varieties of sorghum receiving 27 kg. of nitrogen per ha. at planting and 27 kg. after the second harvest (N_2).

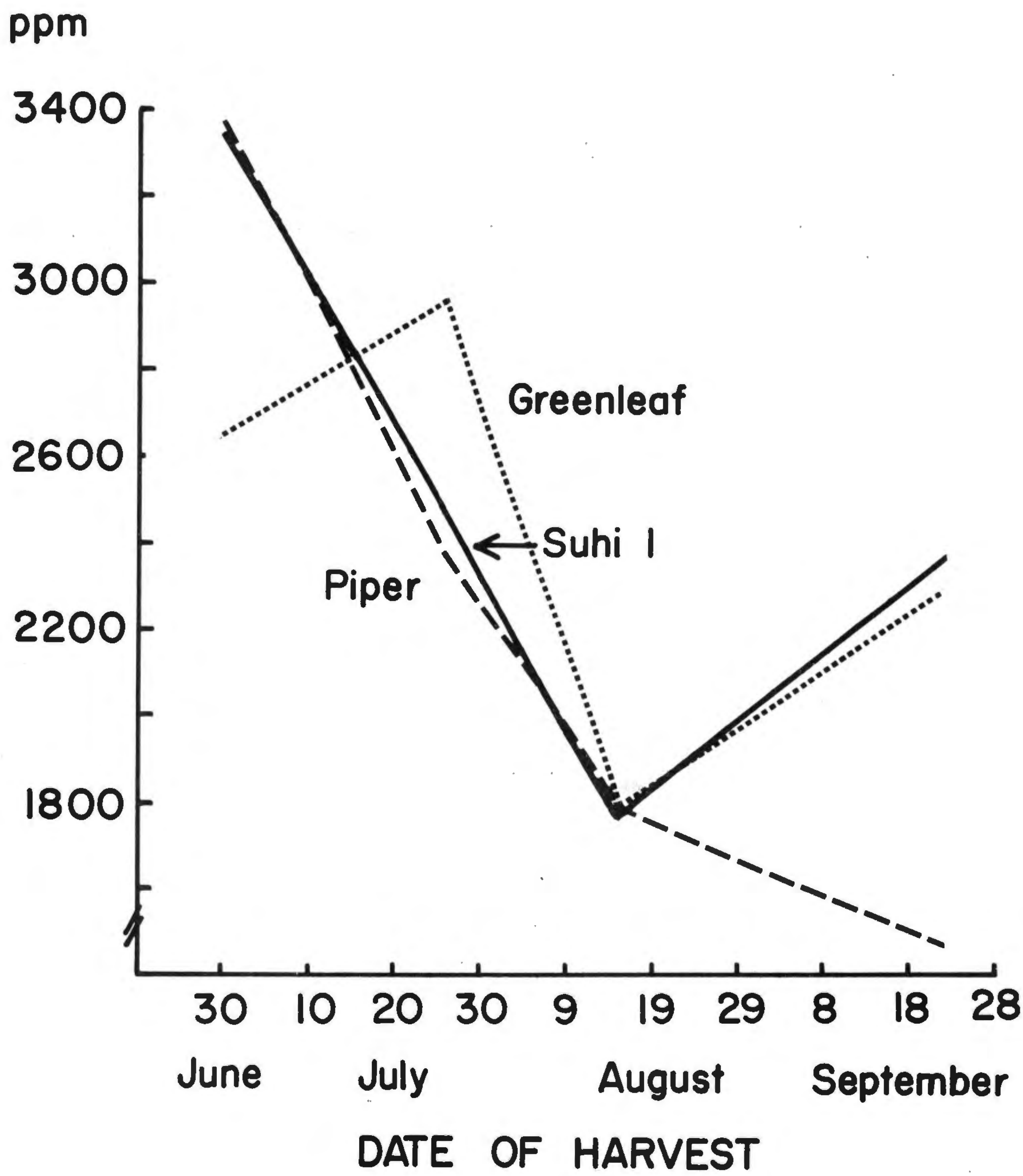

Figure 14. NO_3-N content of three varieties of sorghum receiving 108 kg. of nitrogen per ha. at planting (N_3).

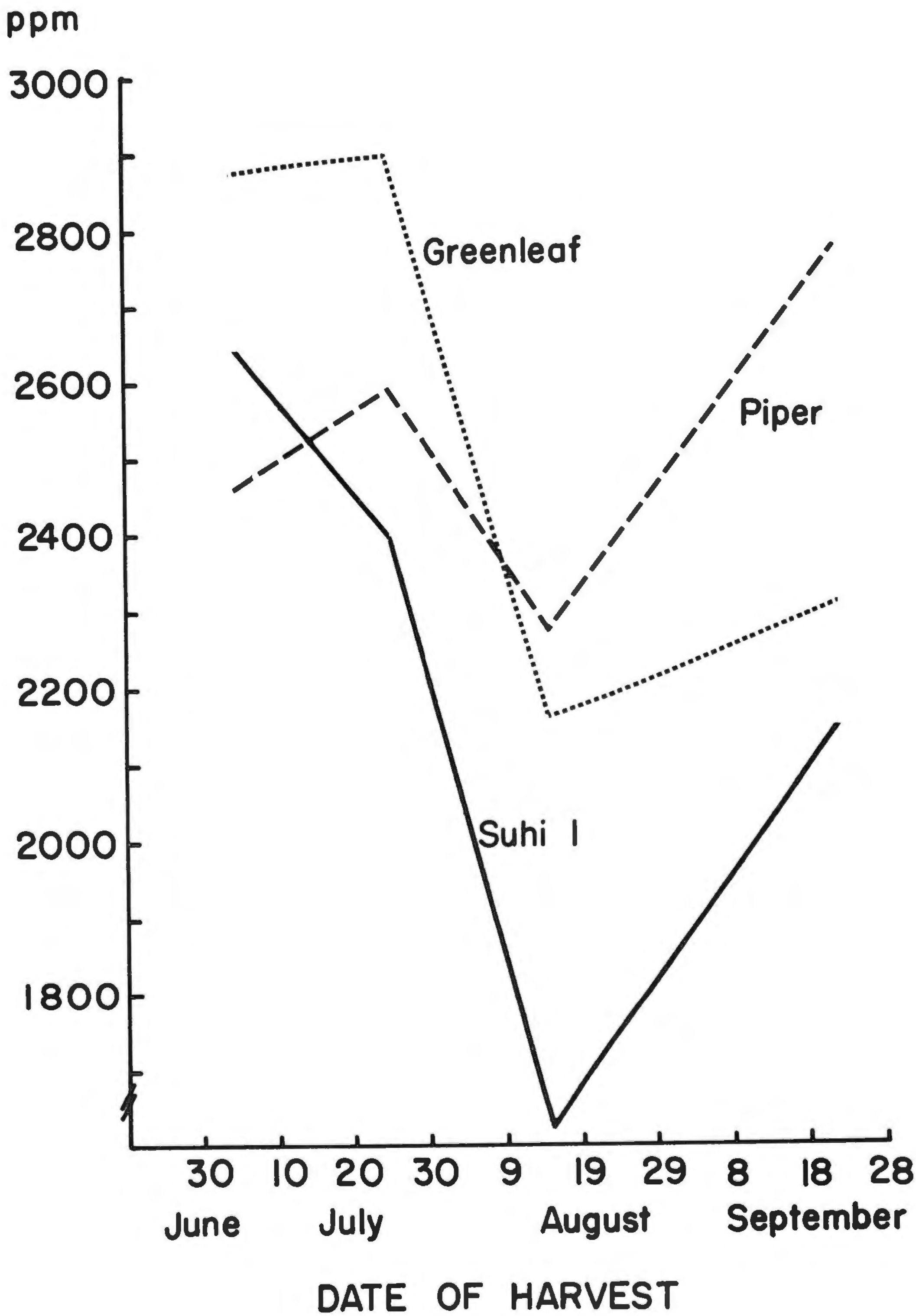

Figure 15. NO_3-N content of three varieties of sorghum receiving 27 kg. of nitrogen per ha. at planting and 27 kg. after each of the first three harvests (N_4).

for Piper at the N_3 nitrogen treatment at the fourth harvest. The 3750 ppm reading was obtained from Suhi-1 at the N_2 nitrogen treatment at the first harvest.

The minimum toxic level of nitrate cannot be stated simply in terms of concentration. Instead, it must be defined in terms of quantity ingested per unit live weight in a given time. An intake of more than 20 grams of nitrate per 100 pounds live weight per 24 hours is likely to prove fatal (1). Experimental data indicate that, for forage, a level of 0.3 percent nitrate on a dry weight basis can be considered a maximum safe amount. Economic losses and eventually mortality occur above this 0.3 percent level (13).

In this study only six individual nitrate observations were above the 0.3 percent or 3000 ppm safe limit. Although there was no significant variety difference over the season, four of the six dangerous readings were obtained from Suhi-1. Piper and Greenleaf were responsible for one each.

In this study two 27 kg. per ha. applications produced as much dry matter as a single 108 kg. application. Four 27 kg. per ha. nitrogen applications produced significantly more dry matter than a single 108 kg. application. Split nitrogen applications also resulted in more uniform yields throughout the growing season. These results support the present recommendations of split applications of nitrogen for forage sorghum.

HCN potential was also more uniform throughout the growing season with split nitrogen applications. Rates of 108 kg. or more nitrogen per ha. at planting are likely to produce dangerous levels of HCN at the first harvest. When using nitrogen at rates higher than 108 kg. per ha., split applications would become increasingly important.

Although the data relating to nitrate nitrogen were inconclusive, previous experimental work has shown that high levels of nitrogen fertilization are related to nitrate toxicity (7,12,18,21).

Suhi-1 averaged 8.11 metric tons per ha. per cutting as compared with 5.89 for Piper and 5.65 for Greenleaf. In this study, Piper never reached the dangerous level of HCN potential, and Greenleaf produced only two readings which would be considered dangerous. However, Suhi-1 consistently produced HCN levels which would be considered dangerous. If Suhi-1 is used to obtain higher yields, the risk of HCN poisoning would be increased.

CHAPTER V

SUMMARY

The effect of nitrogen fertilization on yield, hydrocyanic acid potential (HCN-p) and nitrate accumulation was studied in three varieties of sorghum in 1966. The five nitrogen treatments were: N_0 which received no applied nitrogen; N_1 which received 54 kg. per ha. of nitrogen at planting; N_2 which received 27 kg. per ha. at planting and 27 kg. after the second cutting; N_3 which received 108 kg. at planting; and N_4 which received 27 kg. at planting and 27 kg. after each of the first three cuttings. The varieties used were Greenleaf, Piper, and Suhi-1. The plants were cut at a 20-cm. stubble height each time they reached a height of 75 cm. and analyzed for yield, HCN-p, and nitrate content.

Yield was influenced more by distribution of nitrogen applications than by the amount applied. However, plants receiving some nitrogen at any time during the growing season produced higher yields than plants receiving no applied nitrogen. There was also a variety difference in regard to yield. Suhi-1 significantly outyielded Greenleaf and Piper in total season production.

HCN-p was also affected by nitrogen fertilization. In general, the higher total nitrogen rates produced higher levels of HCN in the plants. Split applications of nitrogen produced higher season averages of HCN than the same rates applied only at planting; however, the highest harvest readings occurred from plants receiving all their nitrogen at planting.

Suhi-1 was significantly higher in HCN potential than Greenleaf, and Greenleaf was higher than Piper. Suhi-1 was the only variety which consistently produced HCN levels that would be considered dangerous.

The data were inconclusive as to nitrate nitrogen accumulations. The range of the readings was from 1475 to 3750 ppm. No trends or patterns were detected.

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