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Nitrogen and Phosphorus Losses From Agronomy Plots In North Alabama

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NITROGEN AND PHOSPHORUS LOSSES FROM AGRONOMY PLOTS IN NORTH ALABAMA

By

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ABSTRACT

A study of nitrogen and phosphorus losses from Decatur silt loam soil was conducted over three cropping periods from 1969-1972. Experimental agronomy plots at Alabama A. & M. University were seeded to cotton, corn, soybeans, and millet and compared with uncropped and unfertilized check plots.

The effects of these crops on nitrogen losses — total nitrogen, nitrate-nitrogen, and ammonium-nitrogen (for 1971-1972 only) — and phosphorus losses were evaluated. Average total rainfall and losses of sediment and runoff were also determined.

Losses of total nitrogen and nitrate-nitrogen were generally positively correlated with the amounts of rainfall, runoff, and sediment. Phosphorus losses were positively correlated with sediment losses. More than 95% of phosphorus losses were associated with sediment loss. Corn was generally more effective in reducing total nitrogen and nitrate-nitrogen losses via surface runoff than cotton; whereas nitrate-nitrogen concentrations in subsurface water were lower in samples from cotton plots. The effect of crops on loss of all nutrients was considerably smaller than seasonal effects and sediment losses.

The effect of two fertilizers, ammonium nitrate and sulfur-coated urea (a slow-release nitrogen fertilizer), upon nutrient losses showed no evidence of superiority for sulfur-coated urea in reducing the total nitrogen or nitrate-nitrogen losses.

This report was submitted in fulfillment of Project Number 13020 DWH, Grant Number 800401, by the Department of Natural Resource and Environmental Studies, Alabama Agricultural and Mechanical University, under the (partial) sponsorship of the Environmental Protection Agency. Work was completed as of December 1972.

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ACKNOWLEDGMENTS

Dr. Robert R. Bradford was the principal investigator of this study. Dr. Luke Mugwira was the associate investigator during the last year. Mr. Leslie Glover, an undergraduate student in the Department of Natural Resource and Environmental Studies, provided assistance in field-related activities while Mr. V. J. Thakore and Mr. Donald Outland, Research Assistants, assisted in the chemical and physical analyses of samples.

Support of the project by the Office of Research and Development, Environmental Protection Agency, and the cooperation of Dr. George W. Bailey, Grant Project Officer, are gratefully acknowledged.

SECTION I

CONCLUSIONS

1. Average monthly losses of nitrate-nitrogen (NO_3-N) and soluble phosphorus (P) from small cotton, corn, millet, and soybean plots which had been treated with fertilizers were approximately the same as losses from uncropped and unfertilized check plots.

2. The concentration of NO_3-N in subsurface water was higher than the concentration observed in surface runoff; magnitudes of five-fold were observed in some cases. This suggested that, for this soil, more NO_3-N may have been lost through infiltration and percolation than via surface runoff.

3. Loss of nitrogen (N) as ammonium-nitrogen (NH_4-N) in surface runoff from the first two or three runoff producing rains following application of fertilizers may constitute a more serious problem than loss of NO_3-N over the same interval. The surface losses of NO_3-N accounted for only 25% of the total N lost from the plots.

4. Sediment borne N and P constituted the greater loss of these two nutrients. More than 95% of P was lost with the sediment.

5. The slow-release nitrogen used in this study showed no evidence of being superior to ammonium-nitrate in reducing loss of NO_3-N or total N. Losses of NH_4-N from sulfur-coated urea (SCU) treated plots were higher during the first three runoff producing rains than from plots treated with ammonium-nitrate. This may have been accentuated by the actual runoff of SCU pellets from the plots along with surface water and sediment.

6. The type of crop grown may be a factor in loss of N.

SECTION II

RECOMMENDATIONS

1. Growers should be encouraged to use management and tillage practices which minimize erosion of croplands since the most serious losses of N and P occurred as sediment contained in surface runoff.

2. Nitrogen and phosphorus requirements of major agronomic crops should be established for the different geographical regions.

3. The optimum time to apply fertilizers to agronomic crops should be determined. This is particularly needed where double cropping is practiced since plant cover greatly influences loss of nitrogen and phosphorus.

4. Growers should be encouraged to apply fertilizers at rates not in excess of those recommended on the basis of soil test results.

5. Slow-release nitrogen fertilizers should be developed which release N sufficient for adequate growth and nutrition of plants but which reduce the need to apply large quantities of nitrogen. If such fertilizers are in pellet form, care should be taken in the incorporation of such fertilizers into the soil.

SECTION III

INTRODUCTION

There is considerable interest in the fate of nitrogen and phosphate fertilizers applied to croplands. Some environmentalists believe that nitrogen lost from fertilized fields through percolation and surface runoff and phosphorus losses through surface runoff significantly contribute to the eutrophication of waterways in the United States and also reduce the quality of drinking water. The North Alabama area of the Tennessee Valley has annual rainfall of about 140 cm which results in high amounts of runoff and erosion, and possible loss of fertilizers from fields to which they are applied into rivers and reservoirs.

Previous research data from different regions suggest that the amount of nitrogen removed from croplands depends on the kind of nitrogen fertilizer, crop, rainfall, and associated cultural practices.[1,2,3] It has been found that phosphorus is lost through erosion essentially as sediment-borne P;[4] and very little is lost through leaching and runoff water.[5,6,7] There is, however, no general agreement on how much nitrogen and phosphorus are contributed to water bodies by agriculture. Thus it has been suggested that the prolification of Milfoil and algal blooms in several areas may be caused by changes in the nutrient budget which created conditions ideal for growth of aquatic plants.[8] Some environmentalists believe that losses of nutrients from commercial fertilizers applied to agricultural land play a significant role in the increased instances of eutrophication.[9] Others argue that many water bodies naturally have enough NO_3-N to support algal blooms and that good plant cover reduces sediment loss from land through runoff and thus enhances water quality.[10]

The objectives of this study were to:

1. Determine amounts of nitrogen and phosphorus in surface runoff from Decatur silt clay loam soil under un-cropped and cropped (cotton, corn, soybeans, and millet) conditions.
2. Compare nitrogen and phosphorus losses through surface runoff from plots treated with a slow-release nitrogen source and a conventional nitrogen source.

SECTION IV

EXPERIMENTAL APPROACH

A field containing Decatur silt clay loam, which had not been cropped for several years, was selected for use in this investigation. Two adjacent sites with 1% and 6% slope, respectively, were graded to uniform slope. Each site contained seven hydrocollection units (plots) 2.4 m x 4.6 m and were spaced 2.1 m apart in order to minimize fertilizer contamination. Each hydrocollection unit was marked by metal frames 2.4-m wide, 4.6-m long, 0.5-m high, and imbedded into the soil to a depth of 15 cm. Surface runoff from the plots was directed into 190-liter holding tanks through 15-cm diameter metal conduits installed at ground level. The holding tanks were fitted with covers to prevent unwanted precipitation from entering.

Suction lysimeters — consisting of a plastic pipe, 5 cm in diameter, capped on the lower end by a porous ceramic cup, and designed to permit intake and removal of subsurface water — were installed to a depth of 1.2 m in the center of each plot. The lysimeters were maintained in an evacuated condition between sampling periods by means of a portable vacuum pump. Two rain gauges were located in the test area for collecting data on natural rainfall. No supplementary irrigation was used during the investigation. After each runoff producing rain representative runoff samples were taken in duplicate from each holding tank. These samples were stored at 0°C prior to chemical analysis.

1969-1970 CROPPING AND RUNOFF SEASON

Initial soil analyses were:

Total N in top 15 cm ----------------	9.1	kg/ha
Total P in top 15 cm ----------------	414	g/ha
Soluble P in subsurface water (1.2 m)--	0.44	mg/l

During the first year of the study, losses of N and P in runoff and percolating water were monitored from the plots cropped with 'Stoneville' cotton, 'Pioneer 309B' corn, and 'Hood' soybeans. Each crop was planted in two plots. A check plot was left at each site and crops were randomized within each site. Fertilizers for the following crops were applied as NH_4NO_3 and 0-20-20 broadcast and disked under at the following (kg/ha) rates:

	N	P_2O_5	K_2O
Cotton ---------------	22	67	67
Corn -----------------	22	62	62
Soybeans -------------	0	45	45

Because of the delayed funding of this proposal, the crops were planted on August 12 which was late in the season for these crops in North Alabama; therefore, no sidedressing with additional 67 kg/ha of N was made as originally planned. The plants were harvested on October 15 and barley was planted on all plots to provide a winter cover crop.

Total nitrogen, which includes organic-nitrogen plus ammonium-nitrogen, was determined in surface runoff by Kjeldahl method. Nitrate-nitrogen and soluble phosphorus were determined in surface runoff and subsurface samples by methods recommended by FWPCA.[11] Surface runoff and subsurface water were filtered to remove sediment prior to analysis for nitrate-nitrogen and soluble phosphorus.

Sediment content in surface runoff samples was determined by thoroughly mixing one liter of surface runoff, then quickly decanting the homogeneous sample into a tared 100-ml beaker. The sample was then brought to dryness on a steam plate and the beaker reweighed.[12]

Total phosphorus and organic phosphorus in sediments removed from surface runoff were determined by procedures described in Methods of Soil Analysis.[13] Total nitrogen in sediments removed from surface runoff was determined by the Kjeldahl method. Rainfall data were obtained via two rain gauges located in the plot area.

Statistical tests employed to compare data collected were analysis of variance, least significant difference (LSD), and simple correlation. A preliminary analysis of variance of the data indicated that there were no significant differences between the two sites for the parameters studied. Consequently, the two sites were treated as blocks for the three cropping seasons (1969-1972).

1970-1971 CROPPING AND RUNOFF SEASON

The practices employed during the first year of the investigation were repeated in 1970 and 1971 with some modifications. In the second year, nitrogen losses were evaluated as a function of N fertilizer. Conventional ammonium nitrate (AN) was compared with slow-release fertilizer, sulfur-coated urea (SCU-D), supplied by the Tennessee Valley Authority.

This experiment was intended to evaluate relative losses of N in runoff as influenced by these two N fertilizers. Fertilizers for the crops shown were applied at the following (kg/ha) rates:

	N	P_2O_5	K_2O
Cotton ----------------	90	67	67
Corn ------------------	90	62	62
Soybeans --------------	0	45	45

The following chemical composition and dissolution rates were calculated from weighted average values for this SCU blend:

Composition		Dissolution rate, % N	
% N	% S	7 days	Daily 7-14 days
29.6	30.8	9.0	0.3

The dissolution rates were measured in water at 38°C. Sulfur-coated urea contained 3% sealant (wax) and 0.25% microbiocide (coal tar) overlaid on a layer of sulfur. The same cotton, corn, and soybean varieties used in the first year were planted on May 11. Barley was grown on all plots as a winter cover crop.

Because of the very low concentrations found in 1969-1970 samples, subsurface water was not analyzed for NO_3-N and soluble P. Analytical techniques for measuring N and P losses, statistical methods, and meteorological procedures were the same as those used in 1969-1970 season.

1971-1972 CROPPING AND RUNOFF SEASON

Data for 1970-1971 showed no significant difference in N loss between the three row-crops grown; therefore, in 1971-1972 cotton and soybeans were replaced by a forage crop, namely millet. It was thought that because of the tillered growth characteristics of millet, it might substantially differ from corn which is a typical representative of row crops. Plots were rototilled and fertilized on April 3rd. Millet and corn were planted on May 16.

Efforts were made to quantify N and P losses during ten runoff producing rain periods from April 1971 through March 1972. Surface runoff samples from the plots were analyzed for NH_4-N in addition to the analyses indicated for the 1969-1970 season. Collection of rainfall data and statistical tests used were the same as described for the first year of the study.

Crops grown, replications, fertilizers (application methods were the same as for the 1969-1970 season) and their rates for the 1971-1972 season are shown below:

Crop	Replications	N Source	Kg/ha		
			N	P_2O_5	K_2O
Corn	3	NH_4NO_3	100	35	35
Corn	3	SCU	100	35	35
Millet	3	NH_4NO_3	100	35	35
Millet	3	SCU	100	35	35
Fallow	2	—	00	00	00

SECTION V

RESULTS AND DISCUSSION

1969-1970 CROPPING AND RUNOFF SEASON

Results

Rainfall data (cm/mo) on plot area during the 1969-1970 season are given below:

Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
11.15	6.32	6.30	22.71	6.02	7.34	14.96	23.06

The average total monthly rainfall, surface runoff, and sediment losses for the 1969-1970 cropping and runoff season are shown in Figure 1. Rainfall was high in September, December, March, and April and was uniformly lower during the rest of the season. The average monthly runoff and sediment losses followed distribution patterns similar to those observed for rainfall (Fig. 1).

Nitrogen Losses —
The average monthly total nitrogen loss, the concentration and total loss of NO_3-N in surface runoff, and the concentration of NO_3-N in subsurface water are shown in Tables 1, 2, 3, and 4, respectively. All of these forms of nitrogen were significantly affected by the type of crop and the time (month) of the season. The total N loss in the season increased only where cotton was planted (Table 1). The average NO_3-N concentration in surface runoff was significantly higher in plots planted to cotton, corn, and soybeans than in runoff from check plots (Table 2). When averaged over the 8-month sampling period, total NO_3-N losses through surface runoff from plots planted to cotton were lower than losses from corn and soybean plots (Table 3). However, the concentration of NO_3-N in the subsurface water was higher only on corn plots (Table 4).

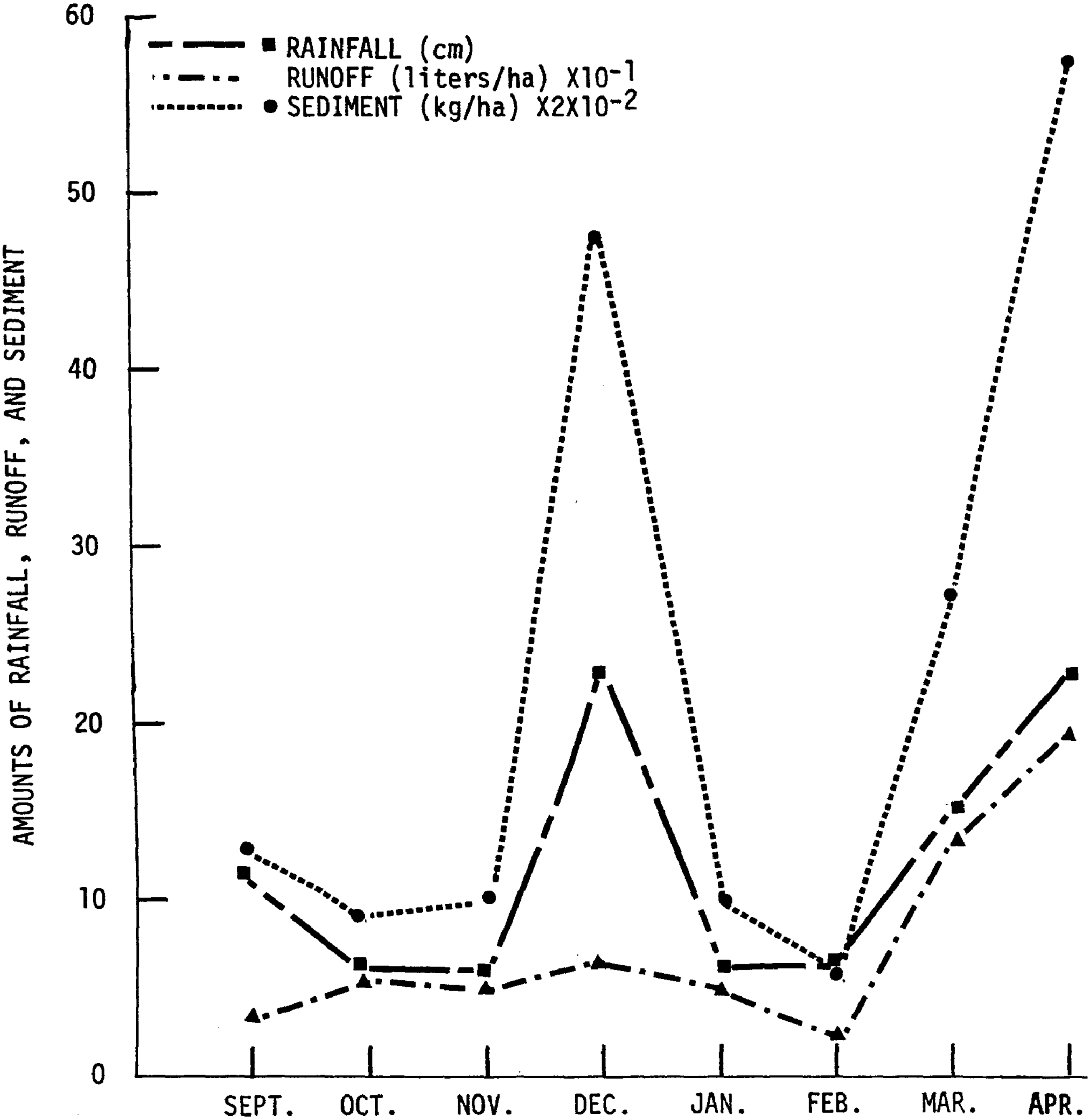

Figure 1. Relationships between rainfall, runoff, and sediment during the 1969-1970 season.

Table 1. AVERAGE LOSS OF TOTAL NITROGEN THROUGH SURFACE RUNOFF FROM PLOTS SEEDED TO DIFFERENT CROPS (kg/ha)

1969-1970	Crops				
Month	Cotton	Corn	Soybeans	Check	Means
Sept.	10.8	8.4	10.1	9.1	9.6
Oct.	9.5	6.3	6.7	6.2	7.2
Nov.	9.0	6.2	6.7	5.6	6.9
Dec.	24.6	18.5	21.3	20.7	21.3
Jan.	9.0	7.3	6.7	5.6	7.2
Feb.	8.4	6.7	6.2	5.6	6.7
Mar.	15.8	14.0	15.7	13.4	14.8
Apr.	24.6	19.7	16.9	17.9	19.8
Means	14.0	10.9	11.3	10.5	

LSD at 0.05 for comparing means:		F ratio
Crops	1.2	8.96*
Months	1.7	68.1**

*, ** Significant at the 5% and 1% level of probability, respectively.

Table 2. AVERAGE CONCENTRATION OF NITRATE-NITROGEN IN SURFACE RUNOFF FROM PLOTS SEEDED TO DIFFERENT CROPS (mg/1)

1969-70	Crops				
Month	Cotton	Corn	Soybeans	Check	Means
Sept.	0.17	0.22	0.20	0.17	0.19
Oct.	0.11	0.10	0.15	0.07	0.11
Nov.	0.10	0.09	0.13	0.12	0.11
Dec.	0.23	0.24	0.33	0.18	0.24
Jan.	0.17	0.18	0.12	0.11	0.14
Feb.	0.20	0.22	0.16	0.14	0.18
Mar.	0.23	0.25	0.25	0.18	0.22
Apr.	0.19	0.20	0.17	0.16	0.18
Means	0.17	0.19	0.19	0.14	

LSD at 0.05 for comparing means:		F ratio
Crops	0.03	3.1*
Months	0.04	7.4*

* Significant at the 5% level of probability.

Table 3. AVERAGE LOSS OF NITRATE-NITROGEN THROUGH SURFACE RUNOFF FROM PLOTS SEEDED TO DIFFERENT CROPS (g/ha)

1969-1970	Crops				
Month	Cotton	Corn	Soybeans	Check	Means
Sept.	4.48	7.28	5.71	5.15	5.65
Oct.	4.48	4.03	7.84	3.36	4.93
Nov.	3.47	3.92	6.27	5.60	4.82
Dec.	11.76	15.23	17.47	11.31	13.94
Jan.	5.71	7.39	6.16	4.48	5.94
Feb.	2.80	4.03	3.47	2.80	3.28
Mar.	26.32	31.92	32.48	24.08	28.70
Apr.	33.15	34.83	31.36	28.56	31.98
Means	11.52	13.58	13.85	10.67	

LSD at 0.05 for comparing means:		F ratio
Crops	1.86	7.11*
Months	2.63	198.8**

*, ** Significant at the 5% and 1% level of probability, respectively.

Table 4. AVERAGE CONCENTRATION OF NITRATE-NITROGEN IN SUBSURFACE WATER FROM PLOTS SEEDED TO DIFFERENT CROPS (mg/1)

1969-1970	Crops				
Month	Cotton	Corn	Soybeans	Check	Means
Sept.	0.92	1.16	0.92	0.96	0.99
Oct.	0.25	0.24	0.22	0.20	0.23
Nov.	0.23	0.22	0.21	0.17	0.20
Dec.	0.90	1.15	0.91	0.95	0.98
Jan.	1.03	1.15	0.98	0.91	1.02
Feb.	1.08	1.10	0.97	1.05	1.05
Mar.	1.17	1.11	1.05	1.07	1.10
Apr.	1.07	1.17	0.93	1.00	1.04
Means	0.83	0.91	0.77	0.79	

LSD at 0.05 for comparing means:		F ratio
Crops	0.06	4.3*
Months	0.09	78.3**

*, ** Significant at the 5% and 1% level of probability, respectively.

Losses of total N and NO_3-N and the NO_3-N concentrations were generally positively correlated with the amounts of rainfall, runoff, and sediment loss. The highest levels of each of the six parameters occurred during the months of December, March, and April — and also in September in the case of NO_3-N concentration (Figs. 1 and 2). The following data also indicate that the N and P losses were significantly correlated with the amount of runoff and sediment losses. Correlation coefficient (r) relating surface runoff and sediment loss to nitrogen and phosphorus (P) levels is given below:

	Surface runoff	Sediment
Sediment loss	.707**	
Total NO_3-N	.948**	.733**
Total N	.619**	.913**
Soluble P	.724**	.437*

The concentration of NO_3-N in subsurface water was five times higher than in surface runoff and remained approximately 1 ppm during the growing season except for the low values in October and November (Table 4).

Phosphorus Losses —
The data in Table 5 indicate that the losses of soluble P through runoff and percolation were not influenced by the type of crop grown. Although the level of soluble P in surface runoff did not change during the sampling period, total loss of soluble P by runoff and the concentration of the P in subsurface water changed between different months (Table 5). Total soluble P in surface runoff was higher in March than in other months. Total soluble P in surface runoff, sediment P, and organic P in sediment loss were generally correlated with rainfall and runoff (Figs. 1 and 3). Comparison of data in Tables 5 and 6 indicate that nearly all P losses from the plots were due to sediment loss. Organic P losses accounted for approximately 30 to 40% of the total P lost from the plots.

Concentration of P in subsurface water was quite variable and was not significantly affected by the crop. These P levels were higher from September to December than from January to April. The concentrations of P in surface runoff and in subsurface water are within the range reported by Duley[14] who found P contents of 0.12 to 1.50 ppm in surface runoff water collected from a set of unfertilized erosion plots receiving natural rainfall.

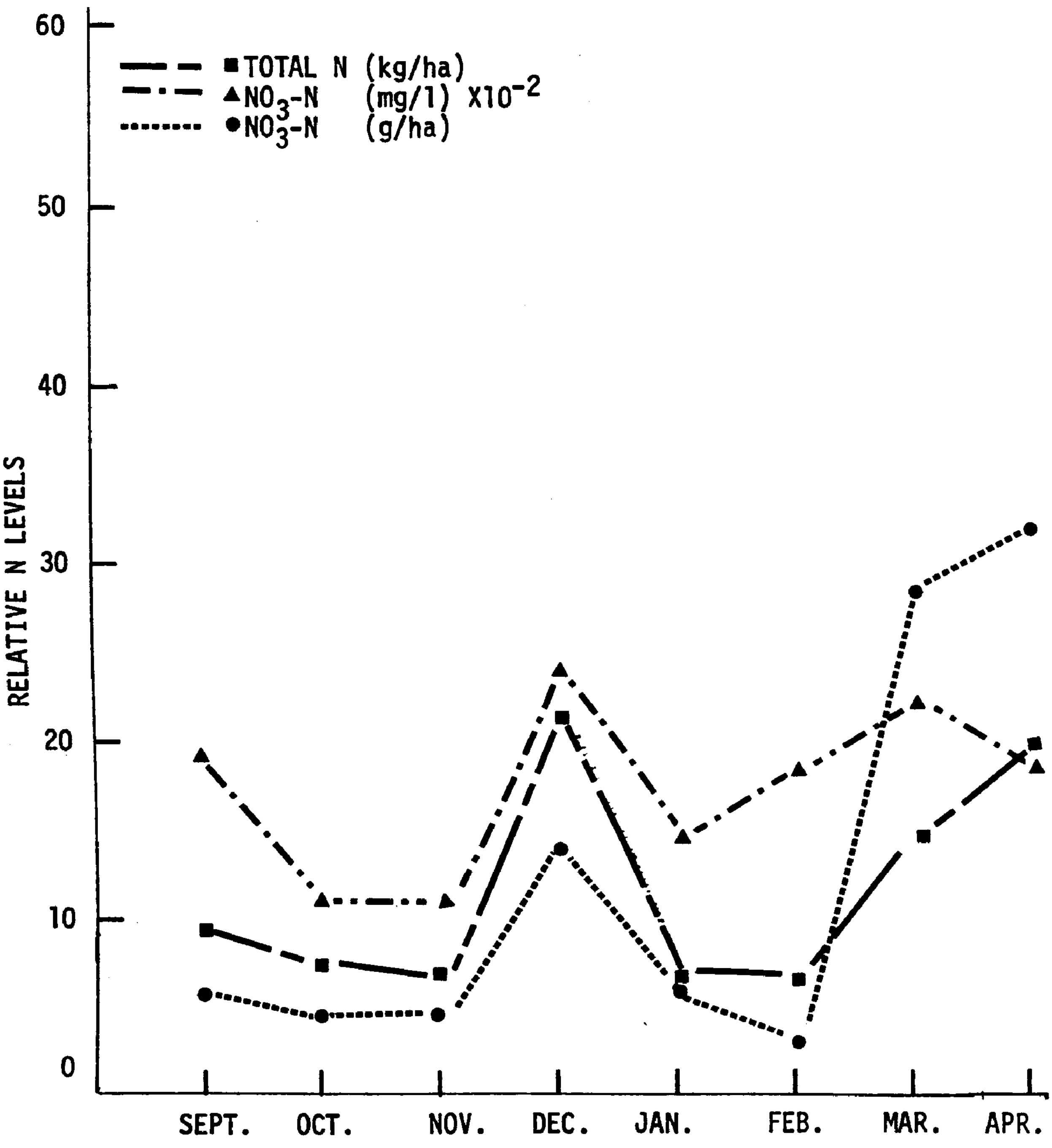

Figure 2. Nitrogen losses from plots through surface runoff during the 1969-1970 season.

Table 5. AVERAGE LOSS OF PHOSPHORUS THROUGH SURFACE RUNOFF FROM PLOTS SEEDED TO DIFFERENT CROPS (g/ha)

1969-1970	Crops				
Month	Cotton	Corn	Soybeans	Check	Means
Sept.	5.4	5.6	4.3	4.4	4.9
Oct.	6.0	10.2	4.1	9.6	7.5
Nov.	5.4	9.0	9.5	8.3	8.1
Dec.	10.5	11.3	11.3	4.5	9.4
Jan.	8.0	9.1	8.5	6.9	8.1
Feb.	2.4	3.9	2.8	1.3	2.6
Mar.	18.1	18.8	15.8	9.9	15.7
Apr.	8.4	14.0	18.0	11.0	12.7
Means	8.0	10.2	9.3	6.9	

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Months	3.6	11.1*

* Significant at 5% level of probability
NS Non-significant

Table 6. AVERAGE LOSS OF TOTAL PHOSPHORUS IN SEDIMENT DERIVED FROM PLOTS SEEDED TO DIFFERENT CROPS (kg/ha)

1969-1970	Crops				
Month	Cotton	Corn	Soybeans	Check	Means
Sept.	12.3	11.2	12.3	16.8	13.2
Oct.	11.2	6.7	6.7	11.2	8.9
Nov.	11.2	6.7	11.2	11.2	10.0
Dec.	61.6	39.7	45.9	45.9	48.2
Jan.	11.2	6.7	11.2	11.2	10.0
Feb.	6.7	6.7	6.7	5.6	6.4
Mar.	29.1	22.4	29.1	28.0	27.1
Apr.	90.7	50.4	50.4	40.3	57.9
Means	29.3	18.8	21.7	21.3	

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Months	11.87	24.62**

NS Non-significant

** Significant at the 1% level of probability

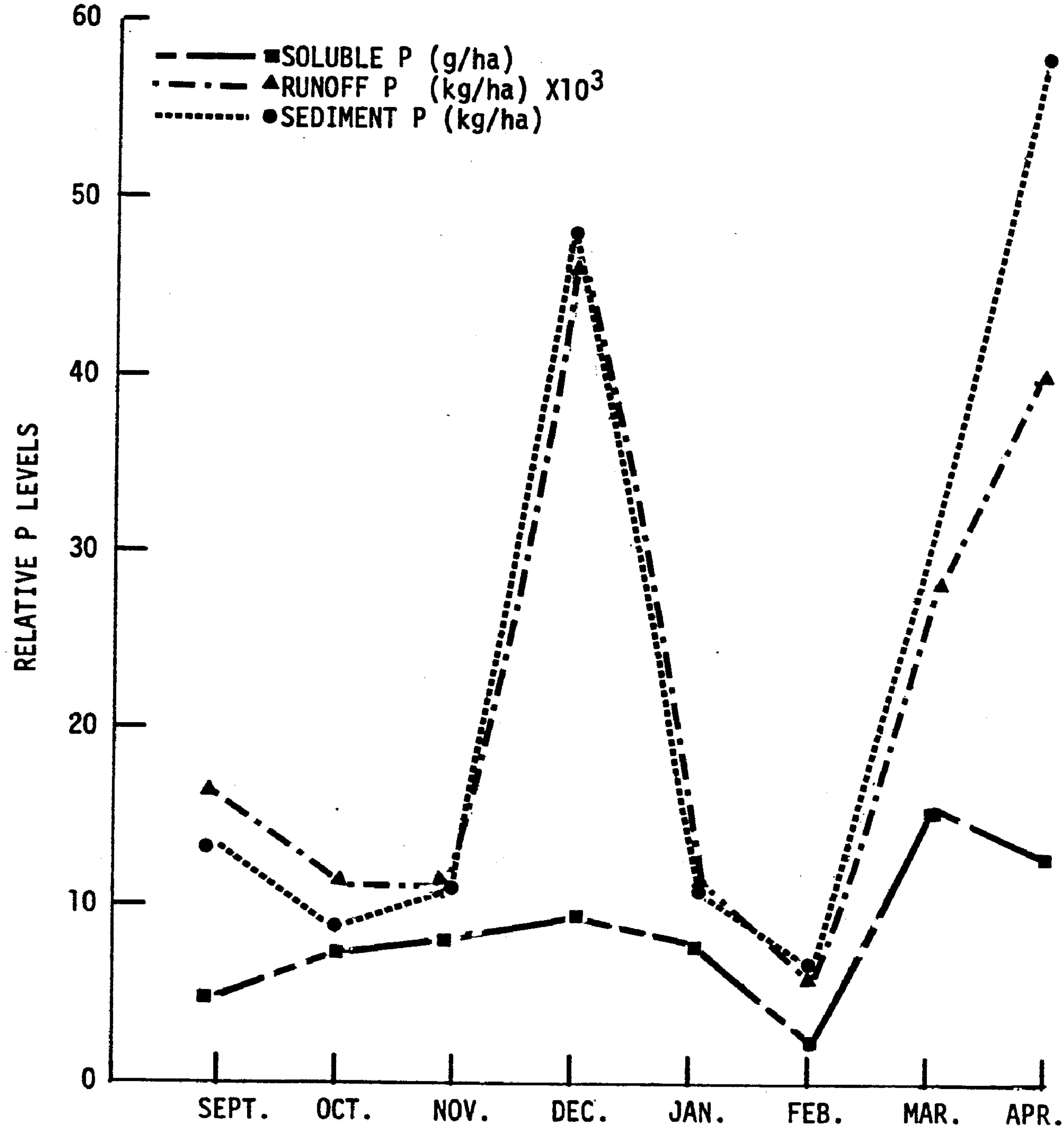

Figure 3. Phosphorus losses from plots through surface runoff during 1969-1970 season.

Discussion

To determine nitrogen losses from surface runoff in 1969-1970, data were collected for total N and NO_3-N. Of these, NO_3-N losses were only a small percent (generally less than 1%) of the total.

Total N losses were invariably associated with high rainfall months as exemplified by the high values in December, March, and April. Rainfall was the single most important factor affecting N losses through surface runoffs and its impact can be seen on cropped and fertilized as well as on check plots (Table 1).

Contribution of nitrate from farmland to the ground water is of interest in terms of causing contamination of drinking water. For the 1969-1970 season, NO_3-N losses in subsurface water were not correlated with rainfall (Table 4). The data for this period indicated that cotton because of its growth habit, elaborate root structure, and longer growing season was more efficient than corn in reducing loss of NO_3-N in subsurface water. In general, these losses were approximately at the level of 1 ppm (Table 4). Although this concentration of nitrate in the subsurface water exceeded 0.03 ppm NO_3-N level that would cause eutrophication,[14] it is doubtful that these losses significantly affect water quality. Additional dilution of such concentration in ground water should also be considered when interpreting such data.

Phosphorus Losses —
Our data confirms earlier findings that a very large amount of P is lost with the sediment; only 1% or less P leaves the cropland in soluble form.[1] The concentration of P lost can generally be estimated by multiplying the total sediment lost by the total P content of sediment which, in this study, was found to be 0.5%. The type of crop did not affect soluble P loss. Since soluble P is in equilibrium with sediment P and it is in greater magnitude, practices which would reduce erosion would contribute considerably toward reducing loss of total P from cropland.

1970-1971 CROPPING AND RUNOFF SEASON

Results

Rainfall data (cm/mo) on plot area during the 1970-1971 season are given below:

May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
7.34	6.60	6.02	7.29	5.08	10.74	6.60	5.26	8.38

The average total monthly rainfall, runoff, and sediment losses from the experimental plots during the 1970-1971 season are shown in Figure 4. The highest monthly rainfall occurred in October, followed by May and January, with monthly precipitation varying between 5.08 cm and 6.60 cm during the rest of the season. Monthly runoff and sediment generally followed a similar pattern as rainfall.

The data were analyzed initially to compare N loss for the two different fertilizer materials, sulfur-coated urea and ammonium nitrate. A second analysis was done to compare N and P losses among corn, cotton, soybeans, and check plots.

Nitrogen Losses —
The results for total N losses and losses of NO_3-N through surface runoff from plots that received AN and SCU are given in Tables 7 and 8. Neither fertilizer source showed evidence of being superior to the other in reducing losses of NO_3-N or total N via surface runoff during the 1970-1971 season. The fluctuation of average monthly concentrations of NO_3-N in surface runoff generally followed those of average monthly rainfall and runoff.

Data for comparing the effects of cotton, corn, and soybeans on N losses are shown in Tables 9 and 10. The total N loss and total losses of NO_3-N are not significantly affected by the type of crop. Differences in concentrations and total losses of NO_3-N during the season were apparently a result of fluctuations in surface runoff. Comparison of the data in Tables 7 and 8 indicate that NO_3-N accounted for only 4% of the total N loss from the plots. The nitrogen losses from plots via surface runoff during 1970-1971 season are shown in Figure 5.

Phosphorus Losses —
It was assumed that SCU and AN would probably not influence P losses from plots and no statistical tests were made to compare the effects of the two fertilizers on P losses. Table 11 shows P losses as functions of the type of crop and month during the 1970-1971 season. The average total P content in sediment was approximately 0.5%. Considering the amounts of sediment in the runoff from plots (Fig. 4), it is evident that most of the P losses were due to sediment losses. The data in Figures 4 and 6 show that total P in surface runoff was closely associated with sediment loss throughout the 1970-1971 season.

Discussion

Nitrogen and phosphorus losses from plots were not affected by growing cotton, corn, or soybeans nor by SCU and AN applications equivalent to 90 kg/ha of N on cotton and corn plots. These losses were generally increased by high rainfall and were correlated with runoff and sediment

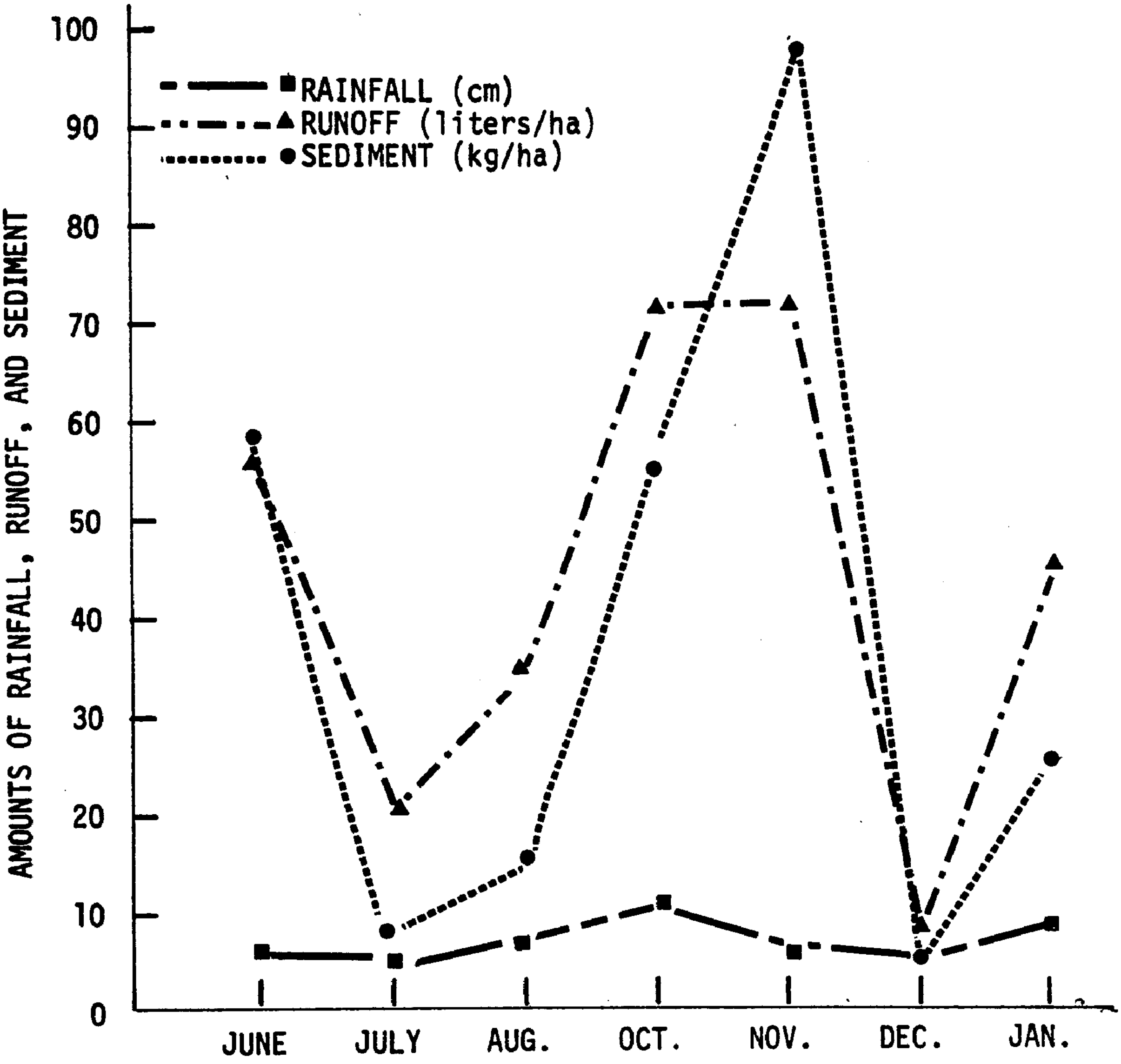

Figure 4. Relationships between rainfall, runoff, and sediment during the 1970-1971 season.

Table 7. AVERAGE LOSS OF TOTAL NITROGEN THROUGH SURFACE RUNOFF FROM COTTON AND CORN PLOTS TREATED WITH SULFUR-COATED UREA AND AMMONIUM NITRATE (g/ha)

1970-1971	Corn		Cotton		
Month	SCU	AN	SCU	AN	Means
June	172	61	202	116	138
July	199	189	187	260	209
Aug.	228	197	23	47	124
Oct.	146	130	292	249	204
Nov.	142	243	292	682	340
Dec.	22	24	19	25	22
Jan.	216	177	239	209	210
Means	161	146	179	227	

LSD at 0.05 for comparing means:	F ratio
Crops	NS
Fertilizer Sources	NS
Months	NS

NS Non-significant

Table 8. AVERAGE LOSS OF NITRATE-NITROGEN THROUGH SURFACE RUNOFF FROM COTTON AND CORN PLOTS TREATED WITH SULFUR-COATED UREA AND AMMONIUM NITRATE (g/ha)

1970-1971	Corn		Cotton		
Month	SCU	AN	SCU	AN	Means
June	8.1	6.0	16.4	6.8	9.3
July	1.0	4.2	2.4	2.4	2.5
Aug.	8.8	7.6	3.2	2.0	5.4
Oct.	3.0	2.9	24.5	4.6	8.7
Nov.	8.1	21.3	8.9	25.3	15.9
Dec.	0.4	0.4	0.3	1.8	0.7
Jan.	3.0	1.9	4.5	9.0	4.6
Means	4.6	6.3	8.6	7.4	
Grand Means	5.5		8.0		

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Fertilizer sources		NS
Months	5.5	6.7*

NS Non-significant

* Significant at the 5% level of probability.

Table 9. AVERAGE LOSS OF NITRATE-NITROGEN THROUGH SURFACE RUNOFF FROM PLOTS SEEDED TO DIFFERENT CROPS (g/ha)

1970-1971	Crops				
Month	Cotton	Corn	Soybeans	Check	Means
June	11.6	7.1	17.9	12.2	12.2
July	2.4	2.6	5.1	4.4	3.7
Aug.	2.6	8.2	9.6	6.5	6.7
Oct.	14.5	3.0	5.6	1.6	6.2
Nov.	17.1	15.7	10.0	4.8	11.7
Dec.	1.0	0.4	2.3	0.6	1.1
Jan.	6.8	2.4	5.8	3.0	4.5
Means	8.0	5.5	8.1	4.7	

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Months	5.5	5.6**

NS Non-significant

** Significant at the 1% level of probability

Table 10. AVERAGE LOSS OF TOTAL NITROGEN THROUGH SURFACE RUNOFF FROM PLOTS SEEDED TO DIFFERENT CROPS (g/ha)

1970–1971	Crops				
Month	Cotton	Corn	Soybeans	Check	Means
June	158	116	114	193	146
July	224	194	373	202	248
Aug.	35	213	138	96	120
Oct.	270	137	121	170	175
Nov.	487	193	161	345	296
Dec.	22	23	46	40	33
Jan.	224	196	203	159	196
Means	203	153	165	172	

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Months	115	5.1**

NS Non-significant

** Significant at the 1% level of probability

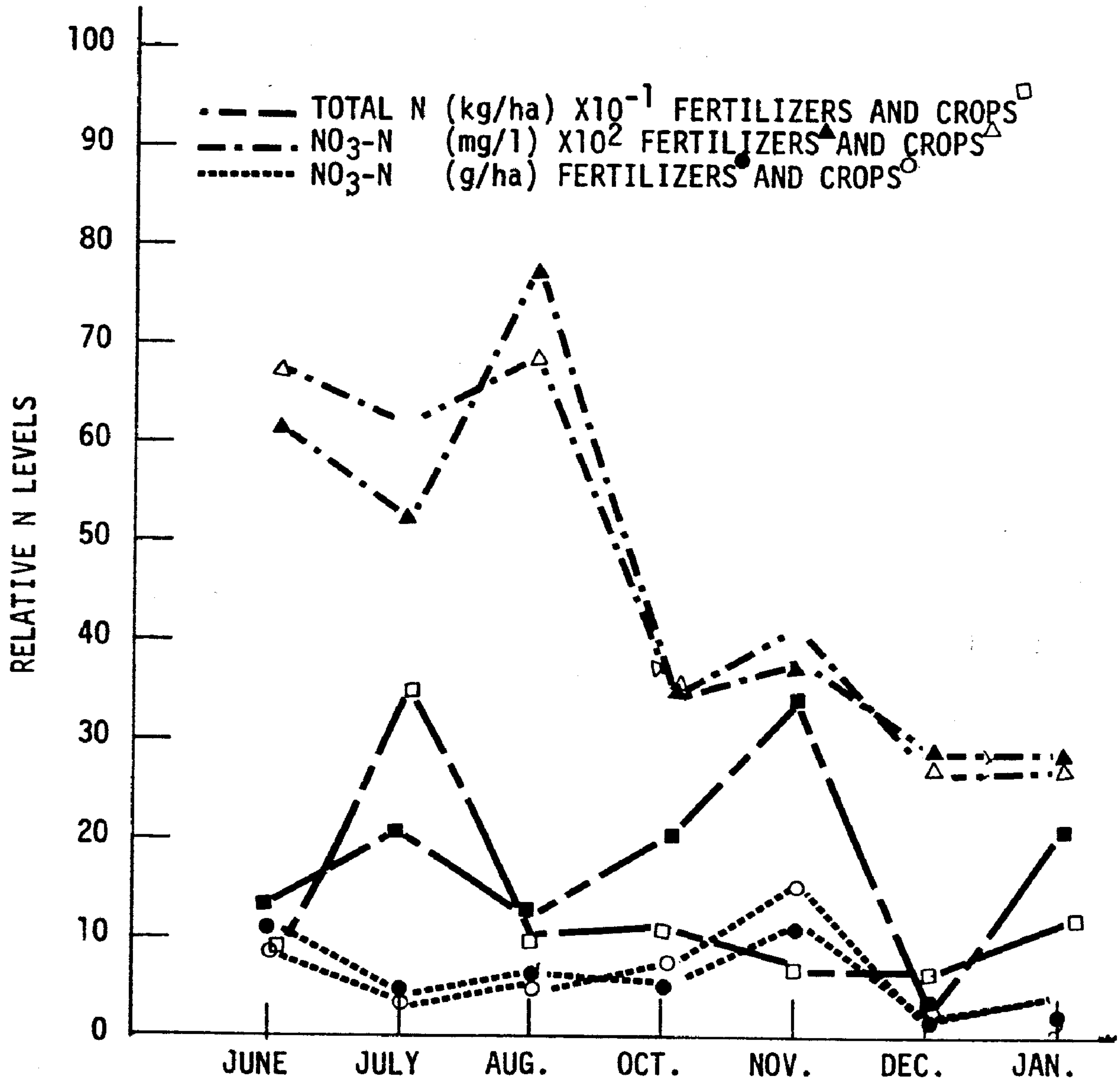

Figure 5. Nitrogen losses from plots through surface runoff during the 1970-1971 season.

Table 11. AVERAGE LOSS OF PHOSPHORUS THROUGH SURFACE RUNOFF FROM PLOTS SEEDED TO DIFFERENT CROPS (g/ha)

1970-1971	Crops				
Month	Cotton	Corn	Soybeans	Check	Means
June	4.5	5.6	4.3	1.0	3.8
July	1.2	1.8	1.0	0.3	1.0
Aug.	0.4	3.8	1.0	0.5	1.4
Oct.	5.4	4.3	1.2	0.8	2.9
Nov.	18.9	7.8	4.0	6.0	9.2
Dec.	0.5	0.4	0.8	0.3	0.5
Jan.	2.5	2.4	1.3	0.8	1.8
Means	4.8	3.7	1.9	1.4	

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Months	3.9	4.4**

NS Non-significant
** Significant at the 1% level of probability

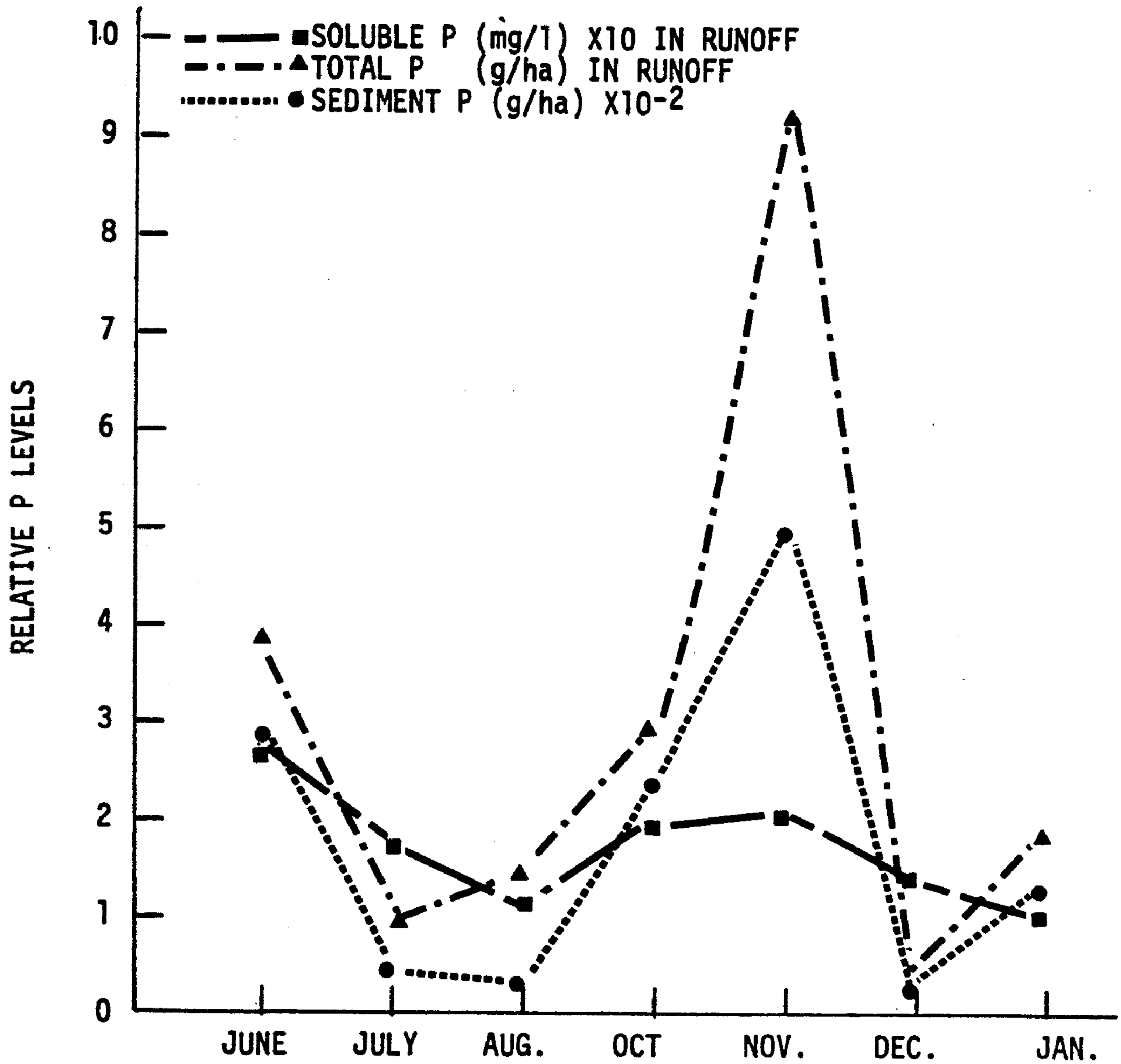

Figure 6. Phosphorus losses from plots through surface runoff during the 1970-1971 season.

loss suggesting that the seasonal conditions were more important considerations in controlling N and P losses from fields than were crop type and fertilizer forms.

Phosphorus data supported findings of the first cropping year which indicated that practically all P losses from the plots were associated with sediment.

1971-1972 CROPPING AND RUNOFF SEASON

Results

Rainfall data (cm/runoff producing rain) on plot area during the 1971-1972 season are given below:

Apr. 4/6	July 7/16	Aug. 8/6	Dec. 12/3	Dec. 12/11	Dec. 12/27	Jan. 1/3	Jan. 1/18	Feb. 2/1	Mar. 3/17
8.36	11.94	7.54	5.72	11.44	6.55	8.46	8.28	6.55	12.55

For 1971-1972 the data (surface and sediment runoffs, rainfall, total N, P, etc.) were prescribed for each runoff producing rain period rather than averaged over a month as was done in 1969-1970 and in 1970-1971. The average total rainfall, runoff, and sediment losses from the plots during 10 runoff producing periods for the 1971-1972 season are given in Figure 7. Runoff did not follow a similar distribution pattern to that of rainfall during most of the runoff producing rains. The lack of correlation between rainfall and runoff may have been due to variable rainfall intensity during the intervals between runoff periods.

Nitrogen Losses —
When compared with check plots, growing corn and millet did not reduce nitrogen losses from the plots (Tables 12, 13, and 14). However, total N and nitrate-nitrogen losses were significantly affected by AN, SCU, and by time of sampling during the season. The losses of N over the 1971-1972 cropping and runoff season were higher for SCU and AN treated plots than for check plots. Total N losses occurring in the first four runoff producing periods accounted for 50 to 70% of all N losses monitored (Fig. 8). Losses of N during the remaining 1971-1972 season were relatively uniform. However, NH_4-N losses were approximately five times those observed for NO_3-N. Computations from data in Tables 12 and 14 indicate that NH_4-N loss accounted for about 20% of total N losses through runoff.

Phosphorus Losses —
Total loss of P in 1971-1972 season are shown in Table 15. Corn and millet did not affect P losses from plots when compared with check plots.

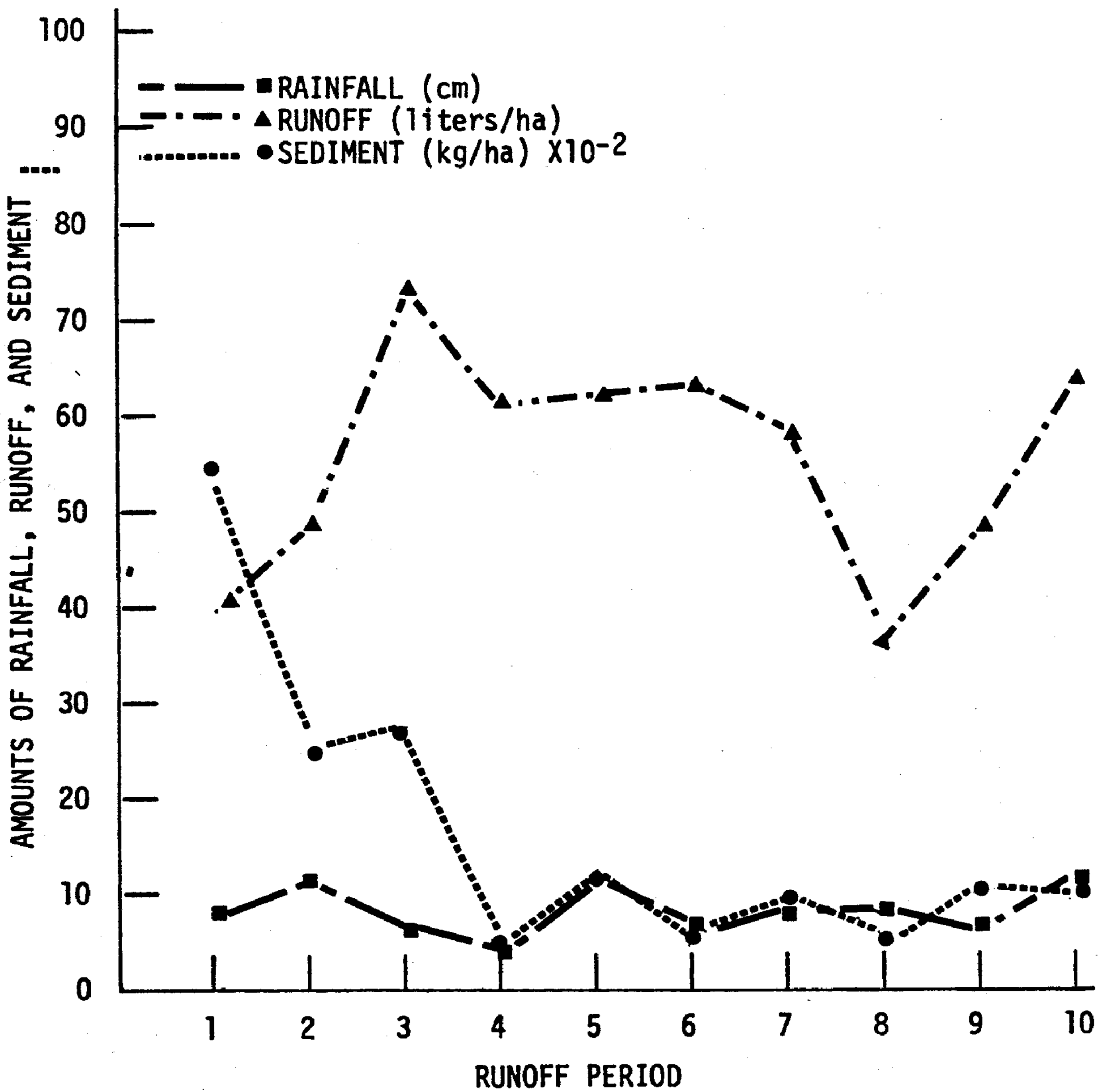

Figure 7. Relationships between rainfall, runoff, and sediment during the 1971-1972 season.

Table 12. LOSS OF TOTAL NITROGEN THROUGH SURFACE RUNOFF FROM CORN AND MILLET PLOTS TREATED WITH SULFUR-COATED UREA AND AMMONIUM NITRATE (g/ha)

1971-1972 Runoff date	Corn SCU	Corn AN	Millet SCU	Millet AN	Check	Means
Apr. 6	963	883	1045	542	418	770.2
July 16	471	536	653	475	405	508.0
Aug. 6	394	646	660	264	461	485.0
Dec. 3	233	416	335	170	359	302.6
Dec. 11	152	441	138	143	158	206.4
Dec. 27	125	260	132	128	165	162.0
Jan. 3	107	142	80	89	142	112.0
Jan. 18	239	171	276	242	153	216.2
Feb. 1	234	312	299	273	166	256.8
Mar. 17	180	325	284	262	204	251.0
Means	310	413	390	259	263	
Grand Means	329		304			

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Fertilizers	52	7.2**
Runoffs	94	34.9**
Crop x fertilizer x runoff interaction	208	NS

NS Non-significant

** Significant at the 1% level of probability

Table 13. LOSS OF NITRATE-NITROGEN THROUGH SURFACE RUNOFF FROM CORN AND MILLET PLOTS TREATED WITH SULFUR-COATED UREA AND AMMONIUM NITRATE (g/ha)

1971-1972	Corn		Millet			
Runoff date	SCU	AN	SCU	AN	Check	Means
Apr. 6	36.0	43.0	47.5	19.8	2.6	29.78
July 16	6.4	5.2	18.3	3.6	1.4	6.98
Aug. 6	15.7	5.9	19.9	3.9	2.6	9.60
Dec. 3	37.5	6.9	46.6	24.5	2.7	23.64
Dec. 11	6.6	4.5	17.3	10.3	2.0	8.14
Dec. 27	5.5	9.6	13.8	6.1	2.7	7.54
Jan. 3	1.7	2.6	7.7	2.0	1.8	3.16
Jan. 18	3.0	2.1	13.7	2.0	1.8	4.52
Feb. 1	2.3	1.9	2.0	1.5	1.3	1.80
Mar. 17	8.3	5.2	14.7	4.5	5.5	7.64
Means	12.3	8.7	20.1	7.8	2.4	
Grand means	7.8		10.1			

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Fertilizers	3.2	40.2**
Runoffs	5.9	14.7**
Crox x fertilizer x runoff interaction	14.1	NS

NS Non-significant
** Significant at the 1% level of probability

Table 14. LOSS OF AMMONIUM-NITROGEN THROUGH SURFACE RUNOFF FROM CORN AND MILLET PLOTS TREATED WITH SULFUR-COATED UREA AND AMMONIUM NITRATE (g/ha)

1971-1972	Corn		Millet			
Runoff date	SCU	AN	SCU	AN	Check	Means
Apr. 6	184	224	233	61	31	146.6
July 16	98	96	110	52	24	76.0
Aug. 6	108	95	122	53	28	81.2
Dec. 3	39	90	65	73	25	58.4
Dec. 11	21	55	25	30	11	28.4
Dec. 27	28	84	42	56	48	51.6
Jan. 3	30	57	27	40	40	38.8
Jan. 18	22	25	27	17	22	22.6
Feb.1	22	35	30	22	28	27.4
Mar. 17	28	27	31	27	35	29.6
Means	58	79	71	43	29	
Grand means	55		50			

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Fertilizers	14.9	15.0**
Crops x fertilizer interaction	21.0	6.3*
Crop x fertilizer x runoff interaction	31.0	4.4*

NS Non-significant
** Significant at the 1% level of probability

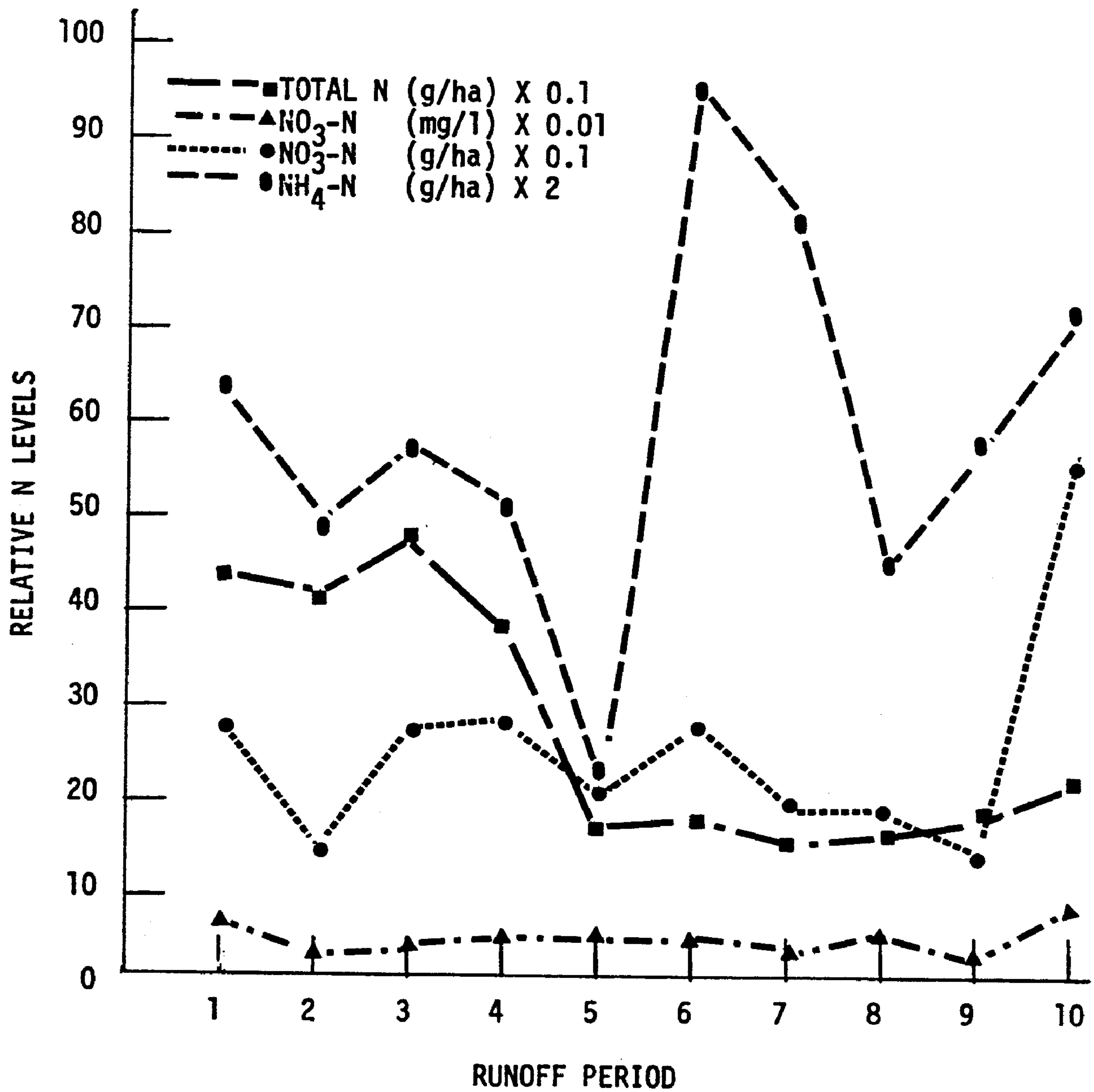

Figure 8. Nitrogen losses from plots through surface runoff during the 1971-1972 season.

Table 15. LOSS OF PHOSPHORUS THROUGH SURFACE RUNOFF FROM CORN AND MILLET PLOTS TREATED WITH SULFUR-COATED UREA AND AMMONIUM NITRATE (g/ha)

1971-1972	Corn		Millet			
Runoff date	SCU	AN	SCU	AN	Check	Means
Apr. 6	53.5	120.7	98.3	68.3	2.1	68.58
July 16	46.8	98.1	66.8	62.5	7.2	56.28
Aug. 6	52.2	109.7	44.2	41.1	9.5	51.34
Dec. 3	18.1	12.7	11.5	15.9	7.2	13.08
Dec. 11	15.1	15.5	14.3	12.0	3.9	12.16
Dec. 27	12.2	26.9	63.8	17.9	7.5	25.66
Jan. 3	18.3	17.0	14.0	15.4	11.6	15.26
Jan. 18	41.3	27.4	47.7	47.1	5.7	33.84
Feb. 1	36.3	43.6	49.7	33.5	9.2	34.46
Mar. 17	37.3	46.9	59.0	45.8	9.8	39.76
Means	33.1	51.9	46.9	36.0	7.4	
Grand means	40.0		43.9			

LSD at 0.05 for comparing means:		F ratio
Crops		NS
Fertilizers	9.7	37.5**
Runoffs	17.8	7.1**

NS Non-significant
** Significant at the 1% level of probability

The P levels in runoff were highest in the first three runoff periods and lower during the fourth, fifth, sixth, and seventh periods (Fig. 9). The P losses in runoff in 1971-1972 were not as closely related to sediment loss as in the 1969-1971 period.

Discussion

The application of 100 kg/ha N as SCU and AN increased N losses from plots cropped with corn and millet during April to December 1971, especially where SCU was applied. Data from samples taken April 6th reflect high values for nutrient loss since the plots had been rototilled and fertilized on April 3rd just prior to a runoff producing rain. In the first four runoff producing periods, the lighter weight and larger pelleted SCU may have washed with the runoff resulting in an inflated value of total N loss from such plots when compared with AN.

The results obtained in this study suggest that for annual corps, SCU is not superior to AN in controlling N and P losses through surface runoff. Cropping practices employed for growing millet and corn apparently had no effect on N and P losses.

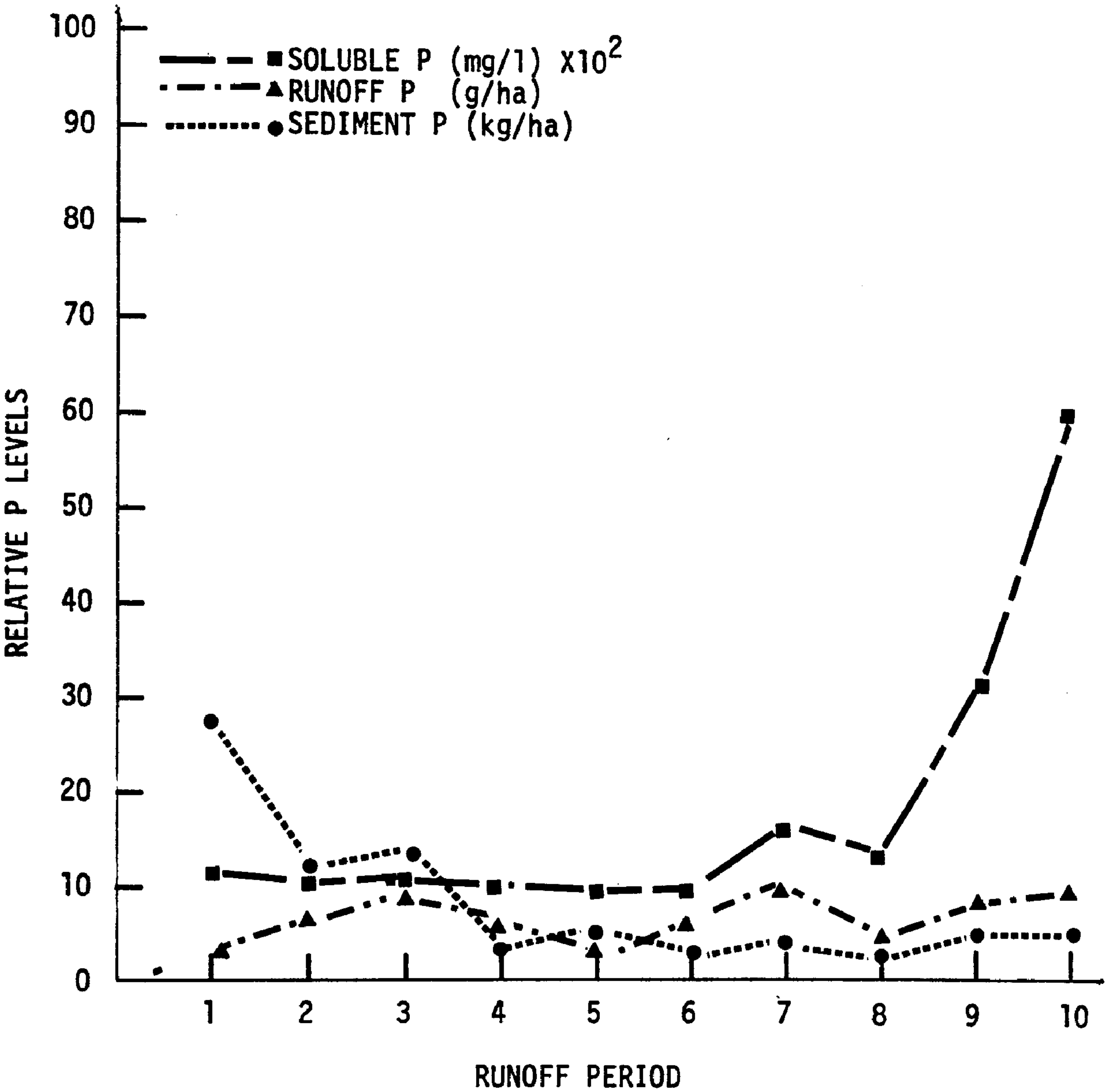

Figure 9. Phosphorus losses from plots through surface runoff during 1971-1972 season.

SECTION VI

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SECTION VII

GLOSSARY

AN — Ammonium-nitrate

N — Nitrogen

NH_4-N — Ammonium-nitrogen

NO_3-N — Nitrate-nitrogen

P — Phosphorus

SCU -- Sulfur-coated urea (slow-release nitrogen fertilizer)

Total Nitrogen -- Organic nitrogen plus ammonium nitrogen

Average monthly losses — Sum of concentrations, vclumes, or quantities, measured for each runoff producing rain during a given month divided by the total number of runoff producing rains for the month.

Check Plots — Those plots which were uncropped and unfertilized.

Infiltration — Movement of water from the surface into the soil.

Non-treated Plots — Plots to which no fertilizers were applied.

Percolation - Movement of water through the soil.

Surface Runoff — The water fraction of surface runoff after sediment has been removed from water.

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16. Abstract

A study of nitrogen and phosphorus losses from Decatur silt loam soil was conducted over three cropping periods from 1969-1972. Experimental agronomy plots at Alabama A. & M. University were seeded to cotton, corn, soybeans, and millet and compared with uncropped and unfertilized check plots.

The effects of these crops on nitrogen losses — total nitrogen, nitrate-nitrogen, and ammonium-nitrogen (for 1971-1972 only) — and phosphorus losses were evaluated. Average total rainfall and losses of sediment and runoff were also determined.

Losses of total nitrogen and nitrate-nitrogen were generally positively correlated with the amounts of rainfall, runoff, and sediment. Phosphorus losses were positively correlated with sediment losses. More than 95% of phosphorus losses were associated with sediment loss. The effect of crops on loss of all nutrients was considerably smaller than seasonal effects and sediment losses.

The effect of two fertilizers, ammonium nitrate and sulfur-coated urea, upon nutrient losses showed no evidence of superiority for sulfur-coated urea in reducing the total nitrogen or nitrate-nitrogen losses.

17a. Descriptors Water qualtiy, Water pollution — agricultural sources, Nitrogen - Phosphorus losses. Cropping effects, Seasonal effects, Fertilizer effects, Sediment losses, Cultural practices.

17b. Identifiers

Nutrient loss reduction, North Alabama Decatur silt loam, Seasonal-Cropping-Fertilizer Effects, Water quality — Sediment loss Interaction.

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