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UTILIZATION OF NITROGEN FROM CROP RESIDUES IN OXISOLS AND ULTISOLS

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INTRODUCTION

With the increased cost of N fertilizer and its unavailability in many of the less developed countries, increased attention must be given to alternate sources of N in crop production. An examination of the amount of N which can be supplied from mineralization of crop residues is essential, especially under the conditions of the well drained, acid soils in the humid tropics. Of particular importance is the role of grain legumes in a rotation to supply food and provide N to a succeeding crop.

The availability of N in crop residues to succeeding crops has not been well evaluated. Total N content of residues and maturity of crop most certainly influence the N availability.

The objective of this study was to determine the N supplied by crop residues to succeeding crops in rotation experiments conducted on Oxisols and Ultisols.

MATERIALS AND METHODS

Crop rotation experiments were conducted on three different soils : sandy Oxisol (Bayamon), typic Haplorthox, clayey with high sand content, oxidic isohyperthermic, clayey Ultisol (Humatas), typic Tropohumult, clayey kaolinitic isohyperthermic ; and clayey Oxisol (Catalina), Tropeptic Haplorthox, clayey, oxidic, isohyperthermic. The Bayamon soil occurs at an elevation of 50 to 130 m while the Catalina and Humatas are at elevations of 220 to 580 m. At all experimental sites the pH was about 5.2. Chemical characteristics are shown in Table 1.

Table 1 - Selected chemical properties of soils used in the crop residues experiments

Soil	Depth cm	Organic Matter	pH	C.E.C. cations meq/100 g	Exchangeable cations meq/100			
					Ca	Mg	K	Al
Bayamon Sandy Loam	0-25	1.6	5.2	2.5	1.3	0.8	0.1	0.3
	24-50	0.7	4.8	2.3	1.2	1.2	0.7	0.4
Humatas clay	0-25	3.7	5.1	7.9	6.4	0.8	0.7	0
	25-50	1.2	4.6	12.4	3.0	0.8	0.2	8.4
Catalina clay	0-25	3.9	5.2	8.7	7.1	1.0	0.6	0
	25-50	1.2	5.2	4.8	4.0	0.6	9	0

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The rotation experiments followed split-plot designs with six replications. The main plots were three rotations : soybeans, corn, corn ; fallow corn, corn and corn, corn, corn. The subplots inclued two treatments for the two corn crops following the initial crop : 0 and 110 kg/ha of N applied as urea, one fourth at planting time and be the rest when the plants were one month old.

For the first crop in the rotation, corn hybrid Pioneer X-306B and soybean variety Jupiter were planted in the corresponding plots on the same day. Grasses and weeds were allowed to grow on the fallow plots. Weeds were removed by hand from the corn and soybean plots as necessary. Crop protection practices to prevent insect and disease incidence were followed as recommended under local conditions. The plots at the sandy Oxisol and at the clayey Ultisol were irrigated as necessary using a sprinkler system. The soybean and corn experimental plots received a complete fertilizer at planting, except that no N was applied to the soybeans.

After harvesting the first corn and the soybean crops, the corn roots, soybean stover, and weed fallow were plowed about 2 weeks before planting the next crop (X-306 B corn). The second and third crops in the rotation (corn), also received a complete fertilizer, except that half of each plot received no N while the other half received N at the rate of 110 kg/ha. Data on grain yields were taken at the three locations. In addition, the amount of soybean stover and weed fallow were determined at the sandy Oxisol and analyzed for N.

RESULTS AND DISCUSSION

Table 2 - Initial soybean and corn grain yields.

Soil type	Soybean yield kg/ha	Corn yield kg/ha
Bayamon sandy loam	1743	4950
Humatas clay	1620	6240
Catalina clay	1061	4473

The soybean yields are only fair when compared with yields of previous experiments at the same sites. Yields of about 3170 kg/ha have been previously obtained in the Bayamon sandy Oxisol and in liming experiments at other sites. The corn yields are good especially at the Humatas site.

The grain yields of the corn crops following the initial corn crop, soybean crop and fallow are given in Table 3 for the three sites. In the first crop on both the Bayamon and the Humatas soils, corn with and without fertilizer N (as whole treatments) following soybeans yielded substantially more than corn following fallow. Mean differences were significant. This was not the case at the Catalina clay site.

Table 3 - The effect of plowed in soybean stover, fallow and corn ratoons on yield of field corn X-306B (kg/ha).

Treatments	Bayamon sandy loam		Humatas clay		Catalina clay
	Crop 1 kg/ha	Crop 2 kg/ha	Crop 1 kg/ha	Crop 2 kg/ha	Crop 1 kg/ha
Fallow, N	2377	4073	1814	3162	4461
Fallow + N	3940**	5577**	3867**	6765**	5734**
Soybean N	3972	4325	2770	3005	4782
Soybean + N	5745**	5595**	4495**	6488**	6729**
Corn, N	2879	3816	2137	2773	4870
Corn, + N	5284**	5413**	5088*	6369**	5976**

1/** Highly significant over no nitrogen

The effect of applied fertilizer N on succeeding corn crops is striking at all sites for that corn crop regardless of the previous crop. For the Humatas soil soil the yield was doubled in five instances out of six and for the Bayamon soil the increased yield due to applied N are also evident at the Catalina site.

Table 4 presents data on the amount of soybean stover and weed fallow plowed in and their N content. The N content is presented in increasing amounts as calculated from its percent and dry matter. There was no apparent statistical relationship between the amount of N returned to the soil from these residues and average yields of the subsequent corn crops. When the grain of a legume such as soybeans is harvested, the stover has a low N content and a relatively high C/N ratio. Consequently, the mineralization of the residues and release of available N to the succeeding crop is likely to be low.

It should be noted that the three continuous cron crops on Humatas soil, which were harvested over a period of less than 14 months, produced about 18,000 kg/ha of grain with the application of 110 kg/ha of N per crop. This would not be possible unless a substantial amount of N was applied from sources other than the applied N such as mineralization of soil organic matter or root residues.

This initial work should lead to further studies with other edible legumes in the rotation which after harvesting would have more green matter in the stover with a lower C/N ratio. Mineralization studies should help to clarify the situation.

Table 4 - Dry matter plowed in, its nitrogen content and yield data of field corn X-306B

Treatment	Dry matter kg/ha	Nitrogen kg/ha	Ave corn yield two crops kg/ha
Bayamon sandy loam			
Fallow	5270	78	2478
	6430	90	3196
	6240	98	3999
	8330	140	3596
	8450	142	2375
	9580	144	3740
Soybean stover	790	7	4047
	1025	7	4616
	1090	8	4691
	1340	9	3838
	1490	10	3800
	1671	12	4077
Humatas clay			
Fallow	2370	26	2480
	3280	288	2386
	4770	51	2854
	4495	55	2942
	5535	68	2264
	6640	70	1999
Soybean stover	4560	11	2835
	5730	12	3461
	3060	35	2920
	3200	42	2075
	4440	55	2967
	5070	101	3068
Catalina clay[1]/			
Fallow	780	9	6342
	880	10	2394
	1020	18	4391
	1730	19	4255
	2550	33	5738
	4100	82	3468
Soybean stover	3000	22	4562
	3000	23	4600
	3500	30	4500
	5510	46	5618
	5400	49	5732
	5300	62	3659

[1]/ Yield of one corn crop.