COVER CROPS AND NITROGEN MANAGEMENT FOR NO-TILLAGE CORN

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ABSTRACT

Growth and yield of corn (Zea mays L.) are influenced hy N nutrition and crop management schemes. The objective of this study was to determine the N fertilizer requirements for corn following four different winter crops in four different experiments with conventional and no-tillage management. Five management regimes (conventional tillage after winter crop for forage, conventional tillage using winter crop for green manure, no-tillage using winter crop for a mulch, no-tillage after winter crop for forage, and conventional tillage fallow) were employed as main treatments in a randomized complete block design with five levels of inorganic N (0, 67, 134, 201, and 268 kg N ha^{-1} as split plots. Each experiment was replicated four times on an Arredondo fine sand (sandy, siliceous, thermic Grossarenic Paleudult) near Gainesville, Florida. No-tillage corn from the no-tillage mulch treatment reached the Nsufficiency level of 2.70% or higher with only 67 kg N ha-1 when using crimson clover (Trifolium incarnatum L.) or lupine (Lupinus angustifolius L.) as cover crops. Reduction of fertilizer recommendations by 67 to 134 kg N ha^{-1} may be possible for irrigated corn, depending upon the tillage system and cover crop. Implications for reductions in pollution of water with N fertilizer are obvious if these findings continue to prove accurate.

INTRODUCTION

Nitrogen is the single most important fertilizer input and is required in the largest quantities for crop production (Olson and Sander, 1988). A corn crop has a sufficient level of N if the concentration in the ear leaf at early silking and tasseling is between 2.70% and 4.00% (Jones et al., 1991). Legumes are one source of organic N that can be sacrificed for succeeding crops as a cover crop in double-cropping systems (Gallaher and Eylands, 1985; Huntington et al., 1985; Reeves, 1992). Cover crops, especially rye (Secale cereale L.), not only provide cover to protect the soil against erosion, hut also provide a good mulch to compete against weeds, moderate soil temperature, and conserve water for succeeding crops, such as no-tillage corn (Gallaher, 1977). Cover crops can be killed before or after planting the succeeding crop using no-tillage management (Gallaher, 1980; Gallaher, 1986). The objective of this study was to determine the N fertilizer requirements for corn following four different winter crops in four different experiments with conventional and no-tillage management.

MATERIALS AND METHODS

The studies were conducted at the University of Florida Green Acres Agronomy Farm near Gainesville on an Arredondo fine sand (94% sand, 2% silt, 4% clay). Winter crops that preceded the corn in each of the four experiments were Wrens Aburzzi' rye, hairy vetch (Vicia villosa L. Roth.), 'Tift Blue' lupine and 'Dixie' crimson clover. Five management regimes (conventional tillage after winter crop for forage, conventional tillage using winter crop for green manure, no-tillage using winter crop for a mulch, no-tillage after winter crop for forage, and conventional tillage fallow) were employed as main treatments in a randomized complete block design with five levels of inorganic N (0, 67, 134, 201, and 268 kg N ha^{-1}) as split plots. Each experiment was replicated four times.

Pioneer Brand 3320 temperate corn was planted with an in-row subsoil no-tillage planter in early March 1992 to achieve a final population of 76,500 plants ha^{-1}. Carbofuran, atrazine, metolachlor, and gramoxone plus X77 surfactant were applied at planting at labeled rates for control of insects and weeds. Water was applied by overhead sprinkler. From tasseling through rapid grain fill, 3 cm of water was applied every 4 days, depending upon rainfall. Additional fertilizer was broadcast at planting according to soil test recommendations.

Sampling for ear leaf N and yield was taken from the center two rows of the four-row plots. Ear leaf samples were collected at early tasseling and silking. Leaf samples were dried at 70 C in a forced air oven, ground to pass a 2-mm stainless steel screen in a Wiley mill, and stored in air-tight plastic bags. Micro-Kjeldahl techniques were used to determine leaf N levels (Gallaher et al., 1975; Gallaher et al., 1976). Grain yields were determined at black layer.

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Data was subjected to routine analysis of variance (ANOVA) for a split-plot experimental design. Duncan's new multiple range and LSD tests were used to separate tillage and N treatment means, respectively. Main treatment, sub-treatment, or interaction means were separated appropriately when significance occurred at the 0.05 level of probability.

RESULTS AND DISCUSSION

The Florida Extension Service recommends 268 kg N ha^{-1} for irrigated corn seeded for 74,000 plants ha^{-1}, which were the conditions for these experiments. It was observed that for most tillage systems, corn after rye reached the 2.70% N or higher sufficiency level (Jones et al., 1991) with only 201 kg N ha^{-1} (Table 1). Heavy infestation of root-knot nematodes (Meloidogyne incognita, [Kofoid and White] Chitwood) reduced the growth of vetch and is likely the reason for corn response to inorganic N fertilizer to be no better than that after the rye cover crop. The no-tillage mulch treatment resulted in the 2.70% N or higher level with only 67 kg N ha^{-1} in the corn after crimson clover and corn after lupine experiments. The benefits of cover crops in obtaining the lowest level of the N sufficiency range (2.70%) ranked in order of greatest to least benefit would be lupine > crimson clover > rye = vetch under the conditions of these experiments.

Grain yield responded to inorganic N in a quadratic manner in all experiments and tended to level off at about 201 kg N ha^{-1} (Table 2). All tillage systems gave similar responses for corn after rye and crimson clover, but fallow treatments had lower corn yields than the four cover crop treatments after vetch and lupine. Irrigation likely eliminated some of the mulching benefits from the cover crops, but also, likely provided an environment for better N use efficiency. These experiments show that the use of cover crops could reduce the N recommendation for irrigated corn by 67 to 134 kg ha^{-1} depending upon the tillage system and cover crop.

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Table 1. Corn ear leaf N (%) affected by cover crop-tillage management and N fertilizer in 1992.

Tillage†	Nitrogen level (kg ha^{-1}) 0	67	134	201	268	Avg
	percent					
	Corn after Rye					
CT-F	2.38	2.05	2.64	2.86‡	3.16	2.62a
CT-GM	2.19	2.01	2.56	3.01	3.07	2.56a
NT-M	2.47	2.39	2.37	2.91	3.18	2.66a
NT-F	2.25	1.86	2.22	2.42	2.96	2.34a
Fallow	1.77	1.87	2.14	2.14	3.01	2.31a
Avg	2.21y	2.032	2.38x	2.79w	3.07v	
	CV=10.42% LSD=0.16 Interaction was not significant					
	Corn after Vetch					
CT-F	1.70	2.45	2.56	2.89	3.00	2.52a
CT-GM	1.96	2.11	2.43	*2.10*	2.93	2.43a
NT-M	2.01	2.51	2.57	2.59	3.15	2.57a
NT-F	1.19	2.06	2.37	2.84	3.02	2.44a
Fallow	1.33	1.83	2.31	2.66	2.97	2.22 b
Avg	1.782	2.19y	2.45x	2.74w	3.01v	
	CV=10.12% LSD=0.15 Interaction was not significant					
	Corn after Crimson Clover					
CT-F	1.86	2.53	2.62	2.95	3.10	2.61 b
CT-GM	2.53	2.62	2.11	2.98	3.23	2.83a
NT-M	1.87	2.82	2.74	2.91	2.99	2.66ab
NT-F	1.64	2.52	2.52	2.73	3.22	2.53 b
Fallow	1.71	2.39	2.75	3.10	3.16	2.62 b
Avg	1.92y	2.57x	2.68x		2.93w	3.14v
	CV=11.88% LSD=0.20 Interaction was not significant					
	corn after Lupine					
CT-F	2.40x a	2.72w ab	2.80vw a	3.04w a	3.06v a	2.80
CT-GM	2.21x a	2.64w ab	2.83vw a	3.11v a	3.10v a	2.78
NT-M	2.24x a	2.79vw a	2.76w a	3.03vw a	3.07v a	2.78
NT-F	1.85x b	2.44w b	2.69w a	3.12v a	3.21v a	2.66
Fallow	1.64y b	1.97x c	2.64w a	2.96v a	3.10v a	2.46
Avg	2.07	2.51	2.75	3.05	3.11	
	CV=7.89% LSD=0.30 Interaction was significant					

†CT-F=Conventional tillage using winter crops for forage; CT-GM=Conventional tillage using winter crops for green manure; NT-M=No-tillage using winter crops for mulch; NT-F=No-tillage using winter crops for forage; Fallow=Conventional tillage with no winter crop. Values in columns among tillage treatments not followed by the same letter (a,b,c,d,e) are significantly different at the 0.05 level of probability according to Duncan's multiple range test. Values in rows among N levels not followed by the same letter (v,w,x,y,z) are significantly different at the 0.05 level of probability according to LSD. Nitrogen sufficiency range should be between 2.70% to 4.00% (Jones et al., 1991).

*Bold values show lowest N fertilizer required to obtain at least 2.70% N.

Table 2. Corn grain yield (15.5% moisture) affected by cover crop-tillage management and N fertilizer in 1992.

Tillage†	Nitrogen level (kg ha^{-1}) 0	67	134	201	268	Avg
	g m^{-2}					
	Corn after Rye					
CT-F	241	597	879	1136	1112	795a
CT-GM	180	649	838	999	1118	757a
NT-M	236	721	834	1146	1170	801a
NT-F	238	595	782	1111	983	742a
Fallow	134	525	751	837	1063	662a
Avg	207y	617x	817w	1046v	1069v	
	cV=15.52%	LSD=73	Intaraction was not significant			
	Corn after Vetch					
CT-F	371	679	878	1022	1071	804a
CT-GM	364	637	783	921	1090	759a
NT-M	356	672	824	968	1082	780a
NT-F	335	621	836	948	1013	750a
Fallow	165	564	780	993	1129	726 b
Avg	318z	635y	820x	971w	1077v	
	CV=12.30%	LSD=59	Interaction was not significant			
	Corn after Crimson Clover					
CT-F	454	771	1098	1331	1317	994a
CT-GM	511	840	988	1325	1302	993a
NT-M	447	787	1052	1325	1292	981a
NT-F	366	719	978	1263	1225	910a
Fallow	286	731	961	1194	1415	917a
Avg	413y	769x	1015w	1287v	1310v	
	CV=15.03%	LSD=91	Interaction was not significant			
	Corn after Lupine					
CT-F	938y a	1093xy a	1189wx ab	1357vw ab	1402v a	1196
CT-GM	734y bc	993x a	1164wx b	1323vw ab	1439v a	1131
NT-M	819x ab	1038w a	1363v a	1475v a	1451v a	1229
NT-F	620x c	997w a	1250v ab	1375v ab	1411v a	1131
Fallow	440z d	661y b	986x c	1218w b	1412v a	943
Avg	710	956	1190	1350	1423	
	CV=10.75%	LSD=171	Interaction was significant			

†CT-F=Conventional tillage using winter crops for forage; CT-GM=Conventional tillage using winter crops for green manure; NT-M=No-tillage using winter crops for mulch; NT-F=No-tillage using winter crops for forage; Fallow=Conventional tillage with no winter crop. Values in columns among tillage treatments not followed by the same letter (a,b,c,d,e) are significantly different at the 0.05 level of probability according to Duncan's multiple range test. Values in rows among N levels not followed by the same letter (v,w,x,Y,z) are significantly different at the 0.05 level of probability according to LSD.