



UNIVERSITY OF
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Ms. Marlene Czerniak
Florida Dept. of Agricultural & Consumer Services
Agricultural Environmental Services
3125 Conner Boulevard, Suite 125
Tallahassee, FL 32399-1650

Dear Ms. Czerniak,

Please find enclosed the annual progress report for the FDACS funded project **5533** titled, "Utilization of legumes in crop rotation programs to reduce nitrate leaching from potato production into the upper St. Johns River watershed".

If you have any questions or comments, please do not hesitate to contact me.

Sincerely,

Chad Hutchinson

cc: Pat Muse, Horticulture Department, University of Florida
Sherri Stephens, IFAS Office of Sponsored Programs, University of Florida

**Annual Progress Report – FDACS Project
Year 2, 2001-2002**

Title: Utilization of legumes in crop rotation programs to reduce nitrate leaching from potato production into the upper St. Johns River watershed

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Personnel: This past season, personnel funding was used to support one technical position and temporary staff as needed for management of the project. The technician managed the data collection from the plots in an efficient and professional manner. A graduate student has been assigned to the project. The student is beginning to compile all data from the first two seasons into a complete report.

Background: Best Management Practices (BMPs) are under consideration for potato production in the Tri-County Agricultural Area (St. Johns, Putnam, and Flagler counties) near Hastings, Florida. BMPs will reduce nitrate non-point pollution in the St. Johns River from potato production areas. Although these BMPs do not restrict farming, potato growers are concerned that the fertilizer recommendations may result in reduced production. The funded proposal investigates the ability of legumes planted as both a summer cover crop and fall cash crop to supply nitrogen to the following potato crop. With legumes in rotation, growers may be able to supply potato plants with high nitrogen rates while meeting the BMP rate for inorganic nitrogen. The treatments are: cowpea, sorghum/sudan grass hybrid, or no summer cover crop in combination with fall planted bush bean (Table 1). Potatoes will be planted in all plots following beans and fertilized at five nitrogen rates (0, 100, 150, 200, 250 lb/acre). Soil, plant, and water nutrient levels will be measured in all three crops. Nitrogen use efficiency for the potato crop will be determined. Loss of nitrogen from the system will be estimated under each treatment. Cost studies will be prepared that enable growers to compare the cost of the alternative systems to present systems.

Table 1. Cropping Systems for Potato Production Field Experiment

Main Plot	Sub-Plot	Crops			Nitrogen Treatment
		Summer	Fall	Winter/Spring	
1	A	Sorghum/Sudan	None	Potato	0 lb/acre N
	B	Sorghum/Sudan	None	Potato	100 lb/acre N
	C	Sorghum/Sudan	None	Potato	150 lb/acre N
	D	Sorghum/Sudan	None	Potato	200 lb/acre N
	E	Sorghum/Sudan	None	Potato	250 lb/acre N
2	A	Sorghum/Sudan	Bush Green Bean	Potato	0 lb/acre N
	B	Sorghum/Sudan	Bush Green Bean	Potato	100 lb/acre N

	C	Sorghum/Sudan	Bush Green Bean	Potato	150 lb/acre N
	D	Sorghum/Sudan	Bush Green Bean	Potato	200 lb/acre N
	E	Sorghum/Sudan	Bush Green Bean	Potato	250 lb/acre N
3	A	Cowpea	None	Potato	0 lb/acre N
	B	Cowpea	None	Potato	100 lb/acre N
	C	Cowpea	None	Potato	150 lb/acre N
	D	Cowpea	None	Potato	200 lb/acre N
	E	Cowpea	None	Potato	250 lb/acre N
4	A	Cowpea	Bush Green Bean	Potato	0 lb/acre N
	B	Cowpea	Bush Green Bean	Potato	100 lb/acre N
	C	Cowpea	Bush Green Bean	Potato	150 lb/acre N
	D	Cowpea	Bush Green Bean	Potato	200 lb/acre N
	E	Cowpea	Bush Green Bean	Potato	250 lb/acre N

Project Objectives:

1. Increase crop diversification and production in the tri-county potato production area surrounding Hastings, Florida while maintaining or reducing nitrate movement from farming operations into the St. Johns River.
2. Compare the nitrate leaching potential associated with alternative crop rotation schedules to traditional potato production practices.
3. Document crop growth and production under a reduced inorganic nitrogen system that takes advantage of legumes for nitrogen production.
4. Develop an analysis of the economic costs and returns associated with alternative cropping systems compared to traditional potato production practices and make cost studies available to growers in the area.

Progress on Objective 1:

The first objective is actually an overall goal for the project. This goal is met through the combination of research and extension programs. Year one results were presented at the Tri-County Agricultural Fair in October 2001. The results of the first and second season will be presented in Toronto, ON, Canada at the International Society of Horticulture, American Society of Horticultural Science, and Potato Association of America combined meetings in August, 2002. In addition, the results will be presented in Indianapolis, IN, USA at the Soil Science Society of America meetings in August, 2002. A summary of the results from the first two years will be presented in a fact sheet format and distributed to county faculty in potato growing areas of the state.

Progress on Objective 2:

Plant tissue samples, soil samples, and water samples were collected with little modification from the protocol listed in the original proposal. Results have not returned from the UF Analytical Research Laboratory for the 2002 potato season. At this time, this data cannot, therefore, be summarized. A more complete report on nitrate leaching will be presented in the final report.

There were visual differences in the potato crop over the first two seasons dependent on the nitrogen treatments that should correlate to nitrogen levels in the plant tissue. There were visual differences in the cover crop planted in June 2001 following the potato crop (Fig 1, Table 2). These differences indicate that the potato crop did not fully utilize the nitrogen applied in the high nitrogen plots during the first production year. These visual differences will be verified by analyzing plant dry weight and tissue samples.



Figure 1. Cowpea and sorghum-sudan grass cover crop following potato. Growth differences between plots are attributed to the amount of residual nitrogen remaining in the bed following potato.

Progress on Objective 3:

Documentation of green bean and potato production under a reduced inorganic nitrogen system can be reported. Yields from the 2001 green bean crop are reported in Table 3. Although not significant, green bean plants following cowpea produced 36 more boxes per acre of green beans than plants following sorghum-sudan grass cover crop.

The potato crop grew under less than ideal conditions. Record high temperatures late in the season were recorded in the Hastings area. Although tuber set was good, high temperatures late in the season reduced tuber bulking. This resulted in reduced yields compared to the first season. The season was very dry with the majority of water for crop production supplied through the seepage irrigation system.

To summarize production results, all interactions of the split plot design were analyzed. Results for total yield of potato will be presented.

- Total yields of potato for the main cover crop plots (sorghum-sudan and cowpea) were 227 and 212 cwt/acre, respectively, and were not significantly different.
- Total yields of potato for the fall crop sequence (green beans and no fall crop) were 216 and 223 cwt/acre, respectively, and were not significantly different.

- The interaction of summer cover and fall cash crop for total yield were not significantly different: cowpea/green bean 211 cwt/acre; cowpea/no crop 214 cwt/acre; sorghum-sudan/green bean 222 cwt/acre; and sorghum sudan/no crop 232 cwt/acre.
- There was a significant interaction between nitrogen treatments for total yield: the no nitrogen treatment produced significantly fewer potatoes than all other nitrogen treatments (110 cwt/acre). The 100, 150, 200, and 250 lb/acre N treatments produced 243, 250, 254, and 242 cwt/acre, respectively.
- There was a significant interaction between the summer cover crop and potato nitrogen rate for potato total yield. The no-nitrogen potato treatment for both cover crops produced significantly fewer potatoes than all the fertilized treatments.
- The fall crop/nitrogen treatment interaction production data was the most interesting data set (Table 4). Marketable production of potatoes in the green bean - 0 lb N/acre treatment was 36 cwt/acre more than in the fallow - 0 N lb/acre treatment. The summary of this interaction is that a legume fall cash crop may be supplying nitrogen to the following potato crop. However, in all other treatments total and marketable yield were either the same or higher in the fallow plots compared to the green bean plots. So, at higher nitrogen rates, the addition of nitrogen from the fall bean crop to the system is masked.

Progress on Objective 4.

An analysis of the economic costs and returns associated with alternative cropping systems compared to traditional potato production practices is being developed.

Conclusion:

The second year was successful even though yields were lower than expected due to weather conditions. Priorities for the coming year are to get the graduate student fully involved in the project and to have him summarize the data from the first two seasons.

Table 2. Sorghum-sudan grass (Sudex) and cowpea cover crop production following potato nitrogen treatments.

Fall TRT	Nitrogen TRT ¹ lb/acre	Plant Dry Weight lb/A
Cowpea	0	4,001
Cowpea	100	3,378
Cowpea	150	3,962
Cowpea	200	4,112
Cowpea	250	5,004
Sudex	0	2,164
Sudex	100	2,781
Sudex	150	3,506
Sudex	200	8,085
Sudex	250	7,202

¹Nitrogen was applied to the spring potato. No fertilizer was applied to the summer cover crop. All cover crop production is attributed to residual nitrogen in the field following potato.

Table 3. Green bean yield following sorghum-sudan grass (Sudex) and cowpea cover crop expressed as a function of potato fertilization rate.

Fall TRT	Nitrogen TRT lb/acre	Green Bean Yield 30 lb boxes/A
Cowpea	0	219
Cowpea	100	198
Cowpea	150	189
Cowpea	200	200
Cowpea	250	217
Sudex	0	162
Sudex	100	171
Sudex	150	184
Sudex	200	171
Sudex	250	155
LSD		ns
<i>p</i> -value		0.33

Table 4. Production statistics for fall cover crop/nitrogen treatment interaction for the 2002 potato season.

Variety: Atlantic
 Planted: February 12-13, 2002
 Harvested: June 3, 2002

Fall TRT	Nitrogen TRT lb/acre	Total Yield cwt/A	Market. Yield cwt/A	% Culls cwt/A	Size Distribution by Class (%) ¹					Size Distribution (%)		Specific Gravity
					1	2	3	4	5	2 to 4	3 to 4	
Green Bean	0	127	96	15	12	80	8	0	0	88	8	1.064
Green Bean	100	234	196	9	8	61	29	2	0	92	32	1.073
Green Bean	150	236	199	9	8	55	35	3	0	92	38	1.074
Green Bean	200	257	218	8	8	57	33	2	0	92	35	1.076
Green Bean	250	228	195	7	8	63	27	1	0	92	29	1.073
Fallow	0	92	68	16	12	81	7	0	0	88	7	1.066
Fallow	100	253	205	12	8	63	26	2	0	92	28	1.075
Fallow	150	265	224	10	6	60	33	2	0	94	34	1.076
Fallow	200	250	215	8	6	60	31	3	0	94	34	1.075
Fallow	250	255	220	7	7	59	33	1	0	93	34	1.076
LSD		21	24	ns	ns	ns	ns	ns	ns	ns	ns	ns
p-value		**	**	0.33	068	041	0.42	0.77	0.31	0.63	0.53	0.34

¹Size Classes: 1 = < 1 7/8" (B); 2 = 1 7/8 to 2 1/2"; 3 = 2 1/2 to 3 1/4"; 4 = 3 1/4 to 4"; 5 = > 4"

²Means separated within columns with Waller-Duncan mean separation test at $p < 0.05$.