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Organic farming research project report submitted to the Organic Farming Research Foundation:

Project Title:

An evaluation of summer cover crop mixtures as weed suppressive mulches

FINAL PROJECT REPORT

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Organic Farming Research Foundation Project Report
An evaluation of summer cover crops as weed suppressive mulches
Nancy Creamer, North Carolina State University. 1998.

The objectives of this project were to:

1. Evaluate several different cover crops and cover crop mixtures for quick establishment, contribution of N for subsequent crops, minimal immobilization of N after cover crop kill, susceptibility to being mechanically killed by mechanical methods, and weed control potential at three North Carolina locations: The Vernon James Research and Extension Center in Plymouth, NC; Misty Morning Farm (North Carolinas largest organic vegetable producer); and, the Organic Unit at the Center for Environmental Farming Systems.

2. Host a field day at Misty Morning Farm and the Organic Unit at the Center for Environmental Farming Systems in Goldsboro to familiarize growers and ag extension agents with the various summer cover crop options.

3. Present the research results at the annual meeting of the Carolina Farm Stewardship Association.

4. Develop a Cooperative Extension "Hort Information Leaflet" to summarize the results of this experiment and post the information on the World Wide Web.

Objective 1

Several cover crops and cover crop mixtures were selected for evaluation and were seeded in early-mid June with a grain drill at all three locations (Table 1):

Table 1. Cover crop legumes, broadleaves, grasses, and mixtures selected for evaluation

Cover Crop Species	**Seeding Rate (lbs/acre)**
Legumes and other Broadleaves	
Cowpea	70
Sesbania	20
Hairy Indigo	8
Soybean: yellow	90
Soybean: black seeded trailing	30
Velvet bean	40
Lab Lab	40
Buckwheat	60
Sesame*	12
Aeschynomene*	20
Grasses	
Sudangrass	35
Sorghum-sudangrass	35
Japanese millet	30
Pearl millet	30
German foxtail millet	30
Egyptian wheat*	15
Mixtures	
Soybean(trailing)/sorghum-sudangrass	21/10.5
Cowpea/sorghum-sudangrass	49/10.5
Cowpea/sesbania*	49/6
Soybean/Japanese millet	54/12
Sesbania/velvetbean*	6/28
Hairy indigo/sudangrass**	4.8/14
Velvet bean/pearl millet**	24/12
Velvet bean/sorghum-sudangrass**	24/14

* seeded in Goldsboro only
**seeded in Plymouth only

Cover crops planted at Misty Morning Farm were overcome with intense weed pressure from pigweed and were not able to compete. Data was not collected from Misty Morning Farm for this reason, though we were able to proceed with the field day (see below) as Kenny Haines had several other areas we could demonstrate summer cover crop species and benefits. Plots in Plymouth were lost in 1996 due to severe wet weather, including a rare early summer hurricane (Bertha) on July 12 which devastated the area. We conducted the study in Plymouth an additional year, and those results are included in this evaluation. Hurricane Fran completely destroyed plots in Goldsboro on September 5 (luckily, we had collected aboveground biomass samples early that same day). For this reason, evaluating the method of kill could not be conducted on the plots in Goldsboro. Figure 1 is an aerial photograph of the remains of the cover crop plots surrounded by flood waters caused by Hurricane Fran.

Though 1996 was a particularly bad research year for everyone in the state of North Carolina, we believe that by including the additional year of data from Plymouth in this report, we have still been able to accomplish most of our goals. Data collected in Plymouth and Goldsboro included above-ground cover crop biomass, weed biomass, carbon:nitrogen ratios; total nitrogen in the above-ground biomass, and percent kill by mechanical methods (in Plymouth only).

Data from the legumes and other broadleaf species are present in Table 2. While sesbania produced the most aboveground biomass, it was not included in the Cover Crop Horticulture Information Leaflet because of opposition from NCSU weed science faculty. Sesbania can be an important economic weed in the Southeastern United States. Hairy Indigo is not included in the data, as it emerged so slowly that it was overtaken by weeds and did not produce. Soybeans produced a little more than 90 lbs/acre N, and is the most economic choice for summer legume cover crop species. Cowpea performed very well, but in subsequent studies we have had difficulty killing it mechanically. Sesame may have potential to attract beneficial insects because of the flower structure of the plant. We will be trying to encourage an entomologist to be involved in future evaluations of this cover crop for that reason. While buckwheat does not produce a lot of biomass, it is know for being weed-suppressive and we will be further investigating the potential to manage buckwheat for weed suppression in the future. Velvetbean did not perform well in this experiment because the very large seeded crop was damaged in the grain drill. In studies this year (1998), we were able to plant velvetbean with a Monosem planter, and germination was adequate and the crop was

vigorous. Nearly all of the broadleaf and legume summer cover crops suppressed weeds as compared to the weedy check plots, except when cover crop biomass was extremely low (velvetbean).

Table 2. Results for broadleaf cover crop species grown in Plymouth and Goldsboro.

Cover Crop	Aboveground Biomass (kg/ha)		C:N	Nitrogen
	Crop	Weed		
Sesbania	4807	518	22.7	97.4
Cowpea	3966	187	21.0	84.2
Soybean	3940	881	19.7	90.2
Sesame	3766	220	33.5	46.2
Trailing Soybean	3704	339	21.3	78.9
Buckwheat	3548	310	34.2	48.3
Lab Lab	2241	1371	29.2	34.8
Velvet Bean	1420	1951	20.3	32.5
Weedy Check		2186		
LSD (0.05)	1607	645	7	29

Data for the grass species is presented in Table 3. The most vigorous cover crops did an excellent job of suppressing weeds, and all of the cover crops reduced weeds as compared to the weedy check plots. Sorghum- sudangrass, pearl millet, and sudangrass produced a lot of N, but the C:N ratios were so high in those plots that the N would not be available for a fall cash crop. They will be excellent soil building cover crops however.

Table 3. Results for grass cover crop species grown in Plymouth and Goldsboro.

Cover Crop	Aboveground Biomass		C:N	Nitrogen
	Crop	Weed		
Sorghum-sudangrass	8792	54	53.2	88.2
Pearl millet	6670	69	50.0	64.7
Sudangrass	5639	81	43.8	65.5
German foxtail millet	4569	254	44.3	47.6
Japanese millet	3918	161	42.4	38.8
Weedy Check		2185		
LSD (0.05)	1607	645	7	29

Results for mixtures is presented in Table 4. Hairy indigo and velvetbean (because of poor germination) did not perform well in the mixture combinations. Mixtures moderated the C:N ratio's, and still contributed significant amounts of N. In general they did a very good job of suppressing weeds. While this was an initial trial, the possibilities for mixture combinations are endless, and additional research needs to be conducted to develop optimum seeding rates for mixtures.

Table 4. Results for cover crop mixtures grown in Plymouth and Goldsboro.

Cover Crop Mixture	% Composition	Aboveground Biomass (kg/ha)		C:N	Nitrogen
		Crop	Weed		
S-S*-Trailing Soybeans	95/5	10650	207	24.0	200.8
S-S/velvetbean	99/1	9889	316	59.0	76.4
Cowpea/S-S	25/75	7940	117	33.4	96.7
Sudangrass/hairy indigo	99/1	6780	189	74.1	42.3
Pearl millet/velvetbean	92/8	5504	69	57.6	41.6
Soybean/Japanese millet	64/36	3925	341	28.0	60.7
Cowpea/sesbania	77/23	3910	116	28.3	63.9
Sesbania/velvetbean	100/0	2849	1829	27.7	25.0
LSD (0.05)		1607	645	7	29

*S-S= sorghum-sudangrass

Cover crops in Plymouth were mechanically killed three different ways by mowing, rolling, or undercutting (Table 5). In general, undercutting greatly improved mechanical killing of all of the broadleaf species not killed by rolling alone and provided greater than 90% kill for 5 of the 6 broadleaf species. The grasses were much better controlled by undercutting, except for the two species that were killed by all three methods. Without exception, the broadleaf species were easily killed by mowing, even in the vegetative stages. In contrast, most of the grasses had begun to regrow 3 weeks after mowing, with the exception of Japanese millet which had already formed ripe seed, and German foxtail millet, which was in the green seed stage. Rolling provided little control of the summer cover crops, except for German millet, Japanese millet, and buckwheat. The buckwheat and Japanese millet had already formed mature seed. While cowpea was easily killed mechanically in this study, when killed two weeks earlier by mowing in 1997 and undercutting in 1998, considerable regrowth occurred.

Table 5. Percent kill of various summer cover crop species killed by mowing, undercutting, or rolling in Plymouth, North Carolina

Cover Crop	Growth Stage	Mow	Undercut	Roll
Broadleaves				
Cowpea (Iron Clay)	Vegetative	98	85	5
Sesbania	Vegetative	100	100	34
Lab Lab	Vegetative	96	98	25
Velvetbean	Vegetative	100	95	52
Soybean	early bloom	100	99	12
Buckwheat	mature seed	100	100	100
Grasses				
Pearl Millet	Heading	0	73	18
German Foxtail Millet	green seed	100	100	100
Japanese Millet	mature seed	100	100	100
Sorghum-sudangrass	mature seed	0	89	25
Sudangrass	green seed	0	84	28

We are optimistic about the beneficial use of summer cover crops in vegetable production systems. They can provide many benefits to soils and subsequent crops (see Cover Crop bulletin). This research has led us to current on-going studies which include: (1) comparing broccoli production in mechanically killed summer cover crops of cowpea, German foxtail millet, and cowpea/millet mix, with three rates of

soybean meal for an N source; (2) Investigating more thoroughly the potential of velvetbean as a summer cover crop, with a variety trial of 5 velvetbean species, and a mixture study looking a various seeding combinations of velvetbean with sorghum-sudangrass and pearl millet; and, (3) a further evaluation of other legumes including sunnhemp, aeschynomene, guar, and pigeon pea.

Objective 2

In spite of poor research conditions, we did host two very successful field days (one of which included an extension agent training) in 1996. At Misty Morning farm (Kenny and Wanda Haines) a field day was held on October 16. Dr. Joe Patt from Rutgers University, who studies using cover crops to attract beneficial insects into cropping systems, was a guest speaker. The event included a tour of Misty Morning Farm, including the greenhouse operation and cover crop plots, with a focus on discussion of weed suppression aspects of summer cover crops. Other benefits in utilizing cover crops in organic production systems were also discussed. A dinner followed, with a slide presentation by Dr. Patt. Approximately 30 agents, producers, and others attended the field day.

The second field day was in Goldsboro, and was combined with an extension in-service training for ag agents. The field day was held on August 21, and the summer cover crops were at their peak. The program began at 9:00 with an introduction to cover crop benefits and species (N. Creamer). Other morning talks included: cover crop/vegetable management options (D. Sanders); impact on nutrient cycling (N. Ranells), and other fertility issues (D. Sanders). Following lunch, there were talks on: cover crop impact on weeds (N. Creamer), and cover crop impact on disease (F. Louws). The rest of the afternoon was spent in the field at the cover crop plots evaluating growth, development, and weed suppression (Figure 2). We also had some hands-on sampling for beneficial insects with a discussion of cover crop impact on insects (R. McDonald). The feedback was very positive, and the event was well-attended.

Objective 3

On November 10, 1996 I participated in the Carolina Farm Stewardship Association's annual Sustainable Agriculture Conference. I co-led a 4 hour session titled "Biological and Mechanical Equipment for Small Farms", where I discussed cover crops for weed suppression, and mechanical

methods of killing cover crops. I showed slides of all of the summer covers evaluated in this study and discussed pros and cons of each species.

Objective 4

I have completed the Summer Cover Crop Horticulture Information Leaflet (see enclosed). It will be formatted by the designated individual in our department to conform with University and Departmental standards, and put up on our Departmental Web Site at : **http://www.cals.ncsu.edu/hort_sci/ext_home.html**. It will also be included in a web site on Organic Farming Systems that we are currently developing at : **http://courses.ncsu.edu/classes/hs610g/**. This web site is currently under construction, and will not be publicized until sometime in February. The web site was integrated into a graduate level course on Organic Farming Systems which we conducted this past spring, summer, and fall for ag extension agents. Approximately 50 agents attended a series of 6 intensive 2-day sessions on all aspects of organic farming systems. I have enclosed the agendas of that course for your information.