Overview of Green Manures/Cover Crops[1]

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Abstract - Frequently a cover crop or a green manure is utilized in nurseries for a number of reasons, such as to reduce soil erosion, provide ground cover and return organic matter to the soil, break up insect and disease cycles, add nitrogen to the soil, and for other reasons. There are many plant species to choose from, each with its own growth habits and requirements. In order to select the best species for a given soil and climate, growth period, and time of the year, one needs information on characteristics of various species. Results from greenhouse and field studies in Nebraska and North Dakota indicate that hairy vetch and soybean are generally well adapted cover or green manure crops for midwestern United States and can be grown at almost any time for any length of time desired. Hairy vetch can also be grown as a winter annual. Crimson clover is also a good winter cover crop for the southern part of the United States, but is not sufficiently winter hardy north of mid-Missouri/Kansas. For 45-75 days of early spring growth, field peas and faba beans are well adapted. For longer growing periods, perennials and biennials such as sweet clover, alfalfa, rose clover, and others grow well. For warm mid-summer plantings, species such as tinga pea, lespedeza, and cowpea should be considered.

INTRODUCTION

Cover crops provide ground cover and protect against soil erosion, immobilize residual soil nitrates and reduce nitrate leaching potential during non-crop periods, add nitrogen and organic matter to soils, stimulate soil microbial activity, improve infiltration and soil water relationships, break up disease, insect, and weed cycles, and have a number of other beneficial effects. Green manure crops likewise have many of these same effects, but impacts may be greater because they grow for a longer period than cover crops and provide greater biomass. If the cover crop/green manure is a legume, they have the added advantage of potentially adding more nitrogen to the soil plant system, thereby reducing need to add fertilizer nitrogen. Thus these crops may have a number of beneficial impacts (Power, 1987; Hargrove, 1991).

There are a number of crop species that could be used as cover/green manure crops. Also there are situations where use of such crops could be beneficial. Thus it is important that the growth characteristics of the species used match the soil, climate, and time period available for growth. Some species grow most rapidly at lower temperatures, others at higher temperatures. Also some do better than others under water stress. Some have rapid initial growth rates whereas others start slowly but do better later. The purpose of this paper is to present results from several experiments designed to measure relative growth rates and characteristics of a number of species. This information should help in selecting species suited to the local soil, climate, time of year, and length of time available for growth at the site under consideration. Results of three experiments are discussed. One was conducted in the greenhouse in which a number of species were grown at three different soil temperatures for varying lengths of time (up to 119 days). The second was a field experiment conducted on a Williams silt loam for two years at Mandan, North Dakota in which a number of species were planted at several dates during the summer, and sampled about every six weeks. The third experiment was a field experiment similar to that at Mandan but located at Lincoln, Nebraska. Information was collected on a number of growth characteristics in these experiments, but only information on dry matter production is presented here.

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Table 1 – Relative rate of growth (rank) of eight species studied at three soil temperatures and five sampling dates

		Rank							
Days of treatment	***Soil temp. (°F)***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***
35	**50**	FB*	SB	FP	HV	CC	SC	WCL	LD
	68	FB	SB	CC	SC	HV	FP	WCL	LD
	86	FB	SB	FP	HV	CC	SC	LD	WCL
56	**50**	FB	SB	HV	CC	FP	SC	WCL	LD
	68	FB	SB	CC	FP	WCL	SC	LD	HV
	86	SB	FB	LD	SC	WCL	CC	HV	FP
77	**50**	FB	WCL	HV	SC	CC	LD	FB	SB
	68	SB	SC	CC	LD	WCL	HV	FB	FP
	86	SB	LD	WCL	SC	HV	FB	CC	FP
98	**50**	WCL	CC	LD	HV	SC	SB	FB	FP
	68	SB	LD	CC	SC	WCL	FB	FP	HV
	86	SB	LD	WCL	FB	CC	FP	SC	HV
119	**50**	WCL	CC	HV	SB	FB	LD	FP	SC
	68	SB	LD	WCL	HV	FB	SC	CC	FP
	86	SB	LD	SC	WCL	HV	FB	CC	FP

* FB=faba bean; SB=soybean; FP=field pea; HV=hairy vetch; CC=crimson clover; SC=sweet clover; WCL=white clover; LD=lespedeza

RESULTS

Ranking of species in regard to their relative growth rates for the controlled temperature greenhouse experiment are presented in Table 1 (Zachariassen and Power, 1991). For the first 56 days after planting, growth was most rapid for faba bean and soybean at all soil temperatures. These were generally followed by field peas, hairy vetch, and crimson clover. Except at low soil temperatures, sweet clover and lespedeza also often were in the top four species. After about 77 days of growth, soybean was by far the fastest growing species except at the low soil temperature - soybean yields were usually at least double those of the next best species. Next best species were usually lespedeza followed by sweet clover and white clover. At the low (50°F) soil temperature, field pea, hairy vetch, and white clover were the top species with 77 days of growth. Generally field peas and faba beans were starting to mature after 77 days at the warmer temperatures, so they often gave relatively low yields for those situations. Likewise hairy vetch and crimson clover were approaching maturity and their growth rates were also slowing down.

In the field trials, the 50°F planting treatment was simulated by planting in the spring when soil temperatures are normally in the 50-60°F range. The 68°F treatment was simulated by planting in June, and the 86°F treatment by planting in July or August when maximum soil temperatures would occur. Samples of the vegetation produced since seeding were then taken periodically the remainder of the growing season.

Results from two years of field trials in North Dakota are given in Table 2 (Power, 1991). Results agreed well with those from the greenhouse experiment. For the May planting, only faba beans and field peas produced more than 1000 lb dry matter per acre by June 20. By July 12 field pea and subterranean clover were the

Table 2 – Aboveground dry weight (two-year average) of legume species * at several sampling dates following four planting dates, Mandan, North Dakota

Planting Date **	Sampling Date	HV *	SBCL	SB	FP	FB	LD	RCL	SWCL	BFT	ALF	LSD
		POUNDS PER ACRE										
May	*June 20*	360	380	460	1570	1390	§	§	190	§	140	160
	July 12	980	2060	880	3520	1380	520	260	880	330	1090	290
	Aug 1	1250	4490	1880	3730	1990	1300	710	1600	610	1530	340
	Sept 19	1500	2640	¶	¶	¶	2880	1460	2180	970	2080	280
June	*July 12*	290	190	610	690	930	§	§	90	§	90	100
	Aug 1	480	470	1310	1310	1470	300	130	530	§	250	140
	Sept 19	1930	1920	1040	¶	¶	2110	1390	1730	860	1580	200
July	*Sept 19*	220	440	1260	2160	1650	330	110	1130	§	600	190
Aug	*Sept 19*	220	§	§	540	630	§	§	§	§	§	200

*** HV=hairy vetch; SBCL=subterranean clover; SB=soybean; FB=field pea; FB=faba bean; LD=lespedeza; RCL=red clover; SWCL=sweet clover; BFT=birdsfoot trefoil; ALF=alfalfa**

**** Planted between first and fifth day of month indicated**

§ Insufficient growth for sampling

¶ Crop matured

best producers. It is interesting to note that in this environment, early spring seeding of soybean resulted in slow growth by this date. Likewise growth for lespeeza was slow. If allowed to grow until August 1 or September 19 (green manures), several species produced over 3000 lb dry matter per acre from the May planting. By the latter date, lespedeza did well.

For the June planting, highest yields by July 12 were for faba bean, followed by field pea. By August 1, these species plus soybean were the leading producers. If handled as a green manure and allowed to grow the entire season, lespedeza, hairy vetch, and subterranean clover were the best producers For the July and August plantings, hot dry weather at that time of the year often delayed emergence to the extent that there was insufficient growth to sample before frost in September. Again field pea and faba bean grew best for this short time period. In these trials, perennial species such as alfalfa and sweet clover generally exhibited slow initial growth, but moderate season-long growth.

Three year average dry weights for similar field trials at Lincoln, NE are given in Table 3. This was a warmer more humid climate than Mandan. However results are in general agreement with those from the two earlier studies (Table 1 and 2). For the early planting, dry weights by early July were again greatest for field peas (or Austrian winter pea spring planted), hairy vetch, and soybean. By August, dry weights for soybean were clearly much greater than for any other species, while those for hairy vetch were also much greater than the other species. This was generally still true by time of the fall frost; by fall, yields for crimson clover and sweet clover were in the 2000-3000 lb per acre range. For the mid-summer plantings, dry weights by fall were again much greater for soybean than for any other species. Hairy vetch and alfalfa were the only other species to produce over 1000 lb per acre by this time.

Mention should be made of several other species studied for only two years at Lincoln (data not given). As in the other trials, spring-planted faba bean grew as well as any other species the first 60-90 days after planting. Also again, lespedeza exhibited slow initial growth but rapid growth during the warm part of the season. Tinga pea also grew well at all planting dates, and cowpea at the midsummer plantings.

Table 3 – Average (3 yr) dry weight of cover crops at several planting and harvest periods, Lincoln, Nebraska.

Planting:	4/27 - 5/ 17		6/25 -7/ 15	
Harvest:	**7/3-11**	**8/8-13**	**Fall***	**Fall**
	dry weight, lb per acre			
Soybean	1100	4010	5760	2110
Field pea/AWP**	1660	1850	M§	840
Hairy vetch	1330	3210	3540	1570
Alfalfa	440	1440	1830	1430
Rye	740	1210	1060	940
White clover	300	780	1080	140
Sweet clover	850	1880	2250	630
Crimson clover	740	1620	2950	450
LSD0.05	170	510	610	210

* After frost ** Austrian winter pea § Matured 2 or more yrs by harvest

DISCUSSION

All three experiments gave similar results in that they showed that certain species were well adapted to one set of conditions whereas other species did best under other conditions. In general soybean and hairy vetch were two species that in most situations performed reasonably well. (However soybean may not be well suited to very early spring plantings). One does not generally think of soybean as a cover or green manure crop, but these results indicate that in many situations soybean was much superior to any other species. Likewise, in spite of the fact that there has been essentially no genetic development of the species, hairy vetch was also well adapted whenever used. Other research has shown that hairy vetch is best adapted to well-drained soils and is subject to loss of stand if kept in wet soil for extended periods. It is also the only legume cover crop that is sufficiently winter hardy for use as winter cover in the northern half of the United States.

Results from all experiments indicated that for short growing periods in the spring (45-75 days), large-seeded annual species such as field pea and faba bean and sometimes soybean are best suited as a cover crop. However for mid-summer plantings, such as after small grain harvest, species such as soybean, cowpea and tinga pea are also good candidates. If a longer period of growth is possible (over 75 days), species such as lespedeza and sweet clover often did well, in addition to soybean and hairy vetch. Thus it is apparent that one needs to carefully define the conditions under which a cover/green manure crop is to be grown in order to select the best species to use.

It needs to be pointed out that in these studies, generally only one variety of each species was evaluated. We have very little information on differences between varieties within a species, but we do know that there can be large differences. Much additional research is needed to evaluate these differences. Also there is considerable potential for varietal improvement through selection and breeding. As mentioned earlier, although hairy vetch is one of the most universally adapted species studied, there has been essentially no variety improvement work done on this species. The Madison variety is merely a selection made over 50 years ago from seed stock of unknown origin brought in by homesteaders in Nebraska. It appears that there might be a tremendous opportunity to develop this species further.

REFERENCES

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