Kansas Rural Center
SUSTAINABLE AGRICULTURE
MANAGEMENT GUIDES

COVER CROPS AND LEGUMES

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Nature continually works to provide a natural cover over the soil. Farmers can enhance the soil fertility of their fields by using as many legumes and cover crops as they can within their rotations. Legume and sod grasses in rotations will increase soil organic matter, or at least maintain it at relatively higher levels, over row crop production (Smith and Varco). Further advantages of cover crops are less exposure to soil erosion and reduced surface runoff through greater water infiltration in the soil. According to research at Purdue University, fields with a winter cover crop that were used as a green manure crop in the spring had 55% less water runoff and 50% less soil loss than fields without a winter cover. When corn or soybeans are no-tilled into a vigorous cover crop of rye or wheat, soil losses are 90-95% less than conventionally tilled soils (Brunoehler, 1989).

Soil productivity can be increased with long term use of cover crops. Organic matter content increases with cover crops and conservation tillage. Legume cover crops enhance the sustainability of crop production by increasing soil organic matter, improving the long-term nitrogen reservoir of the soil, improving soil structure, conserving soil water and reducing runoff and soil erosion. Disadvantages of cover crops are the cost of seeding; loss of economic production while the cover crop is growing; lowered soil temperature in spring, and depletion of soil water at planting time (Frye and Blevins, 1989).

Approximately 2.2 tons per acre of crop residue per year is considered adequate to maintain soil organic matter at constant levels in continuously cropped soils. Annual green manure crops have a negligible effect on total soil organic matter levels if cultivation is continuous, although they do replenish the supply of active, rapidly-decomposing organic matter (Frye and Blevins, 1989).

The main benefit of legumes in soil organic matter management is the periodic supply of residue which soil microorganisms decompose and in the process release binding agents that are important in improving soil aggregation - the physical process of putting soil particles together followed by the chemical cementing of these particles by organic or inorganic agents. Improving soil aggregation is important to improve water infiltration and to create more favorable soil conditions for growing crops. It is also thought by some agronomists that the use of cover crops which stimulate soil microbial growth is a larger key to better soil aggregation than just additional organic matter alone (Smith and Varco, 1987).

An ideal plowdown time for legumes is between early bud and early bloom. A legume cover crop that begins flowering will increase the amount of carbon which will slow down the availability of nitrogen for the next crop. The nitrogen produced by the legume will remain in the plant tissues whether the plant is living or dead. As long as the legume sod attained its maximum growth prior to fall dormancy, it should not matter whether the plant regenerates in the spring or if it has winter killed ("Green Manures," 1983).

It is best after plowdown of a mature, carbon-rich green manure to wait until the breakdown is well underway before planting the following crop. Soil microbes multiply rapidly to break down the carbonaceous plant matter, and they consume a lot of nitrogen in the process. This process leaves little nitrogen available for plant growth until breakdown has been completed to the extent that the microbes begin to die and release their nitrogen reserve back to the soil. A general rule of thumb applicable to most crops and climates is to allow breakdown of the green manure crop for at least two weeks. When the tilled-in materials break apart or crumble easily, the breakdown may be considered far enough along for the next crop to be planted ("Green Manures," 1983).

Deep-rooted legumes, such as alfalfa, used in crop rotations, are believed to cycle nutrients upwards from subsoils. Winter cover crops trap nutrients that otherwise might have been lost from the root zone and recycle them for the next crop. Legumes have an advantage over other soil-conserving crops because of their ability to decompose more rapidly due to their lower carbon-nitrogen ratio.

Cover crops can reduce nitrate leaching through the soil profile. Winter cover crops prevent this leaching

by depleting both soil nitrates and water. This occurs most actively in late winter and spring when the potential for leaching is often greatest. Some research indicates that nitrogen accumulated in legumes is less subject to leaching than commercial fertilizer during the summer growing season (Smith and Varco, 1987).

One-third of agriculture's 3% share of national energy consumption is used in the manufacturing of nitrogen fertilizer. According to Dr. Larry King, agronomist at North Carolina State University, the substitution of biologically fixed nitrogen from a potential hairy vetch green manure crop that fixed 100 pounds of nitrogen credits uses only 7.2% of the energy required to produce a similar amount of commercial fertilizer.

The portion of green-manure nitrogen provided to a following crop is usually about 50-60% of the total amount contained in the legume. Approximately 40% of the plant tissue nitrogen becomes available the first year following a chemically burned, no-till legume mulch. Approximately 60% of the tissue nitrogen is released when the cover crop is incorporated as a green manure rather than left on the surface as a mulch. Lesser amounts are available the next two growing seasons, but increased yields are apparent. Nutrients from decaying plant material are more readily available for use by succeeding crop plants than those nutrients derived from soil minerals or particles. During decomposition of organic matter, carbonic and other organic acids are formed. These organic acids react with insoluble mineral rocks and phosphates precipitates, releasing phosphates and exchangeable nutrients ("Cover Crops and Green Manures").

If a cover crop is put up as hay, the nitrogen in hay is removed with the crop. If it is grazed, the animals return about 80% of the nitrogen in their excrement (Goldstein, 1989).

Publications

Kansas State University has published a useful bulletin called "Using Legumes in Crop Rotations," 1988. For more information about interseeding legumes into cool-season grasses, Kansas State University has published "Interseeding Legumes into Cool-season Grasses," Publication No. 40, 1978. Another publication is "Performance of Grass-Legume Mixtures in Eastern Kansas," Bulletin 649, 1986.

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CREDITS

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Percentage of Nitrogen in Tops and Roots of Legumes

Legume	Tops	Roots
Soybeans	93	7
Vetch	89	11
Cowpeas	84	16
Red clover	68	32
Alfalfa	58	52

Source: McCleod, Edwin. 1982. "Feed the Soil."

Carbon: Nitrogen Ratios for Plants

Young rye	20:1
Flowering rye	38:1
Mature rye	350:1
Legumes	25:1
Corn stalks	40-60:1
Sawdust	250:1

Source: May, Jack. 1981. "Organic Matter in Nursery Soils."

Legume Forage Nitrogen Production Under Optimum Growing Conditions at Mound Valley, Kansas in 1990-1991

Legume	#N/acre
Winter peas	139
Hairy vetch	127
Sweetclover	82
Black medic	73
Crimson clover	120
Arrowleaf clover	62
L.S.D. (0.05)	31

Source: Kansas State University Research.

Winter Survival of Eight Cover Crops Grown at Two Locations in Eastern Kansas

	Powhattan		Mound Valley	
Legume	1990	1991	1990	1991
	Survival Percentage %			
Winter peas	69	0	92	67
Hairy vetch	75	94	100	73
Sweetclover	100	73	71	59
Black medic	44	0	39	88
Crimson clover	0	2	50	80
Arrowleaf clover	98	0	77	97
Winter wheat	88	90	54	80
Rye	68	94	77	97
L.S.D. (0.05)	23	32	27	20

Source: Long, J.H., J.L. Moyer, and B.H. Marsh. "Winter Annual Legumes and Grass Use as Cover and Green Manure Crops in Eastern Kansas." Kansas State University.

The Kansas Rural Center is a private, non-profit organization that promotes the long term health of the land and its people through education, research and advocacy. The Rural Center cultivates grassroots support for public policies that encourage family farming and stewardship of soil and water. The Rural Center is committed to economically viable, environmentally sound, and socially sustainable rural culture. For more information, contact the Kansas Rural Center at PO Box 133, Whiting, Kansas 66552 or (785) 873-3431.