Cover Crop (Acre) 340

DEFINITION

Grasses, legumes, forbs, or other herbaceous plants established for seasonal cover and conservation purposes.

PURPOSES

- Reduce erosion from wind and water.
- Sequester carbon in plant biomass and soils to increase soil organic matter content.
- Capture and recycle excess nutrients in the soil profile.
- Promote biological nitrogen fixation.
- Increase biodiversity.
- Weed suppression.
- Reduce pest pressure.
- Provide supplemental forage.
- Soil moisture management.
- Reduce particulate emissions into the atmosphere.

CONDITIONS WHERE PRACTICE APPLIES

On all lands requiring vegetative cover for natural resource protection. For example, cropland, orchards, vineyards, small fruit areas, or conservation use areas to be planted to trees or permanent vegetation at a later date.

CRITERIA

General Criteria Applicable To All Purposes

This standard provides guidelines for the selection of cover crops to address single or multiple resource concerns. It supports the principals and recommendations found in MSU-Extension Bulletin E-2646, Michigan Field Crop Ecology.

Plant species, seedbed preparation, seeding rates, seeding dates, seeding depths, and planting methods will be consistent with approved local criteria and site conditions (see Table 1).

The species selected will be compatible with the nutrient management and pest management provisions of the plan.

Cover crops are grown during or between primary cropping seasons. See Table 1 for cover crops or mixtures following row crops, vegetables, small grains (pre-harvest and post- harvest), summer cover, and conservation use land.

Use weed-free and disease-free seed and establish cover crops by over-seeding, frost seeding, aerial seeding, spreading, air-flow broadcasting, or drilling (see Table 1).

Herbicides used with cover crops will be compatible with the following crop.

For legume cover mixtures; use the appropriate inoculant or pre-inoculated seed if that particular legume has not been grown on the site within the last 5 years.

See Table 4 for orchards, vineyards, and nursery cover.

Cover crops will be terminated by harvest, frost, mowing, chopping, tillage, and/or herbicides in preparation for the following crop or after crop emergence where crop protection from wind damage such as abrasion is a resource concern.

Cover crop residue will not be burned.

Do not seed wheat cover crops until after the Hessian fly-free date. If aerial seeding of wheat is included in the rotation, it shall follow the requirements of the NRCS Michigan Agronomy Technical Note 31, Aerial Seeding Wheat.

TABLE 1 - COVER CROP SPECIES

Purpose BD - Bio Diversity EC - Erosion Control EN - Excessive Nutrients NF - Nitrogen Fixation OM - Organic Matter SF - Supplemental Forage SM - Soil Moisture Mgt. WS - Weed or Pest Suppression								Cover Crop Species	Life Cycle	Nitrogen Value (lb/Ac)	Seeding Rate (lb/Ac)	Seeding Depth (inches)	Frost Seed March - mid-April*	Direct Drill or Broad-cast and Shallow Till May 1 - mid-June	Overseed Corn @ Vegetative Stage V4 - V8 Early June - early July	Overseed Corn by Air or Highboy Early August - mid-Sept.	Overseed Corn by Air or Highboy Late/mid-Sept. - mid-Oct.	Overseed at Leaf Drop Mid-August - mid-Sept.	Seed Post-Harvest Mid-July - Sept. 1.	Seed Post-Harvest
BD	**EC**	**EN**	**NF**	**OM**	**SF**	**SM**	**WS**	**Legumes**												
	x		x	x	x		x	Annual medic	SA	40 - 100	10 - 39	¼ - ½			X			NR		
	x		x	x	x			Berseem clover	SA	60 - 90	9 - 20	¼ - ½			X			NR	X	
	x		x	x	x		x	Crimson clover	SA	50 - 60	12 - 20	¼ - ½						X	X	
	x		x	x	x			Field peas	SA	30 - 100	70 - 150	1 - 2								
	x		x	x			x	Hairy vetch	WA	60 - 180	25 - 40	½ - 2	X		X	X		X	X	9/1-11/1
x	x		x	x	x		x	Mammoth red clover	B	60 - 70	8 - 15	¼ - ½			X	X		X	X	
x		x	x	x	x		x	Sweetclover	B	70 - 90	8 - 15	¼ - ½			X	X		X	X	
x		x	x	x	x			Alfalfa	P	50 - 150	9 - 25	¼ - ½								
x	x		x		x			White clover	P	60 - 100	5 - 7	¼ - ½			X	X		X	X	
	x	x	x	x	x			Medium red clover	P	60 - 70	10 - 15	¼ - ½	X		X	X		X	X	
			x					Alsike clover	B/P	60 - 70	4 - 10	¼ - ½								
			x					Birdsfoot trefoil	P	40 - 100	5 - 10	¼ - ½								
x	x	x	x	x				60/40 mix (RC/SC)	B/P	60 - 90	8 - 15	¼ - ½	X		X	X		X		
			x		x			Soybeans	SA	0 - 40	1 Bu	1 - 2		X					X	
x	x		x	x	x	x		Crownvetch	P	50 - 100	3 - 10	¼		X						
								Non-Legumes												
x		x					x	Buckwheat	SA	NA	36 - 60	¼ - ½			X	X		NR	NR	
	x	x		x	x	x	x	Corn	SA	NA	1 Bu	1½		X						
	x			x		x	x	Field Bromegrass	SA	NA	10	¼		X	X					
	x	x			x			Forage turnips	SA	NA	3 - 5	¼ - ½							X	
x	x				x	x		Oats	SA	NA	34 - 68	1 - 2				X		X	X	
	x	x		x	x	x	x	Oilseed radish	SA	NA	15 - 25	¼ - ½				X		X	X	
		x					x	Rape	SA	NA	3 - 8	¼ - ½						X	X	
	x	x		x	x	x	x	Sudan Grass	SA	NA	20 - 25	½ - 1		X					X	
	x	x		x	x	x		Annual ryegrass	AW	NA	15 - 25	¼ - ½			X	X			X	
	x			x	x			Barley	AW	NA	48 - 96	1 - 2					X		X	9/10-9/30
x	x	x		x	x	x	x	Cereal Rye	AW	NA	28 - 112	½ - 1					X	X		9/1-11/1
x	x	x		x		x	x	Triticale	AW	NA	60 - 120	½ - 1					X	X	X	9/10-10/15
x	x	x		x	x		x	Wheat	AW	NA	60 - 120	½ - 1					X	X	X	9/13-10/20 8/1-30 UP

Rye, oats, or barley cover crops are recommended for organic soils. Oats are recommended where the field will not be tilled in the spring and direct seeding is planned.

For vegetable crops a combination of cover crops such as: rye and vetch; rye, hairy vetch, and mustard; or other combinations can be seeded based on the latest MSU recommendations. Follow the guidance in the latest bulletin for seeding specifications and acceptable planting dates.

Use vegetation adapted to the site that will accomplish the desired purpose. Preference shall be given to native species in order to reduce the introduction of invasive plant species; provide management of existing invasive species; and minimize the economic, ecological, and human health impacts that invasive species may cause. If native plant materials are not adaptable or proven effective for the planned use, then non-native species may be used. Refer to NRCS Michigan Electronic Field Office Technical Guide (eFOTG), Section I, Invasive Plant Species for plant materials identified as invasive species.

Additional Criteria To Reduce Erosion From Wind And Water

Cover crop establishment, in conjunction with other practices, will be timed so that the soil will be adequately protected during the critical erosion period(s).

Plants selected for cover crops will have the physical characteristics necessary to provide adequate protection (see Table 1).

The amount of surface and/or canopy cover needed from the cover crop shall be determined using current erosion prediction technology. See Section I of the local NRCS Michigan eFOTG for instructions.

To increase surface residue cover in no-till, ridge till, or strip till residue management systems seeded with small grain cover crops, delay killing the crop until it reaches a height of 8-10 inches. In mulch-till systems, to achieve the planned percent cover after planting, use secondary tillage only once or twice to prepare a seedbed with adequate cover.

To increase surface residue cover in no-till, ridge till, or strip till residue management systems seeded with legumes as the cover crop, delay killing the cover crop until it reaches a height of 6-8 inches. In mulch-till systems, limit tillage to two passes (one primary tillage-chisel or deep disking and a secondary tillage pass), or two other trips.

Additional Criteria To Sequester Carbon In Plant Biomass, In The Soil, And To Increase Soil Organic Matter Content

Cover crop species will be selected on the basis of producing high volumes of organic material to maintain or improve soil organic matter.

The NRCS Soil Conditioning Index (SCI) procedure found in the latest NRCS Revised Universal Soil Loss Equation (RUSLE 2) is used to evaluate the trend of biomass accumulation. The SCI trend needs to be positive to meet the criteria.

The cover crop will be terminated as late as feasible to maximize plant biomass production, considering the time needed to prepare the field for planting the next crop. See Table 1 for seeding rates and dates.

To maintain organic matter in low residue producing crop systems like vegetables, sow Sorghum, Sorghum-Sudan hybrids, Sudan grass, or corn to produce a high level of biomass. Use a rate of nitrogen (100 lbs/ac) to get maximum growth. Kill the cover crop in late summer/early fall with herbicides or shallow tillage and drill a rye cover to increase organic matter and improve soil tilth. See Table 1 for seeding rates and dates. Alfalfa, sweet clover, rye, ryegrass, and clovers in the crop rotation are excellent choices to help build or maintain organic matter in the soil.

Frost seed legumes into small grain crops, from mid-March to mid-April or drill into small grain stubble after grain harvest. See Table 1 for seeding rates and dates.

In row crops, over-seeding of legumes or small grains can improve soil tilth. In corn, spray an herbicide in a 10-inch band over the row and then follow by two cultivations. Over-seed cover crops at the second row cultivation. Timing is very important to successfully establishing a cover crop by over-seeding. Sow legumes between corn growth stages V-4 and V-6. Annual ryegrass should be seeded at V-6 to V-8. Small grains (rye) can be aerial seeded just prior to senescence (leaf drop) in soybeans and corn. See Table 1 for seeding rates and dates.

To enhance carbon sequestration, use crop rotations with high residue producing crops such as corn, small grain, or alfalfa; plus no-till or mulch till; plus cover crops; plus straw bedded manure.

Additional Criteria To Manage Excess Nutrients In The Soil Profile

Cover crops will be established and actively growing before expected periods of high precipitation that can cause leaching.

Cover crop species will be selected for their ability to absorb large amounts of nutrients from the rooting profile of the soil.

The above ground biomass will be removed from the field for maximum nutrient removal efficiency, when nutrients will not be recycled through a subsequent crop.

Non-legume species recycle existing soil nitrogen and can reduce the risk of excess nitrogen leaching into groundwater.

Residual nitrogen is likely to be present after a dry season of below normal rainfall. A fall soil nitrate test or stalk nitrate test is recommended to determine the availability of nitrogen, as excess nitrates can be flushed from the soil into tile systems or groundwater. Rye, oil seed radish, or other small grains can capture about 50 percent of the available nitrates and prevent nitrogen losses.

To prevent nitrate leaching after corn/seed corn maturation on sandy soil, especially under irrigation, aerial seed ryegrass/rye in standing corn or broadcast after harvest.

Nitrate leaching can occur after winter wheat. Frost seed red clover or red/sweet clover mixes in mid-March or mid-April to alleviate this problem. See Table 1 for seeding criteria.

To reduce nitrate leaching and phosphorus runoff from fall manure applications, aerial seed rye/ryegrass or apply rye with liquid manure or oil seed radish. Direct drill rye/ryegrass after harvest. See Table 1 for seeding criteria.

To reduce nitrate leaching and phosphorus runoff from vegetable crops, broadcast or direct drill oil seed radish, ryegrass, or rye. See Tables 2 and 3 for determining which vegetables use the most nitrogen and have the greatest risk for nitrate leaching, especially from sandy irrigated soils.

TABLE 2 - NITROGEN (N) RATE RECOMMENDATIONS FOR VEGETABLE CROPS ON MINERAL SOILS *

Crop	N Rate lbs/ac	Crop	N Rate lbs/ac
Celery	160	Chard	40
Onion	150	Radish	40
Broccoli	120	Rutabaga	40
Brussels sprouts	120	Snap beans	40
Cauliflower	120	Sugar beets	40
Potato	120	Table beets	40
Cabbage	75	Turnips	40
Corn	75	Field beans	10
Mint	75	Oats	10
Rhubarb	75	Rye	10
Sorghum	75	Soybeans	10
Carrot	60	Wheat	10
Endive	60	Clover	0
Asparagus		Pasture	0
Old beds	40		
New beds	60		

* Nitrogen rates per MSU-Extension Bulletins E-2904 & E-2934.

TABLE 3 - NITROGEN (N) RATE RECOMMENDATIONS FOR VEGETABLE CROPS ON ORGANIC SOILS *

Crop	N Rate lbs/ac	Crop	N Rate lbs/ac
Celery	175	Rutabaga	100
Onion	175	Spinach	100
Broccoli	140	Table Beets	100
Brussels sprouts	140	Watermelon	90
Cauliflower	140	Cucumber 50,000	75
Lettuce	125	Endive	75
Sweet Corn	125	Pumpkin	75
Tomato	125	Squash	75
Cabbage	100	Snap bean	60
Carrots	100	Sweet potato	60
Chard	100	Asparagus	
Eggplant	100	Old beds	50
Horseradish	100	New beds	75
Muskmelon	100	Peas	50
Parsnip	100	Radish	50
Pepper	100	Turnips	50
Rhubarb	100		

* Nitrogen rates per MSU-Extension Bulletins E-2904 & E-2934.

To reduce potassium leaching on muck and sandy soils, plant rye or ryegrass cover. Aerial seed cover crops into standing row crops; broadcast seed, and till 2-3 inches deep after harvest; or direct drill into crop residue.

Additional Criteria To Promote Biological Nitrogen Fixation

Only legumes or legume grass mixtures will be established as cover crops.

The specific Rhizobia bacteria will either be present in the soil or the seed will be inoculated at the time of planting legumes.

Nitrogen credits from legume cover crops will be accounted for in the nutrient management plan. Credit for nitrogen produced by legumes is to be included in crop nutrient budgets. See Table 1 for seeding rates and dates.

Addition Criteria To Increase Biodiversity

Cover crop species shall be selected that have different maturity dates, attract beneficial insects, serve as a trap crop from damaging insects, and/or provide food and cover for wildlife habitat management**.** See NRCS Michigan Agronomy Conservation Sheet, Conservation Buffers and Beneficial Insects, Mites, and Spiders.

Additional Criteria For Weed Suppression

Cover crop species will be selected for their chemical or physical characteristics to compete with weeds.

Cover crop residues will be left on the soil surface to maximize allelopathic (chemical) and mulching (physical) effects. Cereal rye and annual ryegrass have allelopathic effects on weed seedlings. Allow rye or ryegrass to reach a minimum 8-inch height before killing with herbicides or tillage to encourage allelopathic effect.

For long-term weed suppression, perennials and/or biennial species can be used. Crownvetch can be a living mulch in crop rotations with corn, hay, and small grain. See the Penn State University Bulletin, Crownvetch and No-Tillage Crop Production for Soil Erosion Control. Also, see MSU-Extension (MSUE) Bulletin E-2896, Cover Crop Choices for Michigan Vegetables or E-2897 No-till drilling cover crops after wheat harvest and their influence on next season's crop.

Additional Criteria To Reduce Pest Pressure

To reduce sugar beet cyst nematode pressure, seed a fall seeding of oil seed radish after small grain.

Cover crop species shall be selected that have different maturity dates, attract beneficial insects, serve as a trap crop for damaging insects, and/or provide food and cover for wildlife habitat management.

To reduce nematode damage to crops, cover crops that manipulate soil structure, soil water potential, and soil humus content are beneficial.

Ground beetles are common predators of weed seeds in many agricultural crops. Cover crops can increase the habitat available to support larger ground beetle populations in no-till fields. See NRCS Michigan Agronomy Conservation Sheet, Conservation Buffers and Beneficial Insects, Mites, and Spiders.

Additional Criteria To Provide Supplemental Forage

Species selected will have desired forage traits, be palatable to livestock, and not interfere with the production of the subsequent crop.

Forage provided by the cover crop may be hayed or grazed as long as sufficient biomass is left for resource protection. See MSU-Extension Bulletin E-2126, Annual Summer Forage Production in Michigan and MSU/KBS cover crop fact sheets for species and management recommendations.

Additional Criteria For Soil Moisture Management

Terminate growth of cover crops early if necessary to conserve soil moisture for the next crop, especially under droughty conditions. Late summer, early fall seeded sorghum is a good choice if spring growth of living covers is a concern for depleting soil moisture needed for germination.

Cover crops established for moisture conservation shall be left on the soil surface until the subsequent crop is planted. A minimum of 50 percent cover is required to reduce evaporation at the soil surface and create the desired Aledo effect.

On poorly drained soils or in areas of potential excess soil moisture, allow the cover crop to grow as long as possible to optimize soil moisture removal yet retain soil moisture for seed germination.

TABLE 4 - COVER CROPS SUITABLE FOR ORCHARDS, VINEYARDS, AND SMALL FRUITS	
Use	**Cover or Green Manure Crop**
Annual cover in orchards, vineyards, and bush fruit	Rye, wheat, ryegrass, or field bromegrass
Strawberries and other small fruit where elimination of green cover in spring is a problem	Marigolds, oats, sorghum, sorghum Sudan grass, or corn drilled in 7-10 inch spacing
Summer cover in non-bearing orchards	Sudan grass, corn, soybeans, or a combination of these

Additional Criteria To Reduce Particulate Emissions Into The Atmosphere

Manage cover crops and their residues so that at least 80 percent ground cover is maintained during planting operations for the following crop, yet retain soil moisture for seed germination.

Inter seed barley with onions or carrots on muck soils to reduce wind erosion losses to the atmosphere. Control barley with cultivation or herbicides.

CONSIDERATIONS

Maintain an actively growing cover crop as late as feasible to maximize plant growth, allowing time to prepare the field for the next crop.

Use deep-rooted species to maximize nutrient recovery.

Consider that grasses utilize more soil nitrogen, and legumes utilize both nitrogen and phosphorus. Use deep-rooted species to maximize nutrient recovery.

Avoid cover crop species that attract potentially damaging insects.

For most purposes for which cover crops are established, the anticipated benefits are usually accomplished when the plant density is at least 25 stems per square foot, the combined canopy and surface cover is at least 60 percent, and the above ground (dry weight) biomass production is at least 2,700 lb/acre.

Cover crops may be used to improve site conditions for establishment of perennial species.

Consider using plant species that enhance biomass collection opportunities.

There is potential to kill livestock with prussic acid poisoning and nitrate poisoning from the young growth of Sudan grass and sorghum-Sudan grass hybrids used in rotational grazing or supplemental feeding.

Consider potential herbicide carryover when selecting the species of the cover/green manure crop. Of the cover crops, rye is most tolerant of triazine carryover, followed by wheat, then oats, and lastly legumes. Legumes are extremely sensitive to triazine carryover released by liming low pH soils. Delay seeding legumes for one year if more than 1 pound of triazine was used the previous year and lime was recently applied.

Cereal rye will grow longer in the fall and begin growth earlier in the spring than wheat.

Aerial seeded cover crops into soybeans, especially wheat, rye, and oats, are best if seeded prior to soybean leaf drop.

Aerial seeding of oats into soybeans (seeded prior to harvest) can add additional residue cover without the need to kill the cover crop the following spring.

Aerial seeded wheat or cereal rye into corn is best if seeded during the early dent stage. This generally occurs the last week of August to mid-September.

Consider grass cover crops when a legume, like soybeans, is planned following the cover crop.

Consider legume cover or a green manure crop when a grass crop, like corn, is planned the following year.

Hairy vetch and clovers can serve as a host to the Soybean Cyst Nematode (SCN). Consider alternative cover crops when SCN is a concern in the rotation. Other SCN host plants include henbit, common Mullen, wild mustard, chickweed, pokeweed, and canola.

Hairy Vetch as a cover crop can also be a weed in future wheat.

Aerial seeded and early no-till established cover crops provide more erosion control the year of establishment.

It is not recommended to plant mustards on the same field for more than two years in a row. Oil seed radish may be susceptible to club root disease or cabbage root maggot and should not be used in a rotation with vegetable crops susceptible to these pests.

Cover crop sown using conventional tillage for seedbed preparation after mid-October can cause more erosion during the establishment year than if a cover crop was not planted.

Consider cover crops after corn silage to reduce soil erosion, replace organic matter losses, and capture nitrogen where manure is fall applied.

To obtain maximum erosion control from cover crops after soybeans or corn, allow them to mature to the specified height per the criteria for erosion control. No-till and mulch-till compliment the use of cover crops.

Crops planted late enough in spring to allow sufficient growth of cover crops are dry beans, soybeans, sweet corn, snap beans, cabbage, cucumbers, tomatoes, and late potatoes.

Inter-seed cover crops at the last weed control cultivation in corn, cabbage, cauliflower, peppers, or eggplant. Inter-seed into snap beans 10 days before the first harvest of beans. Or drill in cover crops and sow primary crop then kill cover with herbicides.

Consider sowing cover crops after the following crops: corn silage, dry beans, cucumbers, early soybeans, early corn, beets, spinach, carrots, lettuce, and potatoes.

Early planted crops such as carrots, beets, direct seeded cabbage, and early potatoes do not allow sufficient growth of cover crops in spring.

Interseeding of cover crops can be used with chemical suppression to reduce wind erosion and plant loss on sand or muck soils.

PLANS AND SPECIFICATIONS

Specifications for establishing, management, and maintenance of cover or green manure crops for each field shall be documented according to the criteria, considerations, operation, and maintenance described in this standard. The plan will contain the following minimum documentation and supporting data recorded on a job sheet or equivalent narratives:

- Location data per NRCS MI 340 Job Sheet
- Purpose(s)
- Seedbed preparation
- Plant species
- Seeding dates
- Planting rate, depth, method, and date
- Fertilization and termination method
- Operation and maintenance (see NRCS MI 340 Job Sheet)
- Height before termination (if applicable)

OPERATION, MANAGEMENT, AND MAINTAINENCE

Control growth of the cover crops to reduce competition from volunteer plants and shading.

Control weeds in cover crops by mowing or by using other pest management techniques.

When seeding legumes, ensure the proper inoculant is used at planting time. It is best to inoculate just prior to planting.

Establish the cover and green manure crop within the recommended planting dates and try to achieve the desired growth stage. In a dry spring, it may require an early termination to prevent further moisture depletion in the seedbed and affect crop germination.

Fertilize a green manure/cover crop in the spring with a high nitrogen fertilizer for maximum growth ahead of planting high nitrogen demanding vegetable crops. The recovery of the nitrogen applied to a green manure crop will amount to about 40 percent for the first vegetable crop. See Tables 3 and 4 to determine the need for this management recommendation.

Caution must be used when broadcasting or aerial seeding treated seed into a crop that is standing (to yet be harvested). Treated seed could show up in the harvested grain and result in rejection.

Burn-down, chop, mow, or till to kill cover crops when planting corn prior to corn emergence. Cover crops such as rye can produce an allelopathic effect that can slow the germination and growth of corn and other competition. It is best to kill the grass cover about a week prior to planting the corn.

REFERENCES

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