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Winter Annual Cover Crops for Maryland Corn Production Systems

A. M. Decker, A. J. Clark, J. J. Meisinger, F. R. Mulford, and V. A. Bandel.

OVERVIEW

A. Description and Benefits:

Cover crops are living ground covers grown between periods of regular crop production. Some of the benefits of using cover crops are to:

1. Reduce soil erosion.

2. Add organic matter.

3. Improve soil physical condition.

4. Increase crop yields.

5. Improve water use efficiency in no-tillage systems.

6. Fix atmospheric nitrogen (N) to reduce production costs.

7. Improve fertilizer nitrogen (FN) responses on corn.

8. Recycle unused soil N to reduce leaching losses.

B. Maximum benefits will be realized by selecting the cover crop species that meets the specific climate, soil and cropping needs of individual farm fields.

1. Cover crop selection is the critical first step.

a. Legumes - fix N and increase water use efficiency.

b. Grasses - do not add N to the soil; they are excellent recyclers of unused soil N; but the following corn crop requires extra FN.

c. Legume/grass mixtures - include desirable attributes of each component.

2. Fall establishment of cover crops is second critical step.

a. Seed as early as possible. Seed after silage harvest or use a shorter season corn hybrid for grain.

b. Consider aerial seeding before crop harvest, especially after soybeans.

c. Drilling results in better stands than broadcasting due to better seed placement and seed/soil contact. Seedings can be conventional or no-till.

3. Proper management of established cover crop stands maximizes benefits.

a. Graze or clip when excessive fall growth occurs. This increases N-fixation and reduces legume stand losses due to diseases.

b. Spring cover growth can be grazed, harvested for silage, plowed under, or left on the surface as a mulch and N source for no-till corn seedings.

c. Spring kill date will vary with cover crop species and spring rainfall pattern, but most legumes should be killed by late April to early May. Grasses should usually be killed by early April.

d. Wait 5 to 15 days before no-tilling into killed covers. This allows soil surface to dry and warm up for faster corn germination and growth.

e. Corn can sometimes be no-tilled before legume covers are killed; however, this practice is risky on heavy soils during a wet spring.

COVER CROP BENEFITS AND CONSTRAINTS

A. Soil erosion control

Farm land is most susceptible to soil, water, and nutrient losses during the winter between fall harvest and spring replanting. Cover crops provide soil protection during this period by intercepting raindrops, increasing infiltration, and reducing runoff. Early seeded covers that establish rapidly and remain green during the winter offer maximum protection. Cover crops killed and left on the surface also protect the soil against erosion, especially during early corn establishment; this advantage is lost when the covers are plowed under. Annual grasses provide more effective early erosion control than legumes although grass/legume mixtures are also good since the grass component establishes quickly and the legume fills in between the grass plants.

B. Organic Matter

Cover crops add organic matter to the soil by adding fixed carbon from the air through above and below ground residues. Organic matter benefits will vary with cover type and tillage system. Plowing winter covers under will speed up the rate of microbial activity and cover crop decomposition. When soils are tilled, both soil moisture and organic matter can be lost. The detrimental effects of continuous plow tillage on soil organic matter and tilth are illustrated in Table 1. Soil physical conditions and corn grain yields were best when corn was planted after 20 years of continuous pasture and poorest following continuous uncropped, tilled fallow. Continuous soybeans were almost as detrimental as fallow, in part due to the small amount of crop residue returned. Continuous wheat or a 5-year rotation with 3 years of pasture was almost as good as continuous pasture due to high residue additions and reduced winter erosion. The benefits of crop rotations are obvious from these data. A continuous corn system with a winter cover crop is in reality a one-year rotation that has many of the benefits of longer more complicated systems. A 5-yr California study with subterranean clover as a no-till cover crop increased soil organic matter over the no cover check by 1.3% at the 0-2" soil depth and by 0.2% at the 2-6" depth (9). A classic cover crop experiment in Connecticut also reported an increased soil organic matter level of 0.3% following grass covers (10). When killed cover crop residues are left on the soil surface with no-tillage, conditions are favorable for microbial decomposition of the plant residue but the rates are slower than with plow-tillage. Surface crop residues can increase soil organic matter, provide for better aeration and improved water regimes which favor microbial decomposition of these residues. This will improve nutrient storage, water infiltration, and ultimately, crop production.

Table 1. Crop rotation on a Beltsville silt loam soil improved soil

conditions and increased crop yields (Strickling, 1975, 11).

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Corn Yields Soil

20-yr Crop Year 21 Soil Aggregate

Rotation Systems 100 lbs N/A Organic Matter Stability

bu/A % %

Continuous fallow 32 0.85 6.0

Continuous pasture (P) 153 2.24 45.7

Continuous wheat (W) 144 2.15 41.9

Continuous corn (C) 51 1.66 11.9

Continuous soybeans (S) 66 1.39 8.7

C-W-C 90 1.75 34.3

C-S-W-C 96 1.81 25.0

C-W-P-P-P-C 152 2.19 40.6

C. Water use efficiency:

Winter cover crops can have a marked influence on soil moisture before and after they are killed and left on the soil surface for no-till corn planting.

1. Before Cover Crop Kill

An actively growing cover crop can remove significant amounts of soil moisture. If allowed to grow too long in the spring, soil moisture needed for rapid germination and early corn growth can be depleted. Water use by covers is especially troublesome when March and April rainfall is abnormally low. However, even in below normal rainfall years, soil moisture stress can usually be avoided if the cover is killed by the last week of April. This allows 1 to 3 weeks, if needed, for rain to replenish soil surface moisture before planting corn.

Cover crops differ widely with regard to soil moisture conservation and use. Recent research demonstrated that hairy vetch, which produces a tight uniform cover, results in higher soil moisture before the crop is killed than will a more open rye canopy, or a light weed cover (Fig. 1, top graph). Vetch provides conditions for reduced water runoff, increased infiltration and reduced evaporation from the soil surface. In wet springs, especially on heavier soils, surface soil moisture under the vetch may actually be too high for proper seed placement and good seed/soil contact when planting no-till corn. In such cases, a 5-15 day delay between herbicide application and corn planting may be needed for the soil surface to dry. This delay will also allow soil temperatures to increase for more rapid corn germination. When excess spring moisture is an annual problem, rye may be a better choice to speed up soil drying and allow earlier corn planting.

2. After Cover Crop Kill

Herbicide-killed cover residues left on the soil surface reduce water runoff, increase infiltration, and reduce surface evaporation. This improves soil moisture conservation, especially before the corn canopy closes when soil surface evaporation is high. Late-killed covers result in better soil moisture conservation than early-killed covers because of heavier, more complete ground cover. Cover residues shade the soil to reduce water evaporation and early weed invasion. Killed legume covers, like vetch, conserve more soil moisture than the more open canopy provided by small grain. Maryland research has shown that vetch/rye mixtures have maintained the best soil moisture relationships into the corn growing season including the very dry year of 1991 (Fig. 1, lower graph). Research data also indicate that soil moisture conservation following corn planting was a more important factor than soil water depletion prior to cover crop kill. However, the net effect of pre-plant water use by the cover vs. post-plant water conservation will obviously depend on the degree of water stress in a particular growing season and the timing of that stress period. This more favorable soil moisture following vetch and vetch/rye mixtures helps explain the enhanced response of corn to nitrogen fertilizer (see synergism, D-2).

D. Soil Nitrogen Relationships:

Cover crops can affect soil N relations by serving as N sources for the next crop, by improving crop response to FN and by conserving residual N that might otherwise be lost to leaching. Corn is one of the most important agronomic crops in Maryland and requires more N than most other crops. Nitrogen is an expensive fertilizer nutrient to manufacture. Price is dependent on the highly variable cost of petroleum used in the manufacturing process. Therefore, efficient N management is extremely important for profitable corn production systems.

1. Nitrogen availability to succeeding crops:

Cover crop N must be released by soil microbes before it can be available for crop use. Legumes killed while still vegetative contain 3 to 4% N and are rapidly decomposed to release N from roots and above-ground growth. For this reason, starter N may not be needed when seeding corn following legume cover crops but can be included with starter P. By mid- to late-summer, most of the legume residue will have broken down and released N for use by a corn crop. Nitrogen release time is related to cover crop species and growth stage at killing. For example, when hairy vetch is killed around May 1, it is still vegetative with 3 to 4% N so microbial decomposition will be rapid. Crimson clover at that date with only 2 to 2.5% N will likely be in full bloom with a lower leaf percent and more fibrous stems resulting in a slower decomposition rate.

Small grain covers, which have a higher fiber and lower N content (1 to 1.5%), decompose more slowly than legumes. Most annual legumes contain adequate N for rapid decomposition of root and top growth by soil microbes while grasses must rely on soil N for this to proceed. The tie up of soil N during plant residue decomposition is called immobilization. This immobilization of soil N by grasses can cause N-deficient corn, especially early in the growing season. Starter FN will usually be required when seeding corn following small grain or other grass cover crops, (unless the field has a history of manure applications). As small grains mature, the N concentration decreases, making it more difficult for soil microbes to decompose the residue. Small grain covers will immobilize less soil N if killed early. However, if early-killed rye provides inadequate moisture conserving mulch, corn grain yields can be lower than after late-killed rye with a better mulch.

The amount of N fixed by fall-seeded legumes and available for subsequent crop use depends on legume species, time of fall establishment, growth stage when killed the following spring, and method of kill. While values vary, approximately 70% of legume-fixed N is found in the top growth. About 60% of total fixed N becomes available the first year. Realistic N credits for hairy vetch, Austrian winter peas, and crimson clover are tabulated in Table 2.

Table 2. Estimated nitrogen credits for three winter legume cover crops.

Cover Crop Lower Coastal Plain Central Piedmont

Average Range Average Range

- lbs available N/acre -

Hairy vetch 100 70-130 80 40-100

Winter peas 90 50-120 60 20-90

Crimson clover\* 80 40-120 50 10-85

\* Crimson may winter kill in the Piedmont if seeded late and winter is severe.

2. Synergism of Legumes and FN

Synergism might be simply defined as "1 + 1 = 3". We have observed greater FN benefits to corn following legumes, especially vetch, than when following small grain or no seeded cover. Grain yields were higher regardless of how much FN was applied to non-legume covers. This synergism may be due to better soil moisture, improved soil structure, or other "rotation effects" that are not yet well understood. For whatever reason, grain yields following a legume cover are usually greater than following small grain or no cover crop (Fig. 2).

Do Not Over-fertilize Corn Following Legume Cover Crops. Legume N credits must be accounted for in your fertilizer program. Depending on soil type, between 40 and 100 lbs of FN will give maximum corn yields following winter legumes. More FN may be needed if legume cover crops are killed before April 20 because legume N production will be low. Due to N immobilization, corn following a small grain cover will require (20-50 lbs/A) more FN than if no cover crop is planted.

3. Conserving Residual Fertilizer N With Cover Crops

Nitrate losses from agriculture into water sources are a concern to society, to agricultural producers, and to farm technical advisors. The agricultural community has an obligation to itself and to society to minimize potential nitrate pollution by developing more efficient N management practices. One such practice is the use of winter cover crops to conserve nitrate, through crop N uptake, during the high-risk, nitrate leaching season of September through May.

Research on a Maryland Coastal Plain soil applied corn FN tagged with 15-N (an isotopic form of N found in minute quantities in nature) in order to follow the fate of FN. Each fall after corn harvest, tagged FN in the soil was measured to a depth of 30 inches. Cereal rye, annual ryegrass, hairy vetch, and crimson clover covers were then planted. Starting in mid-March the following spring FN recovery by the various covers was determined, Fig. 3. Grass covers were more efficient than legumes in recycling unused FN with recoveries of 40 to 60% by mid-April. Legume covers were less efficient, averaging less than 10% FN recovery. Spring nitrate-N concentrations in shallow groundwater below these covers were: 12 ppm for cereal rye, 18 ppm for vetch and 17 ppm for weeds. The greater recovery by rye was reflected in lower nitrate-N concentrations in shallow groundwater. Other research on Maryland's Eastern Shore has also concluded that grass cover crops can reduce the soil nitrate-N concentrations in shallow groundwater (2). A recent extensive literature review concluded that grass covers can reduce both the mass of N leached and the nitrate-N concentrations of the leachate by 20 to 80%, compared to no cover crop (8). The use of cover crops, particularly grasses or grass/legume mixtures, are good management practices to conserve N within the soil/crop system and to reduce nitrate-N contamination of our water resources.

COVER CROP SELECTION AND MANAGEMENT

The selection and management of cover crops depends on specific farm conditions. These would include the farm crop rotation system, work schedules, equipment availability, possible use of covers for livestock feed, and a primary purpose for cover crop use, i.e. providing N for the next crop, erosion control, or preventing nitrate leaching. Rotation can dictate cover crop planting methods and seeding dates. For example, legumes or grasses can be easily established after corn, while faster germinating, more winter hardy grasses are more suitable after soybeans. If covers are to be used for livestock feed, grass/legume mixtures produce greater tonnage of a more nutritionally balanced forage.

It is not practical to consider all combinations of crop rotations, potential cover crop uses, and cover crop species in this publication. The remaining discussion will focus on covers used in continuous no-till corn systems.

The use of winter cover crops can improve any rotation that leaves fields unprotected during the winter. When the spring-planted crop is corn or other FN demanding crop, legume covers will be the best choice, especially on soils with low residual N. However, if residual FN levels are high after fall harvests, because of drought, excessive N fertilization etc., a non-legume cover, such as cereal rye, would be better. When the amount of unused soil N is in doubt, a vetch/rye mixture would provide more environmental protection while supplying N to reduce cover crop costs to the farmer. When soil N is high, rye in the mixture will take up the excess N and will dominate the mixture. When the residual N level is low, less N will be taken up by rye and vetch will dominate. This relationship is illustrated in Table 3.

Timely fall establishment of winter covers can more easily be accomplished if some corn can be harvested early as silage rather than as grain. This is especially useful in the shorter Piedmont growing season. Spring growth of covers can be available for grazing before most permanent pastures are ready or they can be harvested for silage before planting corn. A 3-year study at Poplar Hill compared corn production following crimson clover in which the spring growth was used as pasture, silage, or left in place as a mulch and N source for corn. Corn grain yields were reduced 20 to 30% when the crimson was removed as silage. Grain yield were highest when the cover was grazed because frequent defoliation stimulated N fixation and more N was recycled within the system. Total forage production (crimson + corn) was 20% higher than when no cover was seeded. These data demonstrate that the grazing season can be extended, total forage yields increased, and net return increased by using a winter cover crop (5). Grass-legume mixtures are better suited to livestock systems since they are more productive than pure legume stands, and are also more suitable for grazing and silage preservation.

Table 3. Spring dry matter yields and nitrogen contents of rye and rye/vetch mixture components in the second year of a cover crop/no-till corn study. Covers were planted in the fall of 1989, killed the following spring and corn was planted no-till. After the 1990 corn harvest covers were replanted for the second time into the same plots.

Nitrogen Topgrowth D.M. in 1991 Topgrowth N in 1991

Applied Vetch/rye mix Pure Vetch/rye mix Pure

to corn Vetch Rye rye Vetch Rye rye

- lbs/A - - lbs/A -

0 3749 2254 2815 170 25 24

80 3419 4123 2694 129 38 23

160 3452 4805 3397 135 41 29

240 1693 7718 3507 65 73 26

A. Cover crop selection

Selecting the right cover crop is the most important first step. Questions such as this must be asked: Is the cover crop adapted to my soil and climatic conditions? Do I have the equipment and time needed to fit covers into my cropping system? If the answer is no to any of these types of questions consider other cover crops, other establishment methods, or other cropping systems that are more compatible with your farming operation.

During the early 1980's a large number of winter covers were evaluated at both Coastal Plain and Piedmont locations (4). The species discussed below were identified as best suited for Maryland corn production systems. Other species may be suitable but have not been adequately tested. Note that all of the early Maryland evaluations were made with no-tillage corn following the covers. However, New Jersey research with hairy vetch and cereal rye covers reported similar corn responses when covers were plowed down or killed with herbicides for no-till seeding (3).

1. Hairy vetch (Vicia villosa)

Vetch is the most winter hardy and widely adapted of all legumes evaluated. Corn grain yields have consistently been higher following vetch than any cover tested. Vetch makes most of its growth during April and will fix 2 to 3 lbs N per acre per day. It remains vegetative during this period, percent N is high and, when killed, decomposition and N release is more rapid than for most covers. When killed during the last week of April, 40 to 80 lbs of sidedressed FN will give maximum grain yields (Fig. 4).In some years on some soils no FN will be needed. Killed vetch is one of the easiest covers to plant into since it drys down rapidly to form a tight uniform mat. This mat provides excellent moisture conservation resulting in a synergistic response to applied FN. This tight, uniform thatch can reduce early weed invasion, but pigweed in corn following vetch has been an occasional problem. Increased spray gallonage and/or pressure may be needed to insure that residual herbicides reach the soil surface at burndown, or a post emergence herbicide may be needed.

On light soils in some years when the soil surface under the vetch canopy is dry and warm, corn can be planted into the live vetch with the knockdown herbicide applied after corn planting. No-till coulters will easily cut through the standing vetch and will give good seed/soil contact, thus eliminating the need to wait 5 to 15 days for covers to dry before corn planting. This will only work, however, if the soil is dry and warm enough for corn planting. This will not work on heavy soils in a wet spring.

Vetch has large seeds and is one of the easiest covers to establish by conventional seeding methods or by aerial seeding into standing corn when the canopy starts to dry and open up or into soybean just before leaf drop. Aerial seeding into soybeans has a higher success rate than aerial seeding into corn. Vetch has a high hard seed content and can reseed itself if allowed to set seed before it is killed. This would be useful in a continuous corn system, but could present a weed problem in rotations which include small grain. For this reason, vetch is not the best choice for all farm situations. However, vetch ahead of corn would be killed long before seed set so any volunteer plants could only come from hard seeds left from the original vetch planting. These volunteer seedlings can easily be eliminated from small grains with a single spring application of 2,4-D or Harmony. Seeding rate: 15 to 25 lbs/acre.

2. Austrian Winter Peas (Pisum arvensis)

Peas are similar to hairy vetch in terms of N production, N availability and soil mulching but high grain yields following peas are less consistent because of susceptibility to winter crown rot diseases resulting in winter stand losses. This is especially true when peas are grown for more than one year on the same field. Peas are more difficult to establish than vetch, and seed cost is higher. Unlike vetch, drilling the seed is essential for satisfactory stand establishment. Peas do not create a weed problem in subsequent crops. Seeding rate: 60 to 100 lbs/acre.

3. Crimson Clover (Trifolium incarnatum)

Crimson is less winter hardy than either vetch or peas, and may not be adapted to many areas of the Piedmont. Crimson has a high hard seed content and when allowed to set seed in the spring will produce adequate seed under the corn for fall establishment. Unlike vetch, however, it does not present a weed problem in small grain because the seed is small enough to be screened out at the combine. It matures more rapidly than vetch or peas, and should be killed about one week earlier (early bloom before flower color starts to fade). It is less susceptible to crown rot diseases than peas but more susceptible than vetch. Seeding rate: 15 to 20 lbs/acre.

4. Cereal Rye (Secale cereale)

Rye establishes readily, provides excellent early ground cover, is disease resistant and winter hardy, makes more winter growth and takes up more residual N than other small grains or any of the above mentioned legumes. Because of its winter hardiness, rye can be seeded later than most winter cover crops, but for maximum protection against erosion and maximum uptake of leachable nitrates it should be planted as soon as possible after summer crops are harvested. However, if planted before the Hessian Fly-free date, increased fly populations may reduce wheat yields on nearby fields the following spring.

While rye is one of the most effective winter covers for recycling unused soil N, very little of that N will be available to the following summer crop if the rye is killed too late. In order to minimize this N immobilization, rye should be killed while vegetative or at least no later than late joint (Feeks stage 8) to early boot (stage 9). This will be late March to early April in the lower Coastal Plain and about one week later for the central Piedmont. Rye grows and matures very rapidly in the spring and one rain at the wrong time can make it extremely difficult to kill at the ideal growth stage. When killed late, increased FN rates will be needed to obtain corn yield goals. Recent Maryland research suggests that early killing of rye (late March) does not eliminate N immobilization and does not always provide adequate mulch for effective soil moisture conservation. If rye is killed in late March and the next 4 to 6 weeks have above normal rainfall, significant nitrate leaching can also occur.

Cultivated crops compete with weeds for light, moisture and plant nutrients. This is often more than simple competition for space. Chemicals with allelopathic potential are present in virtually all plant tissues. The production and toxicity of these chemicals varies widely among species. Rye produces enough allelopathic chemicals to reduce weed populations. In some cases these have even been implicated in corn stand reductions. In addition to alleopathy, volunteer rye can be a serious weed problem for certified small grain producers. Seeding rate: 90 to 120 lbs/A (1.5 to 2 bu.).

5. Legume/Grass Mixtures

Legume/grass mixtures provide scavenging of residual N by the grass and N production by legumes, resulting in corn grain yields which are higher than those following a pure grass, but usually lower than yields following pure legumes (Fig. 5). This may be a necessary trade-off to reduce nitrate contamination of groundwater without a large sacrifice in yield goals.

Mixtures can actually serve as a "safety valve" in terms of managing residual soil N levels. Research shows that the botanical composition of mixtures will adjust to residual soil N levels (Table 3, page 6). When residual soil N levels were high rye dominated the mixture and when the N levels were low vetch dominated. When excessive FN (240 lbs/A) was applied to corn, rye growth in the mixture was higher following vetch/rye than following rye alone. Nitrogen accumulation in the topgrowth paralleled that of dry matter yields. In the same study, vetch following unfertilized corn produced 5002 lbs of dry matter and 190 lbs of N, only 5 lbs less than the vetch/rye mixture. Total N production by mixtures is often greater than for pure legume stands, but because of the rye component, more FN may be required for top corn yields. Vetch/rye mixtures can be allowed to grow longer in the spring than pure rye, especially if vetch is at least 50% of the mixture. Kill dates of vetch-dominant mixtures should approach kill dates for pure vetch stands. Rye-dominant mixtures should be managed more like pure rye. Because dry matter yields of mixtures are higher, increased spray volume and/or pressure may be needed for adequate herbicide coverage. The heavier mulch produced by mixtures contributes to better soil moisture conservation but requires a longer period between cover kill and corn planting. This is necessary to allow time for the soil to dry and warm up and for covers to dry so that planter coulters can cut cleanly through the heavy mulch to achieve good seed/soil contact. Seeding rate: 42 lbs rye with 18 lbs vetch, 15 lbs crimson, or 60 lbs of peas per acre.

6. Other cover crops to consider

Early studies (4) established that fall-seeded annual legumes produced more winter/spring growth and provided more N to succeeding crops than adapted fall-seeded perennial forage legumes.

a. Subterranean clover (Trifolium subterranean) shows some promise for Maryland but produces less N and is less winter hardy than other legumes listed above. It should be considered only for the Coastal Plain. It is a low-growing legume that produces a very tight thatch which is extremely effective in reducing early weed invasion. Seed is produced below the soil surface, making it an ideal reseeder. Satisfactory stands were maintained by natural reseeding for four years in continuous no-till corn at Poplar Hill. It has a low hard seed content that allows it to germinate completely during the summer in some years. When this occurs too early in the summer, stands can be lost because it is sensitive to heavy shading produced by the corn. Seeding rate: 15 to 20 lbs/acre.

b. Oats (Avena sativa) rapidly provides soil coverage to guard against erosion and fall leaching losses. Winter oat varieties winter kill in many areas of the state so provide less protection against winter leaching. Fall-seeded spring oats produce excellent fall growth if seeded early and since they do not survive freezing temperatures, knockdown herbicides are not needed prior to no-till corn planting. Seeding rate: 32 to 64 lbs/A

(1 to 2 bu).

c. Wheat (Triticum aestivum) and barley (Hordeum vulgare) can be used in place of rye. They are less effective recyclers of soil N than rye but, like rye, additional FN will be needed to maintain corn yields. They are later maturing than rye so may be more desirable when seeded with a legume for spring silage harvest. Seeding rate: 60 to 120 lbs/A (1 to 2 bu).

d. Annual ryegrass (Lolium multiflorium) makes excellent fall and late spring growth but is less effective than rye in recycling unused soil N. It is potentially a more serious weed problem than either vetch or rye if allowed to go to seed. Seeding rate: 20 lbs/A.

e. (Brassica napus) may be as effective as rye for erosion control and recycling of unused FN if established by mid to late September. Research is needed to establish relative value as winter covers. If early rye planting creates a serious Hessian Fly problem species such as rape or canola may offer a viable substitute. When canola is grown for oil seed production, unless combine adjustments are carefully made, substantial amounts of seed can pass through the combine and create a weed problem. However, any volunteer canola plants are easily killed with recommended corn or soybean herbicide programs. Seeding rates 4-5 lbs/A drilled, 5-8 lbs broadcast.

B. Fall Cover Crop Establishment

Seeding cover crops in fields that would otherwise go through the winter without a living plant cover will benefit any cropping system. However, maximum benefits can only be achieved when fall establishment results in early complete ground cover. When this is accomplished, erosion and leaching losses will be less, weed problems will be fewer, soil moisture use efficiency will improve, and legume N fixation will be maximized.

1. Seeding date

All covers, especially legumes, should be seeded as early as possible.

Optimum dates are Sept. 10 in the Piedmont and Sept. 20 in the Coastal Plain. Seed covers no later than Oct. 1 or Oct. 15 for respective regions. Early seedings result in more complete winter ground cover and better spring growth. Wye researchers reported fall cover crop yield increases of over 80% when rye was seeded 9/13 rather than 10/13 (1). Rye can be seeded later than legumes although very late seedings will sacrifice ground cover and N recycling. Consider using a shorter-season corn hybrid in continuous corn to allow for early cover crop seeding. Other options include aerial seedings into standing corn or soybeans, or seeding a cover crop where double-crop soybeans were not planted following small grain harvest. Cover crops fit easily into livestock systems where corn silage is harvested early enough for timely seeding. Cover crops must be seeded early; do not delay corn crop seeding until all corn and soybean fields are harvested.

2. Seeding methods

Cover crops can be seeded by no-till or conventional methods. Vetch, peas and rye can be seeded with a grain drill, while the clovers may require a small-seeded legume box on the drill. Plant large-seeded legumes at a depth of 1 to 1.5 inches, and small-seeded legumes, such as crimson or the Brassicas, at 1/4 to 3/4 inches. Vetch, crimson and rye may be aerially seeded into standing corn as the canopy opens up, or into soybeans, just before leaf drop. As the soybean leaves drop they cover the seed to create ideal conditions for germination and early seedling development. Broadcast seedings into standing corn are more dependent on timely rainfall than when seeding into soybeans. Broadcast seedings can be made onto lightly disked soil but the most consistent stands are obtained by drilling. This insures proper seeding depth and good seed/soil contact. This is true even if seeding must be delayed until after corn harvest if the late seeding date is not exceeded. Broadcast seeding rates should be increased by about 20% over the drilling rates listed for individual species.

C. Spring Cover Crop Management and Corn Planting

Covers can be killed by plowing under, herbicide applications, or by mowing, and corn can be planted conventionally or no-till. New Jersey research found no difference in corn silage yields when hairy vetch or cereal rye were plowed under with corn planted into conventional seedbed, compared to killing these covers with herbicides followed by no-till corn planting (3).

Maryland cover crop and corn yield data used in this publication were obtained from no-till corn plantings into herbicide-killed cover crops. This program included Gramoxone plus residual herbicides for later germinating broadleaf and grassy weeds. Herbicide costs may be reduced with pure legume covers by using a 2,4-D/Banvel knockdown followed by post-emergence herbicides such as 2,4-D or Bladex for broadleaf and grassy weeds when IPM indicates a potential problem. Experience shows that 5 to 15 days should be allowed between chemical burndown and no-till corn seeding. When slower acting herbicides, such as 2,4-D or glyphosate, are used more time may be needed for covers to dry and soil to warm and dry for proper seed placement and fast corn germination. Seeding into heavy residue covers while the killed stems are still tough can present problems. It is essential that coulters cut cleanly through plant residues rather than just pushing them into the soil. When this occurs poor seed-soil contact results and poor stands are likely. Planter adjustment is critical to insure that corn seed is placed below the mulch at the proper soil depth.

If the cover is plowed down, microbial breakdown of the plant material will be more rapid. But, in the case of cereal grains such as rye, additional FN will still be required. Plowing eliminates the advantage of a mulch that conserves soil moisture and may, thus, eliminate one of the real advantages of a cover crop. No-tilling corn into living vetch and mowing to kill the vetch after corn has emerged can reduce the need for knockdown herbicides. This can be successful in some years but can also result in severe competition with corn for soil moisture and plant nutrients. For this technique to work, mowing must be delayed until around June 1 in order for mowing to kill the vetch. However, if mowing is delayed that long the growing point of corn can be damaged. Crimson clover, on the other hand, can be killed by mowing in early May since it will be in the reproductive growth phase at that time. However, any cover crop allowed to grow into May can cause soil moisture deficits in some years.

Cover crops can be grazed prior to planting corn. Research and experience suggest that more N is fixed when legumes are grazed. In addition most of the consumed N is returned to the field by the grazing animal. The grazed or harvested cover will also leave an easier surface for no-till establishment of corn.

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PUBLISHED ARTICLES

More detailed information can be found in the published journal articles below:

Clark, A.J., J.J. Meisinger, A.M. Decker, and F.R. Mulford. 2007. Effects of a grass-selective herbicide in a vetch–rye cover crop system on corn grain yield and soil moisture. Agron. J. 99:43-48.

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