

Interseeding Cover Crops into Corn

Relay cropping to plant cover crops using new technologies

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The Interseeder is an exciting technology recently released by Interseeder Technologies, LLC and trialed by Penn State University to fine-tune the cover crop mixes that can be used in various regions. Essentially a no-till drill, the Interseeder plants a cover crop into standing corn at V5 to V7 stage, creating a more updated and effective version of the traditional technique of broadcasting a winter cover crop into corn at last cultivation which is still utilized by some organic farmers. This maturity stage falls just after the critical weed free period, when corn would be most sensitive to competition from weeds (or an interseeded crop).

Broadcasting is still frequently done, sometimes using an air seeder or in organic farming scenarios with a seed spinner mounted on the back of a cultivator, but higher seeding rates must be used, and success is highly dependent on sufficient rainfall very close to the time of seeding, either before or after. Broadcasting is also much more effective on tilled than no-till soil. Some of the seed may also land in the leaf whorl. It is chosen for its ease and the lack of expense and equipment needed, but drilling the seed in with the Interseeder achieves better seed placement into moisture, and better seed-to-soil contact, especially in no-till corn ground.

Interseeding provides a flexible and innovative way to fit cover crops into the rotation, whether the farm is large or small scale, organic or conventional, conventional tillage or no-till.



Interseeding corn at V6 stage



Closing wheels and N application tube - latest design components of Interseeder



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High Energy Forages and Soil Building Cover Crops



Spinner mounted on cultivator to spin on cover crop seed

Researchers at Penn State continue to examine the delicate balance between corn and cover crop to be sure that a) the cover crop does not introduce too much competition into the corn and b) the corn does not threaten the eventual thriving of the winter cover crop. They are looking at earlier seeding of the cover crop (at the corn's V3-V4 stage) as well as shortening the corn's maturity to allow for better light penetration and greater cover crop growth in the fall. "Often, reduced drying costs, earlier harvest, improved prices, and residual effects of cover cropping can offset

modest yield penalties associated with earlier hybrids," explains Penn State Extension.

Getting more of the benefits of cover crops

Most interseeded cover crops will give you nutrient credits for your following year's corn, but exact amounts depend on the species you use, in what proportions, your management practices, and ultimately the weather effect on growing conditions of both the corn and interseeded cover crop. Legumes fix a good portion of a following corn crop's nitrogen needs if they are allowed to grow to bloom in the spring (if not harvested for forage). Grasses can more than double the value of winter manure applications by uptaking nutrients before they leach. However, depending on maturity stage, grasses may also immobilize some nitrogen, making it available later as they decompose.

Being able to double-crop with a winter cover crop despite timing constraints also gives you the full benefits of ground cover, including erosion prevention, added soil organic matter and other factors contributing to soil health, and winter annual weed suppression.

By acting as a "break crop", adding diversity in the rotation, the cover crop can also improve yields in corn after corn systems.

Interseeding can be more economical than a typical cover crop planting, since it can be combined with another operation across the field (usually N sidedressing) and/or a post emergent herbicide application.



Interrow Seeder Unit

Weed Management

Avoid choosing fields for interseeding with pre-existing weed management problems.

Residual herbicides can be problematic for interseeded cover crops. The basic approach to weed management is to use a no- or short-residual (shorter half-life) burndown herbicide, or tillage followed by glyphosate or glufosinate prior to the interseeding. The interseeding occurs about 3-5 weeks after corn planting. Research is ongoing about the most appropriate herbicides to use in a rotation

with interseeded cover crops. Non-residual programs based on glyphosate and glufosinate are the best bet until we have more experience.

Species

The best species are cool season annuals or perennials, somewhat drought and shade tolerant, and easy to establish.

Among grasses, **annual and Italian ryegrasses** are the most common. Although ryegrass is one of the most successful cover crops for interseeding, it can also be challenging to kill in the spring.

Medium red clover is the most widely used legume, not only for interseeding but for its traditional relay cropping predecessors – broadcasting in corn at last cultivation and frost-seeding into a small grain in late winter.

On many organic farms, medium red clover broadcast at last cultivation has become standard.

Crimson clover has also had success, although it's more prone to winter-kill in more northern regions. As an annual, it typically grows more fall and early spring biomass compared to medium red clover.

That being said, endless combinations of cover crops can be used in the Interseeder context, and many factors decide their success -

- Crop Physiology
- Planting date
- Seeding rate
- Seeding depth
- Seed-to-soil contact
- Soil moisture
- Amount of sunlight through the corn canopy

Annual ryegrass and medium red clover have been two of the most consistently successful crops for interseeding.

King's AgriSeeds and Penn State have advocated using mixes of about 3-5 species. **King's Broadcaster Mix** is our primary commercial mix that is Interseeder-ready (contains Annual Ryegrass, Crimson Clover, Common Medium Red Clover, Daikon Radish, and Yellow Blossom Sweetclover).



Interseeded cover crop mix,
Union County, PA, October
2014

The **original mix for the PSU interseeder project** has also performed quite well, and it contains Green Spirit Italian Ryegrass, 3-Way Clover (Red Clover, Ladino White Clover, Yellow Blossom Sweetclover). It performed quite well in the 2011-2012 PSU Short-lived trials under the name "King's Mix."

Blends		Cut 1	Cut 2	Cut 3	Total
King's Mix	Italian Ryegrass/ clovers	2.56	2.02	1.95	6.53
Tritcale plus	Tritcale (815@66%+33% ARG)	3.20	1.98	1.35	6.53
Bristol	Radish/Rootmax	1.61	2.52	1.46	5.59
Indy Blend	Radish/Rootmax/Crimson Clover	2.18	1.96	1.31	5.45



Annual ryegrass cover crop after corn harvest in fall

Penn State On-Farm Research Trials (about 12 locations each in 2013 and 2014)

Treatment	Species	Rate (Lbs/A)
Untreated	No cover crop	0
Grass	Annual ryegrass	20
Legumes Mix	Med. Red Clover, Crimson Clover, Hairy Vetch	10+20+15
Legumes + Grass	Annual ryegrass, Med. Red Clover, Crimson Clover, Hairy Vetch	10+5+10+7.5
Grass + Radish (2014 only)	Annual ryegrass, Radish	10+5

Harvest

Most of Penn State's research has been done on corn for grain, although corn for silage will be evaluated more. There may be more short-term damage to the cover crop in a silage harvest situation, but it can usually recover as long as the field wasn't too wet at the time of harvest. For grain harvest, the biggest problem can be smothering from the residue, so be sure to set the combine high so there is no stalk shredding, and avoid mowing stalks to prevent damage to the cover crop.

Conclusions

Penn State's research findings include –

- Interseeding has the most success when the corn is at V5-V6 stage

- Annual ryegrass is the most successful grass; legume establishment is more variable
- Corn yield is mostly unaffected by the interseeding operation
- Effect of the interseeded cover crops on second year corn is still under evaluation

Key Aspects of Early Season Interseeding

- Seed cover crops at V6 stage for corn
- After critical weed-free period for corn
- Previous tests indicate that when timed right, there are minimal or no impact on yields

Latest Interseeder Version Design Components

- Drill units between rows
- Liquid N stream can be applied adjacent to corn row
- Herbicide can be applied under corn canopy
- Assist wheels to carry weight
- Ground drive
- Loading platform
- Conversion to complete Drill Unit
- Hitch for towing
- Commercialized by Interseeder Technologies, LLC - <http://interseedertech.com/>

Interseeded Cover Crops CIG (Conservation Innovation Grant) Summary:

- After two years, fairly high level of successful establishment
- About 70% in 2013 and 90% in 2014 in over 70 trials

Challenges:

- Geographic limitations - better in the North? (prefers cooler and heavier soils; provides good answer to short growing season)
- Identifying suitable species and varieties – **annual ryegrass and medium red clover are consistently two of the best**
- Soil residual herbicides can be problematic – but often necessary to manage HR (Herbicide Resistant) weeds
- Timely cover crop control the subsequent year

*There are many ways to **apply** cover crops into the rotation. We are doing that with various equipment applications both on the small and large scale. We are doing it both on organic and conventional farms, both in conventional tillage systems and in no-till systems. Keys to successful application that we need to understand are: cover crop physiology; planting date, seeding rate, seed depth, seed to soil contact considerations and soil moisture factors. From an Ag-Engineering point of view we need to understand how to utilize the right equipment to get these cover crop seeds established in various rotations and cropping systems including a relay-crop type scenario.*

Dave Wilson, Research Agronomist, 2004

That was a statement made years ago, and the same fundamentals hold true today in the Interseeder context.

Crimson clover 4 weeks after interseeding



Red clover in fall prior to corn harvest



Annual ryegrass



Orchardgrass



Red Clover



Hairy Vetch





Franklin Co. 2013 Interseeding. Photo taken Spring 2014



The older method of using broadcasting on an organic farm

Below is a list of cover crop mixes that have been used with the interseeder and/or for broadcasting at last cultivation on organic farms or conventional farms that may use cultivation. We have put various mixes together for different farms which had different goals and requirements for their particular seeding mix. The King's Broadcaster mix currently is the primary commercial mix that King's has for this type of application, which works very well both interseeded and broadcasted.

Dave Wilson's "original mix" for the PSU Interseeder Project			
# of crops or mixes	Crop or mix	Percentage of Mix by Weight	At 30 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Green Spirit Italian Ryegrass	67.00	20.1
2	King's Three-way clover mix	18.00	5.4
3	Crimson Clover-'Dixie'	15.00	4.5
	Totals→	100.00	30.0
King's Broadcaster Mix Broadcast 25-30 lbs./acre, Interseed at 20-25 lbs./acre			
# of crops	Crop	Percentage of Mix by Weight	At 25 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	40.00	10.0
2	Crimson Clover-'Dixie'	30.00	7.5
3	Medium Red Clover "VNS"	15.00	3.75
4	Daikon Radish	10.00	2.5
5	Yellow Blossom Sweet Clover	4.00	1.0
	Inert	1.00	0.25
	Totals→	100.00	25.0
Mix used by PSU in 2014 at several farm locations this was used at Jim Biddle's farm, Williamsburg, Blair County, PA			
# of crops	Crop	Percentage of Mix by Weight	At 32.5 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	30.77	10.0
2	Crimson Clover-'Dixie'	30.77	10.0
3	Hairy Vetch "VNS"	23.08	7.5
4	Medium Red Clover "VNS"	15.38	5.0
	Totals→	100.00	32.5
Mix recommended by Dave Wilson for Kirby Reichert's organic farmer request who wanted Medium Red & White Clover with Radish Broadcast 25 to 30 lbs./acre, Interseed 20 to 25 lbs./acre			
# of crops	Crop	Percentage of Mix by Weight	At 25 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	60.00	15.0
2	Medium Red Clover "VNS"	25.00	6.25
3	Ladino White Clover "VNS"	10.00	2.5
4	Daikon Radish	5.00	1.25
	Totals→	100.00	25.0

Mix used by organic farmers at last cultivation Mix #1 Broadcast at 30 to 35 lbs./acre, Interseed at 25-30 lbs./acre			
# of crops or mixes	Crop or mix	Percentage of Mix by Weight	At 30 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Green Spirit Italian Ryegrass or Annual Ryegrass	50.00	15.0
2	Crimson Clover-'Dixie'	36.70	11.0
3	Medium Red Clover "VNS"	13.30	4.0
	Totals→	100.00	30.0

Mix used by organic farmers at last cultivation Mix #2 Broadcast at 30 to 35 lbs./acre, Interseed at 25-30 lbs./acre			
# of crops or mixes	Crop or mix	Percentage of Mix by Weight	At 30 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Green Spirit Italian Ryegrass or Annual Ryegrass	50.00	15.0
2	Crimson Clover-'Dixie'	36.70	11.0
3	Mammoth Red Clover	13.30	4.0
	Totals→	100.00	30.0

Mix used by organic farmers at last cultivation Mix #3 Broadcast at 30 to 35 lbs./acre, Interseed at 25-30 lbs./acre			
# of crops or mixes	Crop or mix	Percentage of Mix by Weight	At 30 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Green Spirit Italian Ryegrass or Annual Ryegrass	50.00	15.0
2	Crimson Clover-'Dixie'	36.70	11.0
3	Mammoth Red Clover	6.65	2.0
4	Medium Red Clover "VNS"	6.65	2.0
	Totals→	100.00	30.0

Economic Ryegrass/Red Clover Mix Broadcast at 30 to 35 lbs./acre, Interseed at 25-30 lbs./acre			
# of crops	Crop	Percentage of Mix by Weight	At 30 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	68.00	20.4
2	Medium Red Clover "VNS"	32.00	9.6
	Totals→	100.00	30.0

All Around Mix, Strong ryegrass component Broadcast at 25 to 30 lbs./acre, Interseed at 20-25 lbs./acre			
# of crops or mixes	Crop or mix	Percentage of Mix by Weight	At 30 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Green Spirit Italian Ryegrass or Annual Ryegrass	70.00	21.0
2	Daikon Radish	9.00	2.70
3	Berseem Clover c.v. 'Balady'	14.60	4.38
4	Winter Rape (Barsica or Dwarf Essex)	6.40	1.92
	Totals→	100.00	30.0

3 formulas used for Annual Ryegrass, Crimson Clover & Medium Red Clover Amounts of each have been varied by different farms for desired amount of clover or ryegrass			
# of crops	Crop	Percentage of Mix by Weight	At 27 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	55.56	15.0
2	Crimson Clover	22.22	6.0
3	Medium Red Clover "VNS"	22.22	6.0
	Totals →	100.00	27.0
# of crops	Crop	Percentage of Mix by Weight	At 35 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	51.40	18.0
2	Crimson Clover	34.30	12.0
3	Medium Red Clover VNS	14.30	5.0
	Totals →	100.00	35.0
# of crops	Crop	Percentage of Mix by Weight	At 40 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	50.00	20.0
2	Crimson Clover	37.50	15.0
3	Medium Red Clover "VNS"	12.50	5.0
	Totals →	100.00	40.0

Cornell Mix for 'SCOTTI' Project (Transitioning to Organic Project using interseeder) (NY, PA, MD) Interseed at 45 to 50 lbs./acre Planted at Jim Biddle's farm, Williamsburg, PA - King's strip #4			
# of crops	Crop	Percentage of Mix by Weight	At 45 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Huron Winter Cereal Rye	50.84	22.878
2	Annual Ryegrass	25.42	11.439
3	Hairy Vetch "VNS"	13.58	6.111
4	Medium Red Clover "VNS"	10.16	4.572
	Totals→	100.00	45.0

CONCEPT MIXES

King's Concept mix #1 ADBBD Ryegrass, Radish, Clover, Rape Broadcast at 25 to 30 lbs./acre, Interseed at 20 to 25 lbs./acre Planted at Jim Biddle's Farm, Williamsburg, PA 6/18/15 - King's demo strip #3			
# of crops	Crop	Percentage of Mix by Weight	At 25 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	63.81	15.95
2	Daikon Radish	13.41	3.35
3	Berseem Clover c.v. 'Balady'	10.68	2.67
4	Balansa Clover c.v. 'Fixation'	8.10	2.025
5	Dwarf Essex Rape	4.00	1.0
	Totals→	100.00	25.0

King's Concept mix #2 "Nutrient Mix" Broadcast at 25 to 30 lbs./acre, Interseed at 20 to 25 lbs./acre Planted at Jim Biddle's farm, Williamsburg, PA - King's strip #5			
# of crops	Crop or mix	Percentage of Mix by Weight	At 25 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	69.50	17.375
2	Crimson Clover-'Dixie'	12.50	3.125
3	King's Three-way clover mix	7.50	1.875
4	Berseem Clover c.v. 'Balady'	2.50	0.625
5	Balansa Clover c.v. 'Fixation'	4.50	1.125
6	Dwarf Essex Rape	2.50	0.625
7	Daikon Radish	1.00	0.25
	Totals→	100.00	25.0

King's Concept mix #3 "Strong Legume Overwintering Mix" Broadcast at 25 to 30 lbs./acre, Interseed at 20 to 25 lbs./acre			
# of crops	Crop or mix	Percentage of Mix by Weight	At 25 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Annual Ryegrass	60.00	15.0
2	Crimson Clover-'Dixie'	12.50	3.125
3	Hairy Vetch	12.50	3.125
4	King's Three-way clover mix	7.50	1.875
5	Berseem Clover c.v. 'Balady'	2.50	0.625
6	Balansa Clover c.v. 'Fixation'	2.50	0.625
7	Dwarf Essex Rape	2.50	0.625
	Totals→	100.00	25.0

King's Concept mix #4 "Ryegrass/ Rape overwinter, Berseem & Daikon are Summer/Fall Legume Nitrogen fixer &, Nutrient recycler and then they winter kill" Broadcast at 25 to 30 lbs./acre, Interseed at 20 to 25 lbs./acre			
# of crops or mixes	Crop or mix	Percentage of Mix by Weight	At 30 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Green Spirit Italian Ryegrass or Annual Ryegrass	70.00	21.0
2	Daikon Radish	9.00	2.70
3	Berseem Clover c.v. 'Balady'	14.60	4.38
4	Winter Rape (Barsica or Dwarf Essex)	6.40	1.92
	Totals→	100.00	30.0

King's Concept mix #5 Simple 4 way overwintering mix Broadcast at 25 to 30 lbs./acre, Interseed at 20 to 25 lbs./acre			
# of crops or mixes	Crop or mix	Percentage of Mix by Weight	At 25 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Green Spirit Italian Ryegrass or Annual Ryegrass	40.00	10.0
2	Crimson Clover-'Dixie'	36.00	9.0
3	Medium Red Clover "VNS"	16.00	4.0
4	Dwarf Essex Winter Rape	8.00	2.0
	Totals→	100.00	25.0

Mixes without Ryegrass Component

King's Concept mix #6 Multi-clover mix Broadcast at 12 to 15 lbs./acre, Interseed at 8 to 12 lbs./acre			
# of crops or mixes	Crop or mix	Percentage of Mix by Weight	At 12 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Crimson Clover-'Dixie'	45.00	5.40
2	Berseem Clover c.v. 'Balady'	25.00	3.00
3	King's Three-way clover mix	20.00	2.4
4	Balansa Clover c.v. 'Fixation'	10.00	1.2
	Totals→	100.00	12.0

King's Concept mix #7 Clover-Rape mix Broadcast at 12 to 15 lbs./acre, Interseed at 8 to 12 lbs./acre			
# of crops or mixes	Crop or mix	Percentage of Mix by Weight	At 12 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Crimson Clover-'Dixie'	36.00	7.2
2	Berseem Clover c.v. 'Balady'	30.00	6.0
3	King's Three-way clover mix	24.00	4.8
4	Dwarf Essex Winter Rape	10.00	2.0
	Totals→	100.00	20.0

King's Concept mix #8 2 crop Clover-Rape mix Broadcast at 15 to 20 lbs./acre, Interseed at 12 to 15 lbs./acre			
# of crops	Crop or mix	Percentage of Mix by Weight	At 15 lbs./acre Seeding Rate (lbs. of each crop in the mix)
1	Crimson Clover-'Dixie'	60.00	9.0
2	Dwarf Essex Winter Rape	40.00	6.0
	Totals→	100.00	15.0