What EcoTea™ Residue Digestor Brings to the Farm

EcoTea™ offers an ecological engineered line of products, made up of a large array of plant growth promoting microbes that are beneficial to both plant and soil health. EcoTea™ has gained popularity for its liquid and dry seed dressing products for both spring and autumn seeded crops. Another very important tool to consider when planning a spring or autumn program is EcoTea™'s High Density Inoculum HDI Residue Digestor that can enhance decomposition of thick stubble and layers of fibrous straw, increase soil nitrogen availability, and produce an environment for enriched organic matter reserves.

The HDI Residue Digestor carries a broad spectrum of fungal, saprophytic species. Saprophytes are organisms known as nutrient recyclers and feed on dead, decaying, high organic carbon food sources. This includes everything from tree litter, dead plants, roots, animals, arthropods and microbial necromass. These fungi can produce the enzymes and metabolites that correlate with the eventual humification of these food sources, subsequently, improving soil health. The services that this group of fungi provide are vitally important on agricultural land as they do not require the presence of an active growing plant. These scenarios make up a large portion of the year on the prairies.

Organic Matter Maintenance

Organic matter is made up of several carbon-based groups ranging from the most stable mineral based fractions that have been present since the formation of soils over thousands of years to the most active, plant available forms of carbon, dependent upon photosynthesis from growing plants. Plant growth promoting rhizomicrobes (PGPR) around the roots will induce a plant to release carbon-based root exudates (sugars mainly) to this community in exchange for needed minerals, enzymes and phytohormones required for plant health. Whatever the plant does not take up through the roots, the PGPR community (including fungi) works to store nutrients as carbon backed, stable molecules.

The types of organic matter that saprophytes contribute to are still within the active fraction but focus mainly on the decomposition aspect of dead biomass. This biomass residue is not only made up of large amounts of carbon but also are chalked full of nutrients that can be re integrated into the soil framework. A healthy community of these fungi will not allow crop residue to stratify and be lost to above ground oxidation. These fungal communities in the presence of moisture will form hyphae and use webs of it called mycelium to bind decomposing organic matter and combine it with soil particles to form macro aggregates, thus creating greater pore space and aggregate stability in the soil. Within these soil aggregates humification takes place forming stable carbon reserves which in turn begins building soil.

Soil aggregation seen in the top left picture allows soils to begin increasing their Cation Exchange Capacity (CEC), water infiltration and oxygen flow.

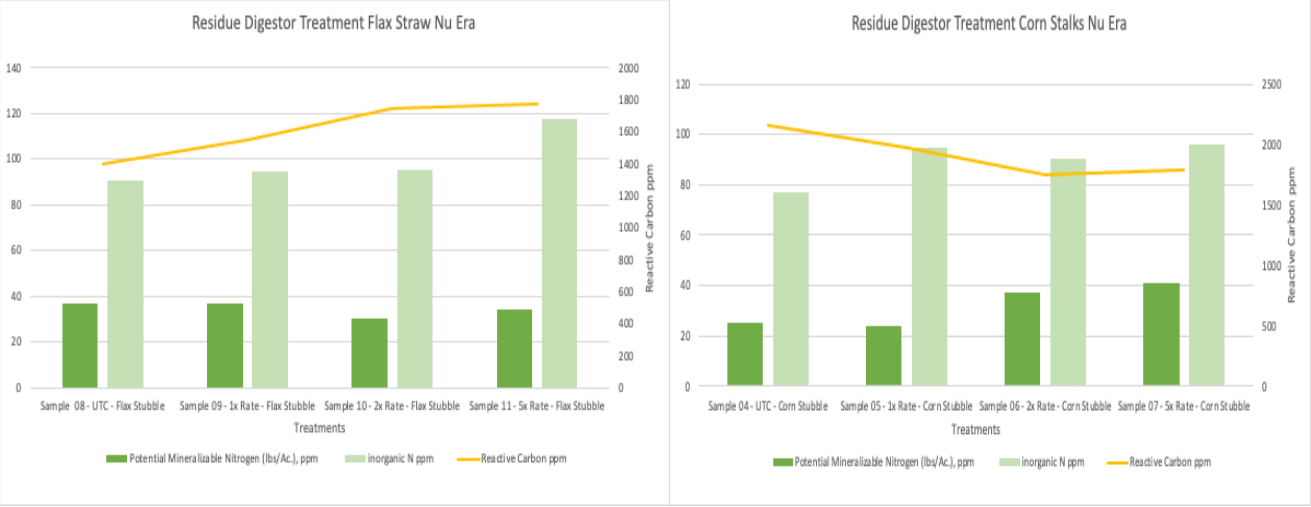
Hypha in the bottom left and mycelium in the bottom right assist in soil aggregation and humification of residues.

Fungal scarification on the top right photo of EcoTea™ treated corn stalks on the right vs untreated on left. Pectin bonds within the cellulose fibers are broken down first initiating brittleness of the straw medium.

Nitrogen Maintenance

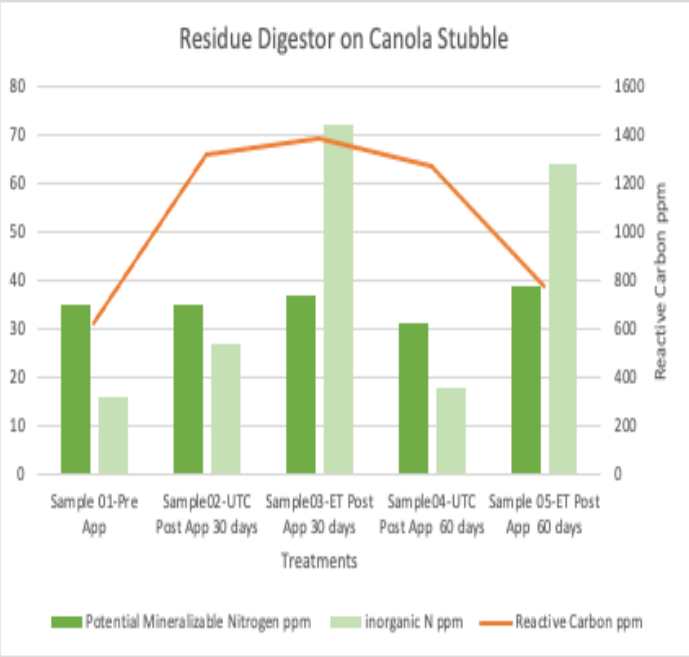
Nitrogen nutrition is vital to the plant and central to amino acid, enzyme, nucleic acid and chlorophyll production. Nitrogen is normally required in larger amounts than most other nutrients but can be detrimental to plant health and yield drag if over applied or put down at the wrong time. One detail worth noting is that a pound of nitrogen does not always equal a pound of nitrogen. There are various forms and oxidation states of nitrogen from the most plant available nitrate NO3- to the largest of amino acid, peptide compounds. The more reduced state that the nitrogen molecule expresses (NH4+, Amino acid.), the greater it binds to organic matter and soil particles. Thus, it is less likely to be lost to leaching, denitrification or volatilization. Soil aggregation as discussed above ensures that free nitrates in the soil solution are converted into organic forms, carbon backboned molecules, and microbially available.

Bacteria requires an ideal 15-20:1 Carbon to nitrogen diet (sometimes tighter ratio) and will draw from inorganic nitrogen reserves to break down straw that generally ranges from 60:1 to 85:1 Carbon to Nitrogen. This turnover of carbon via bacterial decomposition is inefficient in that needed nitrogen must be accessed from organic matter reserves (or fertilizer N). A rule of thumb is that 2000 pounds of wheat straw can hold up to 25 pounds nitrogen +/-. As this process takes place subsequent crops can experience nitrogen shortages depending on how dense the straw biomass ends up being. Bacterial dominant breakdown can also produce a lot of carbon dioxide release at times during the season that there is not a living plant (or sufficient crop canopy) present to pick it up. As builders of soil aggregates, saprophytic fungi, furthermore, ensure that fewer units of nitrogen are immobilized in the decomposition process. They digest exponentially higher carbon units per unit of N than do bacteria and are much more efficient at assimilating Carbon into new cells and molecules resistant to gassing off or to erosion loss. This can often free up more inorganic forms of nitrogen to be available to crops in the spring. This is also why it is important to have living plants in the ground going into freeze up. The free nitrogen catch and release effect autumn plants can offer is key.



In these controlled residue container trials done by Nu Era Ag Technologies high cellulose/ lignin corn stalks and flax straw (crops fairly resistant to bacterial decomposition) was measured for decomposition and nutrient availability. Inorganic Nitrogen levels improve as higher amounts of the product were applied signifying there was less N immobilization occurring. At the same time % Fungi identified by the soil micro biometer reading increased as well. These trials took place without the presence of a growing plant in the soil medium used so reactive carbon levels did not build further using the photosynthetic

pathway. Potential mineralizable nitrogen is the measure of organic nitrogen in the humus and soil fraction that can become plant available through microbial mineralization over a growing season. Both PMN figures remained constant or rose very gradually. This may be once again due to the lack of a living root in the litter boxes and the fact that this high cellulose/lignin based straw type takes longer to breakdown into a form that nitrogen from this medium becomes available.



This in field analyses on the use of HDI Residue Digestor on canola stubble in a fallow year again shows that Potential mineralizable nitrogen builds gradually throughout the season where HDI Residue Digestor was applied and that inorganic nitrogen reserves increase and remain plant available. The adherence of humified organic matter to soil particles creates aggregates and stabilizes Organic matter reserves quicker than bacterial dominant soils.

This ability to yield larger amounts of plant available nitrogen makes the HDI Residue Digestor a useful application in early spring before seeding. In many situations there is a case for the producer to be able to reduce their spring nitrogen applications.

Additions of EcoTea™ Seed Dressing introduces a diverse PGPR community around the roots able to transform this nitrogen into carbon backed amino acids available to the plant in a less energy expensive form. This relationship with the living plant helps build active carbon reserves and humus.

Other Variables to Note:

Over the course of the past few growing seasons, we have made note of a few other key variables that are linked to the use of EcoTea™ HDI Residue Digestor. That worth noting are soil chemical properties such as the balance of Cations in the soil, physical indicators such as soil aggregate stability and water infiltration. Finally, positive economic factors such as crop yield.

There are instances where it is not uncommon to see improvements from low Calcium base saturation to higher levels, while respectively, seeing high sodium saturation readings improve. It is commonly understood that maintaining the proper ratio of cations Ca, Mg, K, Na, H for “x” types of soils is required to produce an environment for efficient nutrient availability, soil gas exchange, improved water infiltration, root penetration, and biological soil aggregation.

Discovery Farm Research Plots at Langham Sk. Both photos on the left were taken at the end of August 2022 in a red spring wheat plot with a high salinity area on its east side. Very little of the wheat germinated and a large portion of what did germinate was left stunted and quickly senesced before producing seed. The photos on the right-hand side were from the exact same time in 2023 with a pea/ canola intercrop on the top photo and canola monocrop on the bottom. There was modest improvement in germination, vigor, brix readings and overall plant density from 2022 especially on the intercrop side. In 2023 the plot received a 2x rate of EcoTea™ HDI Residue Digestor a couple weeks before seeding. There was about 1-1.25 more inches of precipitation that fell in 2023 to allow for greater product efficacy. Sodium saturation improved from spring 2023 soil tests of 7.8% to 5% at the end of August. Calcium saturation improved from 37% to 51% over this time (no calcium-based amendment was added).

A second common denominator worth reporting are the physical and structural changes seen in the soil. As mentioned above, soil macro aggregates allow organic matter to bind to the soil particles which is held together by root exudates, glomalin and hyphae from fungi. The clay particles and humate molecules within the organic matter carry negative charge and can increase the nutrient holding capacity of the soil or cation exchange capacity (CEC). The amount of clay in the soil is the lowest common denominator to how many nutrients it can hold, however, the greater the amount of humus and soil aggregation present, the greater the chance of the soils CEC climbing higher. These variables also prevent the soil CEC from depleting as poor aggregate stability and compaction scenarios can give rise to loss of clay particles to wind and water erosion. At Discovery farm on the salinity area, the soil became slightly more flocculated and may have allowed for Cation Exchange Capacity CEC to improve from 38 – 41.8meq/ 100g. This is an area of the research farm that will be closely monitored in future seasons.

Average Water Infiltration Rate Observation		July	2022	July	2023	August	2023
Plot	Method	Min/sec	Inch's/ Hr	Min/sec	Inch's/ Hr	Min/sec	Inch's/ Hr
1	6"DiamRing, 3"Deep, 450ml water	7.00	8.57	13.00	4.61	12.24	4.84
2	6"DiamRing, 3"Deep, 450ml water	8.45	6.85	12.15	4.9	10.50	5.54
3	6"DiamRing, 3"Deep, 450ml water	6.05	9.86	2.37	22.9	3.20	18
4	6"DiamRing, 3"Deep, 450ml water	4.30	13.33	4.30	13.33	5.40	10.6
5	6"DiamRing, 3"Deep, 450ml water	5.00	12	5.27	11	6.00	10
6	6"DiamRing, 3"Deep, 450ml water	6.20	9.47	2.52	18	3.44	16

Water infiltration data from Discovery Farm highlights plot 3 which is the only area to have the residue digestor applied to it in back-to-back springs of 2022 & 2023. Infiltration averages are the fastest among the plots. Another application is planned again for spring 2024. The only other plots to receive residue Digestor are Plot 5 in spring 2022 only and Plot 2 & 4 in spring 2023.

Soil aggregation within the root zone can be documented in the field or brought inside for a root slake test to monitor aggregate stability of soil adhered to the roots when put under water pressure.

Finally, we have had customer feedback from use of the residue digestor in combination with our seed dressing that have equated to profitable outcomes. We took this feedback and the science behind this product to designed a program at the Discovery Farm Ecotea Plots that would allow the residue digestor to be applied year over year or at one time only.

	Wheat Discovery Farms. (Spring 2022 Cost and Return)	Cost of Seed Coating	Cost of N. Avg b/w blends/ lb	lbs of N/acre	Cost of P2O5/ lb	lbs of P2O5/ac	Cost of K2O/ lb	lbs of K2O/ac	lbs of S/ ac	Cost Residue Digestor/ HDI In Furrow/ Ac	Cost Micros and Hum K/ acre	Total Input Costs/ Acre	Operating Costs	Bu/Ac	Bushel Value	Net Profit/ Acre
1	Dry 70N 31.5P Raxill ST	$ 12.00	$ 1.15	70	$ 1.05	31.5	$ 0.60	12	18	$ -	$ -	$ 132.78	$60.00	19.9	$ 11.00	$ 26.13
2	Dry 61N 31.5P ETLSD	$ 5.50	$ 1.15	61	$ 1.05	31.5	$ 0.60	12	15	$ -	$ -	$ 115.93	$60.00	16.7	$ 11.00	$ 7.77
3	Dry 61N 31.5P ETLSD Residue Digest	$ 5.50	$ 1.15	61	$ 1.05	31.5	$ 0.60	12	15	$ 12.50	$ -	$ 128.43	$60.00	22.6	$ 11.00	$ 60.18
4*	LiQ 63N 10P ETLSD/in Fur/Micro/HK	$ 5.50	$ 1.50	60	$ 2.67	10	$ -	1	0	$ 12.50	$ 39.55	$ 174.25	$60.00	16.7	$ 11.00	$ (50.55)
5	Dry 61N 31.5P Rax ST Residue Digest	$ 12.00	$ 1.15	61	$ 1.05	31.5	$ 0.60	12	15	$ 12.50	$ -	$ 134.93	$60.00	24.1	$ 11.00	$ 70.18
6	1/2LiQ 31.5N 5P ETLSD/infur/micro/HK	$ 5.50	$ 1.50	30	$ 2.67	5	$ -	0.5	0	$ 6.25	$ 18.78	$ 88.88	$60.00	21.8	$ 11.00	$ 90.92

Plot 3 & 5 each received the residue digestor randomly several weeks prior to seeding in 2022. At the end of the season both plots yielded the most wheat out of the 6. Both achieving the 2nd and 3rd highest net profit. Both had reduced Spring applied N of 13% compared to plot 1 Grower Standard.

In conclusion EcoTea™ HDI residue digestor is a safe option to apply in autumn after harvest or before spring planting. The product can easily be applied through a standard sprayer at a rate of 10 litres EcoTea™ per acre with 30-40 litres of water.

The product acts to close the loop of true agri-ecological resilience that the EcoTea™ line of products combine the anabolic liquid carbon pathway the seed dressing helps the plant with and the decomposition pathway the Residue Digestor offers..