BIO - REMEDY CM

Nutrient Solubilization

* Most soils contain an abundance of inorganic P and K, the problem is its usually in an insoluble form and cannot be assimilated by the plant.
* Select beneficial soil bacteria have the capacity to convert insoluble phosphatic and potassium-based compounds into plant available forms.
* Beneficial soil bacteria produce copious amounts of organic acids in the soil profile
* This secondary metabolite is responsible for the conversion of insoluble, inorganic, mineral-based phosphorus, and potassium into plant available forms.
* In acidic soils P tends to bind with Aluminum (Al) and Iron (Fe) to form insoluble aluminum phosphate & iron phosphate.
* In alkaline soils P tends to bind with Calcium (Ca) & Magnesium (Mg) to form insoluble calcium phosphate & magnesium phosphate.
* Inorganic phosphate-based minerals such as calcium phosphate and iron phosphate are then solubilized by these low molecular weight organic acids into plant available P
* Inorganic potassium-based minerals such as feldspar, muscovite, orthoclase, biotite, mica is solubilized by organic acids into plant available K
* The hydroxyl and carboxyl groups associated with organic acids chelate the cations bound to the P & K which in turn converts them into soluble P & K.
* Organic Acids include but are not limited to gluconic acid, 2-ketogluconic acid, lactic acid valeric, succinic, isovaleric acid & acetic acid.
* **The solubilization process results in increased P, K, Ca, Mg, S, Fe, Mn & Zn availability to the plant.**

Nutrient Mineralization

* Most soils contain an abundance of organic P, the problem is its usually in an insoluble form and cannot be assimilated by the plant.
* Select beneficial soil bacteria and fungi have the capacity to convert insoluble phosphatic based compounds into plant available forms.
* Beneficial soil bacteria & soil fungi produce secondary metabolites which includes enzymes.
* This secondary metabolite is responsible for the conversion of insoluble, organic based phosphorus into plant available forms.
* Most soils contain an abundance of phytic acid an indigestible, organic form of phosphorus
* Organic phosphates such as phytic acid are mineralized by enzymes released by the soil bacteria and fungi.
* Phosphate Mineralizing Enzymes include but are not limited to phytase, acid phosphatase, alkaline phosphatase & D-glycerophosphates
* Release of phosphatases enzymes hydrolyzes the organic P and splits it from their organic residues, which converts it to a plant available form
* **The mineralization process results in increased P, Ca, Mg, S, Fe, Mn & Zn availability to the plant.**

Contains Plant Growth Promoting Rhizo-Bacteria

* Stimulating plant growth was once entirely attributed to supplemental applications of N, P, K fertilizers
* Recently the emphasis for stimulating plant growth has shifted to the use of microbial based phytohormones
* Plant Growth Hormones (phytohormones) are secondary metabolites produced by beneficial soil bacteria
* Collectively these organisms are referred to as Plant Growth Promoting Rhizo-Bacteria or PGPR
* Plant Growth Promoting Rhizo-Bacteria produce plant growth hormones (phytohormones) such as auxins, cytokinins & gibberellins
* Auxins stimulate flowering, root architecture, issue differentiation, lateral root initiation, polar root hair positioning & root gravitropism
* Gibberellins control cell elongation, cell division, cell differentiation & stress reduction
* Cytokinins stimulate flowering, control cell division in roots & shoots, increased resistance to drought, enhances chlorophyll synthesis
* **Phytohormones produced by bacteria increase yields independent of supplemental fertilizer applications**

Contains Free Living Nitrogen Fixing Bacteria

* Nitrogen fixing bacteria convert atmospheric di-nitrogen (N_2) into plant available ammonia (NH_3)
* Ammonia then binds with soil constituents such as organic matter and then reacts with water to form ammonium (NH_4)
* After conversion to ammonium (a positively charged ion), it is attracted to the negatively charged soil exchange complex and resists leaching
* Process is mediated by nitrogenase enzyme (secondary metabolite) produced by the organisms themselves
* Paenibacillus are mesophilic, facultative anaerobes, function in both aerobic & anaerobic soil environments
* Paenibacillus form endospores to overcome adverse environmental factors such as drought, lack of nutrients, high salinity
* Paenibacillus are particularly efficient at colonizing rhizosphere of grass plants
* Azospirillum are classified as free-living organisms but prefer to colonize soil in proximity to plant roots (rhizosphere) in lieu of open soil
* Azospirillum colonize surface of plant roots via attachment (glycoprotein) & anchoring (polysaccharide)
* Azospirillum are found in the rhizospheres of a wide variety of agricultural crops & they also adapt well to pH swings
* **Nitrogen fixation increases plant available nitrogen reducing the need for supplemental N applications**

Extracellular Enzyme Producing Bacteria - Fungi

* Includes cellulases, hemi-cellulases, xylanases, chitinases, proteases, amylases, lipases, chitinases
* Extracellular enzymes promote the decomposition, transformation and cycling of nutrients in soil profile
* Decomposition liberates carbon and nutrients from complex materials in soil profile
* In particular cellulase producing bacteria promote the degradation of cellulose residues in soil profile
* Cellulose is a complex polysaccharide comprised of thousands of d-glucose subunits (Six Carbon Sugar)
* Cellulose is the structural component of primary cell wall in plants, most abundant organic compound on earth
* Cellulolysis is a biological process mediated by a select group of extracellular enzymes called cellulases
* Three specific cellulase enzymes (secondary metabolites) mediate cellulolysis (conversion of cellulose > glucose)
* 1, 4-β-endoglucanase (cleaves of β-1, 4-glycosidic bonds along a cellulose chain)
* 1, 4-β-exoglucanase (cleaves non-reducing portion of chain & splits fibrils from crystalline cellulose)
* β-glucosidase (hydrolyzes cellobiose and water-soluble cellodextrin to glucose)
* **Glucose released during degradation of cellulose is utilized by organisms as food source (drives metabolic functions)**
* **Glucose released during degradation of cellulose is utilized by plants as a precursor to structural carbohydrates**

Reduction In Nitrogen Loss / Leaching

* Beneficial soil bacteria significantly reduce the incidence of nitrogen leaching in the soil profile
* Nitrogen (particularly nitrate) is very mobile in the soil profile, and it often leaches past the root system before the plant has a chance to sequester it
* Soil bacteria temporarily incorporate free nitrogen into their bodies utilizing it to satiate their metabolic functions.
* This storehouse of nitrogen is then given back to the plant through a process known as nutrient mineralization.
* Nutrient mineralization occurs when protozoa (another soil dwelling organism) consumes soil bacteria to satiate their own carbon & nitrogen requirements.
* Soil bacteria contain more N than the protozoa require, therefore the protozoa essentially keep the carbon and spit this excess nitrogen back into the rhizosphere (soil influenced by roots) where it is then absorbed by the plant roots.
* Much of this nitrogen would have leached past the roots if it had not been temporarily stored and redeposited in the root zone by microbial means
* **Reduction of N leaching improves efficiency of soil applied nitrogenous based fertilizers**

Bio-Films & Drought Tolerance

* Many of the Plant Growth Promoting Rhizobacteria (PGPRB) promote the formation of biofilms containing exopolysaccharides, oligo-polysaccharides, and alginates
* These compounds improve water availability in the rhizosphere (root-soil interface)
* The water retention capacity of polysaccharides exceeds their mass several fold, therefore even small quantities of polysaccharides facilitate maintenance of a hydrated rhizosphere
* These biofilms drastically enhance water retention and therefore availability in the rhizosphere (direct effect on drought tolerance)
* Biofilms also limit the diffusion of biologically active compounds such as plant growth hormones (hormones enhance drought tolerance too) produced by the bacteria facilitating plant uptake of these vital compounds (indirect effect on drought tolerance)
* **Biofilms enhance water retention at the root – soil interface which enhances drought tolerance**

Siderophores & Iron Sequestration

* Siderophores are low molecular weight secondary metabolites produced by Plant Growth Promoting Rhizobacteria (PGPR) they have a strong affinity for chelating ferric ions from the soil environment
* All microorganisms (beneficial & pathogen) require iron in varying quantities, its used in the electron transport chain to produce ATP
* When iron levels are low in the soil these secondary metabolites scavenge iron from the soil profile making it available to **BOTH** the microorganism itself and the plant
* This is also a mechanism used by beneficial soil organisms to outcompete soil borne pathogens. They use siderophores to outcompete the pathogens for iron
* **Summarily siderophores support the growth of plants by increasing the availability of Fe^{3+} to the plants**

Microbial Synergists

* Contains full spectrum of targeted microbial synergists and growth factors to promote microbial growth & proliferation
* Provides them with energy during critical lag phase of development when metabolic requirements drastically increase
* Contains organic protein source to satiate nitrogen requirements of beneficial bacteria & fungi
* Contains multiple carbon sources (simple sugars) which serves as food source for beneficial bacteria & fungi
* Each organism in formula has a preferred carbon source, by targeting carbon source to organism you optimize microbial growth
* **Inoculants absent microbial synergists exhibit limited growth potential in soil microclimates**

GUARANTEED ANALYSIS

Soluble Potash (K_2O). …...................... 5.00%
Iron (Fe)……….……….…..……….………...2.00%
2.0 % WS Iron (Fe)
Sulfur (S)…….……...…………….…………1.00%
1.0 % Combined Sulfur (S)

NUTRIENTS DERIVED FROM

Sulfate of Potash, Ferric Ammonium Citrate

ALSO CONTAINS NON-PLANT FOOD INGREDIENTS

Active Ingredients

Bacillus firmus 200,000,000 CFU per gram, Bacillus subtilis 200,000,000 CFU per gram,
Bacillus licheniformis 200,000,000 CFU per gram, Bacillus amyloliquefaciens 100,000,000 CFU per gram,
Bacillus megaterium 100,000,000 CFU per gram, Bacillus pumulis 100,000,000 CFU per gram,
Bacillus azotoformans 100,000,000 CFU per gram, Bacillus coagulans 100,000,000 CFU per gram,
Paenibacillus polymyxa 100,000,000 CFU per gram, Paenibacillus durum 100,000,000 CFU per gram,
Streptomyces coelicolor 25,000,000 CFU per gram, Streptomyces lydicus 25,000,000 CFU per gram,
Streptomyces griseus 25,000,000 CFU per gram, Trichoderma reesei 25,000,000 CFU per gram,
Trichoderma hamatum 25,000,000 CFU per gram, Trichoderma harzianum 25,000,000 CFU per gram
Azospirillum lipoferum 20,000,000 CFU per gram, Pseudomonas aureofaciens 20,000,000 CFU per gram,
Pseudomonas fluorescens 20,000,000 CFU per gram, Pseudomonas putida 20,000,000 CFU per gram,

Inert Ingredients

61.00 % Dextrose (Microbial Nutrient & Microbial Carrier), 10.00 % Sucrose (Microbial Nutrient),
3.00 % Hydrated Sodium Calcium Aluminosilicate (Drying Agent), 2.00 % Soy Protein Hydrolysate (Microbial Nutrient),
2.00 % Brewers Yeast Extract (Microbial Nutrient)

97 % Water Soluble By Weight

GENERAL INFORMATION

* May be tank mixed with fertilizers, biostimulants and microbial foods (sugars, humic acids, kelp)
* It is advisable not to co-apply microbial inoculants with pesticides (fungicides, herbicides, insecticides, nematicides, fumigants) as they can compromise integrity of or kill the beneficial organisms herein contained.
* If co-application of inoculant and pesticide is required tank mix and apply same day (minimize time in tank)
* When applied in rotation with pesticides its advisable to allow 5 - 7 days between application of pesticide and inoculant.
* Never tank mix with pesticides that contain imazilil, propiconazole, tebuconazole and triflumizole.
* Do not mix product and store, apply all tank mixes same day
* Agitate tank while adding product and during entire application process

* Always perform jar test when mixing product with other inputs to test for physical compatibility
* To facilitate mixing process you may create slurry (1 lb in 2 gal / 0.45 kg in 7.6 liters of water) and add slurry while agitating
* Optimal results achieved if product is applied early morning, evening or on an overcast day.

TURFGRASS RATES

* Begin applications once turf breaks dormancy or when soil temperatures reach 50° F
* Continue applications throughout growing season until turf reaches dormancy
* Irrigate turf immediately after application to optimize results by bringing product mixture into root zone (rhizosphere)
* Utilize a minimum of 1 gal / 3.785 liter of water per 1000 sq ft / 92 sq meters to facilitate root colonization
* Use higher rate on turf exposed to or species susceptible to abiotic stress (heat, cold, drought, humidity)
* Apply as soil drench through low pressure watering nozzles such as fan nozzles, drench watering systems, hydraulic sprayers, handheld or backpack sprayers.

APPLICATION	AMOUNT / DILUTION	COVERAGE	FREQUENCY
Golf Course Greens	1 – 1 ½ oz 30 – 45 grams	1000 sq ft 100 sq meters	Every 2 – 4 weeks throughout growing season. Irrigate 1/4 - 1/2"
Fairways	0.75 – 1 oz 22.5 – 30 grams	1000 sq ft 100 sq meters	Every 4 weeks throughout growing season. Irrigate 1/4 - 1/2"
Residential	0.50 – 1 oz 15 – 30 grams	1000 sq ft 100 sq meters	Every 4 - 6 weeks throughout growing season. Irrigate1/4 - 1/2"
Sod Farms	0.75 – 1 oz 22.5 – 30 grams	1000 sq ft 100 sq meters	Apply prior to seeding - sprigging after soil has been prepared. Apply at 3 - 4 week intervals throughout growth cycle
Seeding	1 – 1 ½ oz 30 – 45 grams	1000 sq ft 100 sq meters	Apply after seeding and irrigate with 1/8 inch of water after application
Sodding	1 – 1 ½ oz 30 – 45 grams	1000 sq ft 100 sq meters	Apply prior to laying sod and irrigate with 1/4 inch of water after sod has been laid. Lay sod immediately after application

Ornamental Trees, Shrubs, Herbaceous Perennials, Annuals, Roses - Post Plant

* Begin applications once ornamentals break dormancy or when soil temperatures reach 50° F / 10° C
* Apply at the rate of 1.5 - 2 oz per 1,000 square feet / 45 - 60 grams per 92 sq meters of bed space.
* Thoroughly mix the required dosage in sufficient volume of water to achieve desired coverage and apply product mixture as a soil drench or sprench to landscape plantings.
* Use higher water volume for sprench applications. Water volume should be adjusted based on canopy when applying as sprench.
* Apply product mixture every 4 - 8 weeks throughout the growing season
* Apply as soil drench or sprench through low pressure watering nozzles such as fan nozzles, drench watering systems, hydraulic sprayers, handheld or backpack sprayers.

GREENHOUSE MAINNTENANCE RATES

* Prepare a stock solution by dissolving 1 - 1.5 lbs in 8 gallons / 0.45 - 0.68 kg in 30 liters of clean potable water
* Use higher rate on plants exposed to abiotic stress (heat, cold, drought, humidity)
* Run stock solution through injector system @ 1 : 100 dilution & apply at the rate of 10 – 30 gal per 1000 sq ft of table space
* Rate may be adjusted based on plant type and growing media
* 1st application: drench plug tray just prior to transplanting.
* 2nd application: drench 2 weeks after transplanting.
* 3rd application: drench 3-4 weeks after second application.
* If the growth cycle extends beyond 8 weeks, continue drench every 2-4 weeks throughout balance of crop cycle

HYDROPONIC RATES

* Add product directly to reservoir at each nutrient change
* Change nutrient reservoir on a weekly basis * Aerate for optimum results

PHASE	U.S.	METRIC
Cuttings & Transplants	1 teaspoon per 5 gal water	5 grams per 20 liters water
Maintenance Phase	1 1/2 teaspoon per 5 gal water	7.55 grams per 20 liters water
Vegetative Growth Phase	2 teaspoon per 5 gal water	10 grams per 20 liters water
Transition To Bloom Phase	1 teaspoon per 5 gal water	5 grams per 20 liters water
Bloom / Ripening Phase	1 teaspoon per 5 gal water	5 grams per 20 liters water

ROW CROPS - IN FURROW

* Dilute 1 - 2 lbs per acre / 1.12 kg - 2.24 kg per hectare in a sufficient volume of water to achieve desired and uniform coverage
* Apply in furrow to increase biological activity in rhizosphere

ROW CROPS - POST PLANT

* Begin applications once soil temperatures reach 50° F / 10° C
* Apply as soil drench or sprench (soil & foliar)
* For soil drench irrigate immediately after application with a minimum of 1/4 - 1/2 inch of water to bring product mixture into root zone (rhizosphere)
* When applying as sprench (soil & foliage) irrigate 24 hours after application
* Apply at the rate of 2 lb – 4 lbs per acre / 2.24 – 4.48 kg per hectare at 2 - 4 week intervals throughout crop cycle
* Use higher rate and frequency on crops exposed to or species susceptible to abiotic stress (heat, cold, drought, humidity)
* Lack of effectiveness can result from non-uniform distribution of product mixture
* Crop specific rates / timing available

PLANT SAFETY

* Product has been tested on numerous plant species with no apparent phytotoxic response
* However the product has not been tested on every plant variety in combination with all possible tank mixes, under every conceivable environmental condition. We always recommend testing product on a small number of plants to check for adverse plant response PRIOR to full scale field application