WARD Laboratories, Inc.

Ag Testing - Consulting

Account No. : 24781

Biological Soil Analysis Report

NOLAN, MIKE
41095 RD G
MANCOS **CO 81328**

Invoice No. :	**1289907**
Date Received :	**06/03/2019**
Date Reported :	**06/05/2019**
Lab No. :	**7393**

Results For : MIKE NOLAN
Sample ID 1 : CONTROL
Sample ID 2 : 002

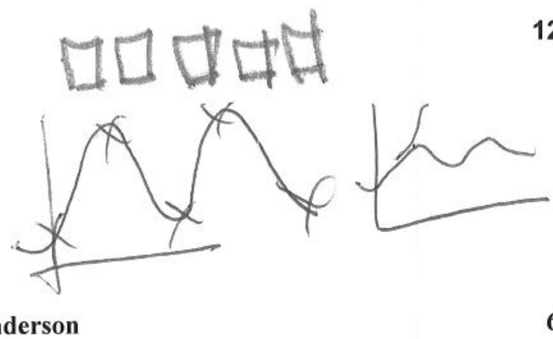
PLFA Soil Microbial Community Analysis

Functional Group Biomass & Diversity

Total Living Microbial Biomass, Phospholipid Fatty Acid (PLFA) ng/g	**2770.44**
Functional Group Diversity Index	**1.468**

Total Biomass	Diversity	Rating
< 500	< 1.0	Very Poor
500+ - 1000	1.0+ - 1.1	Poor
1000+ - 1500	1.1+ - 1.2	Slightly Below Average
1500+ - 2500	1.2+ - 1.3	Average
2500+ - 3000	1.3+ - 1.4	Slightly Above Average
3000+ - 3500	1.4+ - 1.5	Good
3500+ - 4000	1.5+ - 1.6	Very Good
> 4000	> 1.6	Excellent

Functional Group	Biomass, PLFA ng/g	% of Total Biomass
Total Bacteria	**1195.56**	**43.15**
Gram (+)	**692.51**	**25.00**
Actinomycetes	199.91	7.22
Gram (-)	**503.05**	**18.16**
Rhizobia	0.00	0.00
Total Fungi	**286.68**	**10.35**
Arbuscular Mycorrhizal	**80.58**	**2.91**
Saprophytes	**206.10**	**7.44**
Protozoa	**10.72**	**0.39**
Undifferentiated	**1277.49**	**46.11**



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Lab No. : 7393

Community Composition Ratios

Fungi:Bacteria **0.2398**

Bacteria tend to dominate in systems with fewer organic inputs or residues possibly leading to a lower C:N ratio. In addition, bacteria can be more prominent in the early spring or late fall as soil temperatures are usually cooler and vegetation is less active or absent. Dry conditions, slightly alkaline to alkaline pH values, or increased land disturbance through prolonged and extensive tillage, grazing, or compaction may also favor bacteria. While bacteria are important and needed in the soil ecosystem, fungi are desired and more often considered indicators of good soil health. Increased use of cover crops and/or other organic inputs and less soil disturbance should help the soil support more fungi. Adjustments to pH may also be recommended in some more extreme circumstances.

Scale	Rating
< 0.05	Very Poor
0.05+ - 0.1	Poor
0.1+ - 0.15	Slightly Below Average
0.15+ - 0.2	Average
0.2+ - 0.25	Slightly Above Average
0.25+ - 0.3	Good
0.3+ - 0.35	Very Good
> 0.35	Excellent

Predator:Prey **0.0090**

This ratio is also expressed as protozoa to bacteria. Protozoa feed on bacteria which helps release nutrients, especially nitrogen. A higher ratio indicates an active community where base level nutrients are sufficient to support higher trophic levels or predators. However, this ratio will always be a relatively low number because the prey will greatly outnumber the predators.

Scale	Rating
< 0.002	Very Poor
0.002+ - 0.005	Poor
0.005+ - 0.008	Slightly Below Average
0.008+ - 0.01	Average
0.01+ - 0.013	Slightly Above Average
0.013+ - 0.016	Good
0.016+ - 0.02	Very Good
> 0.02	Excellent

Gram (+):Gram (-) **1.3766**

Gram (+) bacteria typically dominate early in the growing season and/or following a fallow period. They also survive better under certain environmental conditions or stressors such as drought or extreme temperatures due to their ability to form spores. Therefore, it is common to see higher values when the community is coming out of dormancy or is stressed. These values will typically begin to approach those of a more balanced bacterial community as the soil conditions become more favorable throughout the growing season. A gram (-) dominated soil may be due to anaerobic conditions or other stressors such as pesticide application or heavy metal contamination.

Scale	Rating
< 0.5	Gram (-) Dominated
0.5+ - 1.0	Slightly Gram (-) Dominated
1.0+ - 2.0	Balanced Bacterial Community
2.0+ - 3.0	Slightly Gram(+) Dominated
3.0+ - 4.0	Gram(+) Dominated
> 4.0	Very Gram(+) Dominated

Stress and Community Activity Ratios

Sat:Unsat **1.8875**

Bacteria alter their membranes under various environmental conditions in order to maintain optimal fluidity for nutrient and waste transport into and out of the cell. Saturated fatty acids may reflect a better adapted community to current environmental conditions. Communities under stressed conditions will increase their proportion of unsaturated fatty acids. This will likely occur most often as a result of low soil moisture or drastic changes in temperature. In general, a higher number indicates a healthier and more stable community.

Mono:Poly **8.0992**

The ratio of monounsaturated to polyunsaturated fatty acids is used along with the sat:unsat ratio to further indicate the degree of community stress. A higher ratio indicates less stress, while a lower ratio would depict higher levels of prolonged stress due to conditions such as temperature, moisture, pH, or nutrient availability (starvation).

Pre 16:1ω7c:cy17:0 **ALL PRE 16:1**

Pre 18:1ω7c:cy19:0 **17.6348**

Cyclo (cy) fatty acids are more prominent during stationary phases of growth or under high stress conditions that influence membrane fluidity and growth rates such as temperature, pH, moisture, and nutrient availability. In general, a higher number or all Pre16/Pre18 is better and indicates an actively growing community experiencing fewer stressors. These values are typically higher early in the growing season (planting) when the community is becoming active and experiencing fast growth. The values may begin to drop towards the end of the growing season (harvest) following a decrease in plant growth activity or as the community approaches a stationary growth phase as the temperature/moisture changes between the seasons.

All ratios should be looked at separately, but should also be taken into context and compared with one another to better understand the big picture. These are general guidelines and statements regarding soil microbial communities. In addition, the scales and ranges presented here are specific for the type of extraction and analytical methods used for PLFA analysis at Ward Laboratories, Inc. They will not necessarily reflect ranges derived from other methods of analysis or the literature. The scales can and should be adjusted slightly depending on the time of year and conditions at sampling along with the climate and soil type of specific regions where comparisons are being made. Conditions such as time of year, past and present crop, moisture, pH, and fertility should be noted or measured close to sampling for PLFA analysis for a more in depth interpretation of results.

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MANCOS CO 81328

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Date Received :	06/03/2019
Date Reported :	06/05/2019

Results For : MIKE NOLAN
Sample ID 1 : CONTROL
Sample ID 2 : 002
Lab No. : 7393
Sample ID 3 :
Sample ID 4 :
Soil Depth : 0 - 6 in

Haney - Soil Health Analysis

1:1 Soil pH	7.1
1:1 Soluble Salts, mmho/cm	0.10
Excess Lime Rating	NONE
Organic Matter, %LOI	4.0
Soil Respiration CO_2-C, ppm C	57.6
Water Extract	
Total Nitrogen, ppm N	30.5
Organic Nitrogen, ppm N	11.1
Total Organic Carbon, ppm C	101
H3A Extract	
Nitrate, ppm NO_3-N	19.6
Ammonium, ppm NH_4-N	0.1
Inorganic Nitrogen, ppm N	19.7
Total (ICAP) Phosphorus, ppm P	17
Inorganic (FIA) Phosphorus, ppm P	13.8
Organic Phosphorus, ppm P	2.8
ICAP Potassium, ppm K	47
ICAP Zinc, ppm Zn	0.54
ICAP Iron, ppm Fe	58
ICAP Manganese, ppm Mn	8.1
ICAP Copper, ppm Cu	0.41
ICAP Sulfur, ppm S	7.3
ICAP Calcium, ppm Ca	716
ICAP Magnesium, ppm Mg	148
ICAP Sodium, ppm Na	23
ICAP Aluminum, ppm Al	194
Calculations	
Microbially Active Carbon (%MAC)	56.8
Organic C : Organic N	9.1
Organic N : Inorganic N	0.6
Organic Nitrogen Release, ppm N	11.1
Organic Nitrogen Reserve, ppm N	0.0
Organic Phosphorus Release, ppm P	2.8
Organic Phosphorus Reserve, ppm P	< 0.1
Soil Health	
Soil Health Calculation	8.89
Cover Crop Suggestion	50% Legume 50% Grass

Reviewed By : Lance Gunderson

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Lab No. : 7393

Haney - Soil Health Analysis Contd.

Nutrient Quantity Available for Next Crop

Nitrogen, lbs N/A	55.4
Phosphorus, lbs P_2O_5/A	38.2
Potassium, lbs K_2O/A	57.0
Nutrient Value, $/A	78.87

Nitrogen Savings by using the Haney Test

Traditional evaluation, lbs N/A	35.3
Haney Test N evaluation, lbs N/A	55.4
Nitrogen Difference, lbs N/A	20.1
N savings, $/A	12.89

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Biological Soil Analysis Report

NOLAN, MIKE
41095 RD G
MANCOS CO 81328

Invoice No. : 1300061
Date Received : 10/07/2019
Date Reported : 10/09/2019
Lab No. : 15448

Results For : MIKE NOLAN
Sample ID 1 : CONTROL
Sample ID 2 : 002

PLFA Soil Microbial Community Analysis

Functional Group Biomass & Diversity

Total Living Microbial Biomass, Phospholipid Fatty Acid (PLFA) ng/g 5732.16
Functional Group Diversity Index 1.467

Total Biomass	Diversity	Rating
< 500	< 1.0	Very Poor
500+ - 1000	1.0+ - 1.1	Poor
1000+ - 1500	1.1+ - 1.2	Slightly Below Average
1500+ - 2500	1.2+ - 1.3	Average
2500+ - 3000	1.3+ - 1.4	Slightly Above Average
3000+ - 3500	1.4+ - 1.5	Good
3500+ - 4000	1.5+ - 1.6	Very Good
> 4000	> 1.6	Excellent

Functional Group	Biomass, PLFA ng/g	% of Total Biomass
Total Bacteria	2928.29	51.09
Gram (+)	1404.73	24.51
Actinomycetes	425.89	7.43
Gram (-)	1523.57	26.58
Rhizobia	0.00	0.00
Total Fungi	727.74	12.70
Arbuscular Mycorrhizal	256.39	4.47
Saprophytes	471.35	8.22
Protozoa	45.25	0.79
Undifferentiated	2030.87	35.43

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Community Composition Ratios

Lab No. : 15448

Fungi:Bacteria **0.2485**

Bacteria tend to dominate in systems with fewer organic inputs or residues possibly leading to a lower C:N ratio. In addition, bacteria can be more prominent in the early spring or late fall as soil temperatures are usually cooler and vegetation is less active or absent. Dry conditions, slightly alkaline to alkaline pH values, or increased land disturbance through prolonged and extensive tillage, grazing, or compaction may also favor bacteria. While bacteria are important and needed in the soil ecosystem, fungi are desired and more often considered indicators of good soil health. Increased use of cover crops and/or other organic inputs and less soil disturbance should help the soil support more fungi. Adjustments to pH may also be recommended in some more extreme circumstances.

Scale	Rating
< 0.05	Very Poor
0.05+ - 0.1	Poor
0.1+ - 0.15	Slightly Below Average
0.15+ - 0.2	Average
0.2+ - 0.25	Slightly Above Average
0.25+ - 0.3	Good
0.3+ - 0.35	Very Good
> 0.35	Excellent

Predator:Prey **0.0155**

This ratio is also expressed as protozoa to bacteria. Protozoa feed on bacteria which helps release nutrients, especially nitrogen. A higher ratio indicates an active community where base level nutrients are sufficient to support higher trophic levels or predators. However, this ratio will always be a relatively low number because the prey will greatly outnumber the predators.

Scale	Rating
< 0.002	Very Poor
0.002+ - 0.005	Poor
0.005+ - 0.008	Slightly Below Average
0.008+ - 0.01	Average
0.01+ - 0.013	Slightly Above Average
0.013+ - 0.016	Good
0.016+ - 0.02	Very Good
> 0.02	Excellent

Gram (+):Gram (-) **0.9220**

Gram (+) bacteria typically dominate early in the growing season and/or following a fallow period. They also survive better under certain environmental conditions or stressors such as drought or extreme temperatures due to their ability to form spores. Therefore, it is common to see higher values when the community is coming out of dormancy or is stressed. These values will typically begin to approach those of a more balanced bacterial community as the soil conditions become more favorable throughout the growing season. A gram (-) dominated soil may be due to anaerobic conditions or other stressors such as pesticide application or heavy metal contamination.

Scale	Rating
< 0.5	Gram (-) Dominated
0.5+ - 1.0	Slightly Gram (-) Dominated
1.0+ - 2.0	Balanced Bacterial Community
2.0+ - 3.0	Slightly Gram(+) Dominated
3.0+ - 4.0	Gram(+) Dominated
> 4.0	Very Gram(+) Dominated

Stress and Community Activity Ratios

Sat:Unsat **1.1414**

Bacteria alter their membranes under various environmental conditions in order to maintain optimal fluidity for nutrient and waste transport into and out of the cell. Saturated fatty acids may reflect a better adapted community to current environmental conditions. Communities under stressed conditions will increase their proportion of unsaturated fatty acids. This will likely occur most often as a result of low soil moisture or drastic changes in temperature. In general, a higher number indicates a healthier and more stable community.

Mono:Poly **14.7147**

The ratio of monounsaturated to polyunsaturated fatty acids is used along with the sat:unsat ratio to further indicate the degree of community stress. A higher ratio indicates less stress, while a lower ratio would depict higher levels of prolonged stress due to conditions such as temperature, moisture, pH, or nutrient availability (starvation).

Pre 16:1ω7c:cy17:0 **ALL PRE 16:1**

Pre 18:1ω7c:cy19:0 **26.0314**

Cyclo (cy) fatty acids are more prominent during stationary phases of growth or under high stress conditions that influence membrane fluidity and growth rates such as temperature, pH, moisture, and nutrient availability. In general, a higher number or all Pre16/Pre18 is better and indicates an actively growing community experiencing fewer stressors. These values are typically higher early in the growing season (planting) when the community is becoming active and experiencing fast growth. The values may begin to drop towards the end of the growing season (harvest) following a decrease in plant growth activity or as the community approaches a stationary growth phase as the temperature/moisture changes between the seasons.

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Results For : MIKE NOLAN
Sample ID 1 : CONTROL
Sample ID 2 : 002
Lab No. : 15448
Sample ID 3 :
Sample ID 4 :
Soil Depth : 0 - 6 in

Haney - Soil Health Analysis

1:1 Soil pH	7.5
1:1 Soluble Salts, mmho/cm	0.35
Excess Lime Rating	NONE
Organic Matter, %LOI	3.6
Soil Respiration CO_2-C, ppm C	28.6
Water Extract	
Total Nitrogen, ppm N	24.4
Organic Nitrogen, ppm N	17.0
Total Organic Carbon, ppm C	155
H3A Extract	
Nitrate, ppm NO_3-N	6.0
Ammonium, ppm NH_4-N	4.5
Inorganic Nitrogen, ppm N	10.4
Total (ICAP) Phosphorus, ppm P	23
Inorganic (FIA) Phosphorus, ppm P	19.3
Organic Phosphorus, ppm P	3.4
ICAP Potassium, ppm K	35
ICAP Zinc, ppm Zn	0.33
ICAP Iron, ppm Fe	35
ICAP Manganese, ppm Mn	5.3
ICAP Copper, ppm Cu	0.31
ICAP Sulfur, ppm S	12.5
ICAP Calcium, ppm Ca	954
ICAP Magnesium, ppm Mg	183
ICAP Sodium, ppm Na	27
ICAP Aluminum, ppm Al	176
Calculations	
Microbially Active Carbon (%MAC)	18.5
Organic C : Organic N	9.1
Organic N : Inorganic N	1.6
Organic Nitrogen Release, ppm N	12.6
Organic Nitrogen Reserve, ppm N	4.4
Organic Phosphorus Release, ppm P	1.9
Organic Phosphorus Reserve, ppm P	1.5
Soil Health	
Soil Health Calculation	7.65
Cover Crop Suggestion	50% Legume 50% Grass

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Lab No. : 15448

Haney - Soil Health Analysis Contd.

Nutrient Quantity Available for Next Crop

Nitrogen, lbs N/A	41.4
Phosphorus, lbs P_2O_5/A	48.9
Potassium, lbs K_2O/A	41.9
Nutrient Value, $/A	66.55

Nitrogen Savings by using the Haney Test

Traditional evaluation, lbs N/A	10.8
Haney Test N evaluation, lbs N/A	41.4
Nitrogen Difference, lbs N/A	30.7
N savings, $/A	19.63

Recommendations
In Actual Pounds of Plant Nutrients per Acre

N Credit :

Sub-Soils :

Crop	**(Haney) Garden, Unit/A**
Yield	**1**
Nitrogen N	40
Phosphorus P_2O_5	30
Potassium K_2O	70
Sulfur S	0
Zinc Zn	0
Magnesium Mg	0
Iron Fe	0
Manganese Mn	0
Copper Cu	0

Crop	**(Haney) Garden, Unit/A**
Yield	**1.3**
Nitrogen N	70
Phosphorus P_2O_5	30
Potassium K_2O	70
Sulfur S	0
Zinc Zn	0
Magnesium Mg	0
Iron Fe	0
Manganese Mn	0
Copper Cu	0

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