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FEATURED ARTICLE: Bringing Life to 'Dead' Soil in New Mexico

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Prescriptions for Successful Revegetation

Bringing Life to 'Dead' Soil in New Mexico

NM DOT revegetation demonstration trial plots two months after seeding on highway overpass construction project. From top to bottom: unfertilized control, concentrated compost, and NM DOT compost.

Knowing soil type and seed vitality is necessary for developing proper plans for revegetation projects. Knowledge of a site's topsoil suitability, climate, and native plant community allows development of proper seed mixes, fertilizer and mulching recommendations, and reclamation plans. This article will describe soil health, how to diagnose soil quality, and how to develop fertilizer recommendations for revegetation projects. A prescription for a nutrient rich, dried compost application was selected using an analytical approach based on soil suitability testing and site characteristics on a roadside project in New Mexico. This case study suggests that well planned revegetation prescriptions are crucial for plant establishment success.

Ailing Soils

Prior to 1883, soil was considered a part of bedrock, a dead substrate where plants found essential elements. However, Vasily Dokuchaev, commonly regarded as the father of soil science, thought differently. According to him, the soil was alive with living organisms and organic material[1]. Today we know that Dokuchaev was correct; in fact, soil has 100 million to 1 billion living microorganisms present in just one teaspoon[2]. These organisms rely on optimal environments to survive and make nutrients available to plants. However, certain events like compaction, topsoil salvaging, and stockpiling can damage significant portions of the living soil[3].

A healthy soil needs the right nutrients and conditions to thrive, just as a person does. When sick or injured a person knows that a doctor will diagnose, prescribe, and monitor health. The same tactics can be used to restore an ailing soil. Instead of a physical or blood test, the soil test and site survey are effective tools to prescribe revegetation plans for erosion control projects.

Determining Soil Health and Quality

The definition of soil health can differ depending on application but in the context of revegetation projects soil health can be considered as the capacity of a soil to function as a living ecosystem that grows and sustains a desired plant community. Soil health differs between in situ (undisturbed) soil and disturbed or stockpiled soil. In order to diagnose soil health, it is best to take a two pronged approach using both field observations and analytical testing.

Fundamental to diagnosing soil health in the field is digging and then studying a soil pit. This step will help differentiate topsoil from subsoil and will identify potential soil health problems such as compaction or salt accumulation. During topsoil salvaging, if the earthwork contractor scrapes too much topsoil from the site, topsoil health will be compromised since lower quality subsoil will contaminate the surface soil. Alternately, if the earthwork contractor does not salvage all of the topsoil in the soil profile, this resource will be wasted and more expensive soil amendments may be needed to ensure successful revegetation. Fortunately, if the appropriate tools are used and the correct observations are made, topsoil can be accurately identified and diagnosed.

Both soil physical characteristics and landscape features provide insight into soil health. Soil structure is the arrangement of soil granules within the soil profile. This structure has a major influence on water and air movement, biological activity, root growth, and seedling emergence. When differentiating topsoil from subsoil, look for healthy topsoil to have a granular structure with a high porosity. It is useful to poke at the soil with a pocketknife and look for a crumbly, fluffy look. Often subsoil structure will be irregular and blocky. In blocky structure, the structural units are three dimensional blocklike shapes with flat or slightly rounded surfaces.

NM DOT revegetation demonstration trial plots four months after seeding on highway overpass construction project. From top to bottom: unfertilized control, concentrated compost, and NM DOT compost.

After earthwork construction, topsoil is not even considered soil by the USDA-NRCS classification system. Soil structure is destroyed. This changes the soil water holding capacity, kills soil microorganisms, and possibly mixes in subsurface salts. In general it is best to avoid storing or stockpiling topsoil. If topsoil must be stored, it is critical to store topsoil in windrows that will not be recompacted or disturbed. Topsoil stockpiles that are in shallow piles and are quickly vegetated will help preserve valuable soil microorganisms.

Soil texture is the distribution of soil particles and is not related to soil structure. Texture can be determined in a hand ribbon test by squeezing a wetted ball of soil out between the thumb and fingers[4]. A silt loam is ideal but all textures are suitable for revegetation. Clays and sands present unique challenges with moisture management, but certain plants are resilient and will thrive in these soils after the initial germination period.

Location and aspect are also indicators of soil type. Take note of the climate, ecological community, native and invasive plant species, ground coverage, slopes, and water features. Certain areas of the country such as Iowa and Illinois farmland have deep, rich topsoil compared to rocky outcrops in Wyoming or New Mexico. However, high quality topsoil can be found in nonagricultural areas. Draws, valley floors, and loess deposits can have high quality topsoil because of water or wind deposition. Soil types differ between north and south facing slopes and often support different plant communities. Knowledge of soil formation also provides clues to topsoil fertility, a topic for another discussion.

Visual observations are useful in assessing soil health but exercise caution before jumping to conclusions. Munsell Soil

The concentrated compost soil amendment was hydraulically applied by the contractor, 814 Solutions. This method allows for extended reach and a uniform coverage.

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Three laborers and an equipment operator were required to apply the NM DOT compost.

Color Charts are used to measure soil color based on hue, value, and chroma. Healthy topsoil generally has brownish, dark earth tones. A distinct or gradual color change will sometimes illustrate the subsoil layer with a brighter colored earth tone. Salt depositions seen in the soil pit can indicate salinity issues. Plant roots are prolific in topsoil but isolated roots can penetrate into the subsurface. Many field observations can be deceiving, which is why laboratory data is the most important means to evaluate soil health.

A soil laboratory analysis is used to identify plant limiting nutrients and conditions and allows for development of an enhanced revegetation plan. Soil testing is best done before earthwork begins but if need be can also be completed after the topsoil has already been stockpiled. Soil samples should be taken from each soil type on the project. Within each soil type sample all soil layers that could be considered topsoil. When sampling stockpiled topsoil it is important to take several subsamples and to homogenize into a composite sample. Important soil testing parameters include but are not limited to soil organic matter, pH, salts, excessive lime, texture, cation exchange capacity, and plant available nutrients.

Reviving a 'Dead' Soil with a Nontraditional Compost Application

The New Mexico Department of Transportation (NM DOT) established a revegetation demonstration plot on a highway overpass construction project to evaluate a nontraditional compost product and application method. The project was a collaborative effort among the government agency, NM DOT; the contractor, 814 Solutions; the distributor, Nilex; and the compost supplier, Suståne Natural Fertilizer. All parties worked together to determine if the new compost application method resulted

This is a close up view of the topsoil present at the NM DOT revegetation demonstration trial plots. The pen is for reference only.

Sustane Concentrated Compost was used as a nontraditional compost amendment for the NM DOT revegetation trial.

The NM DOT Compost is made from yard waste from the City of Santa Fe. The sunglasses are for reference only.

in better native plant establishment, lower costs, and less erosion than the traditional compost application.

The topsoil was sampled by 814 Solutions and sent to Midwest Laboratories for a custom soil analysis. The soil laboratory results were inputted into Suståne's custom soil suitability decision matrix, which is based on the best scientific resources available including government and university research, scientific journals and soil science textbooks. Using this information, the soil was classified as unsuitable for plant growth, and an application rate of 3 tons per acre of Suståne Concentrated Compost 2-6-3 (N-P-K) was recommended as a soil amendment, hereafter referred to as concentrated compost. The deciding factors were an extremely high pH, almost no organic matter, and a low moisture environment.

The concentrated compost was chosen because of its high nutrient content, stability, and for shipping ease. This compost is derived from turkey litter and has been aerobically composted over six months following the USDA National Standards on Organic Agricultural Production. The comparison compost was specified by NM DOT and is derived from yard waste from the City of Santa Fe. Both composts were tested by Midwest Laboratories, and key chemical differences are seen in Table 1. Most noticeable was the difference in nitrogen composition, with the NM DOT compost containing over twice the ammoniacal nitrogen of the concentrated compost. This is significant since ammoniacal nitrogen is water soluble and more unstable than water insoluble nitrogen.

The trial was divided into three one half acre plots between the northbound and southbound highway lanes. Each plot was full sun with 4:1 slopes that formed a mild valley with both east and west facing aspects. The climate is semi-arid with the average annual precipitation around 14 inches.

Parameter	Concentrated Compost	NM DOT Compost	Unfertilized control
Rate (ton/acre)	3	75	0
Rate (in./acre)	negligible	1	0
Nitrogen rate (lb./acre)	120	1,260	0
Ammoniacal N (lb./acre)	11	202	0
Phosphate rate (lb./acre)	360	2,190	0
Potash rate (lb./acre)	180	900	0
pH	6.5	8.1	N/A
Carbon to Nitrogen (C:N) ratio	9:1	20:1	N/A
Conductivity (dS/m)	20	2	N/A

Table 1. Trial plot compost rates and parameters.

The only difference among the plots was the type, application, and amount of compost used. Compost application rates and key chemical parameters are shown in Table 1. The concentrated compost was mixed into a hydroseeding tank and applied at 3 tons per acre through the cannon nozzle. The NM DOT compost was mechanically and hand applied to meet the specification of a one inch thickness. The third plot received no compost or additional fertilizer. NM DOT specified seed mix, mycorrhizal fungi, and straw (barley) were applied to all plots at the same rate. The seed mix included 18 species of grasses designed for drought and stress tolerance, including natives, perennials, annuals, and legumes. Mycorrhizal fungi were disked and drilled in with the seed at 1.2 million propagules per acre per NM DOT spec. Finally, the straw (barley) was blown at 2 tons per acre and crimped and tacked. All seeding work was completed on May 21, 2014.

Sites were compared after two and four months by visual inspection. The concentrated compost test area had the most rapid and by far the highest amount of native plant establishment among the three plots. No erosion was visible. The NM DOT compost test area had very little native plant establishment, some weed coverage, and visible sheet erosion. The unfertilized control had almost no plant growth of any kind, and significant erosion was occurring.

After four months, the concentrated compost plot had considerable native grass coverage as compared to the other com-

parison plots. The NM DOT compost plot had substantial weed growth and very little native plant growth. The unfertilized control simply was ineffective, with no coverage. Erosion was highest on the unfertilized control plot and least on the concentrated compost plot.

The physical and chemical compositions of the two compost products resulted in the dramatic differences in plant establishment. Bioavailability is crucial when choosing a soil amendment. Physically, the smaller particle size of the concentrated compost was more readily available to the seedlings. Chemically, plant nutrients are most available to plants at the 6.5-7 pH range, and the high pH of the NM DOT compost coupled with the highly alkaline soil immobilized much of the applied macro- and micronutrients. Further, the C:N ratio difference between the two amendments was substantial and affected nutrient availability since immobilization is possible above a ratio of 15:1. Finally, biological differences between the two compost sources were unknown but likely affected plant performance. A fully composted soil amendment will have higher populations of beneficial microorganisms when compared to a partially composted material.

The costs for this project were not shared, but the contractor estimated that the nontraditional concentrated compost application can save $915 per acre when a DOT specified compost source is not readily available. For this type of project, the total cost of the traditional NM DOT compost and seeding application is about $3,745 per acre when all costs are considered including materials, equipment, and labor. The total cost of the concentrated compost and seeding application is about $2,830 per acre. This nontraditional application removes the need for a compost spreader, which alone can save over $10,000. Another cost consideration is that of site failure. If revegetation is not successful the first time, redo costs for large revegetation projects can be enormous$_5$ – up to $60,000.

This trial demonstrated that quality of a soil amendment can be more important than quantity when revegetating a site with marginal soil. Each and every soil is different, and soil testing and reclamation planning are necessary to ensure revegetation success. Upfront planning not only improves project results but also reduces unnecessary costs. This trial is a portion of a larger road construction and revegetation project, and the concentrated compost is being considered as the soil amendment of choice this upcoming spring. **L&W**

by Kyle Lilly, M.S.

For more information, contact Kyle Lilly, M.S., Soil Science and Water Resources, Sustane Natural Fertilizer, 310 Holiday Ave., Cannon Falls, MN 55009, Phone: 507-263-3003, Fax: 507-263-3029, Email: kylel@sustane.com, Website: www.sustane.com.

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References

Dokuchaev, V. V. 1883. Russian Chernozem. Israel Program for Scientific Translations Ltd. (for USDA-NSF). S. Monson, Jerusalem, 1967. (Translated from Russian into English by N. Kaner).

Ingham, E.R. 2012. The Living Soil: Bacteria. National Resources Conservation Service (NRCS). <http://soils.usda.gov/sqi/concepts/soil_biology/bacteria.html>.

Johnson, D.B., J.C. Williamson, and A.J. Bailey. 1991. Microbiology of soils at opencast coal sites. I. Short-and long-term transformations in stockpiled soils. Journal of Soil Science. 42: 1–8. doi: 10.1111/j.1365-2389.1991.tb00085.x.

Whiting, D., C. Wilson, J. Reeder. 2014. Estimating Soil Texture. Colorado State University Ag. Extension. <http://www.ext.colostate.edu/mg/gardennotes/214.html>.

Chenoweth, D.R., D. Holland, G. Jacob, L. Kruckenberg, J. Rizza, and B. Whiteley. 2010. Economic Benefits of Completing Reclamation Successfully the First Time for Oil and Gas Sites. Proceeding of the 41st International Erosion Control Association Conference, Dallas, TX.

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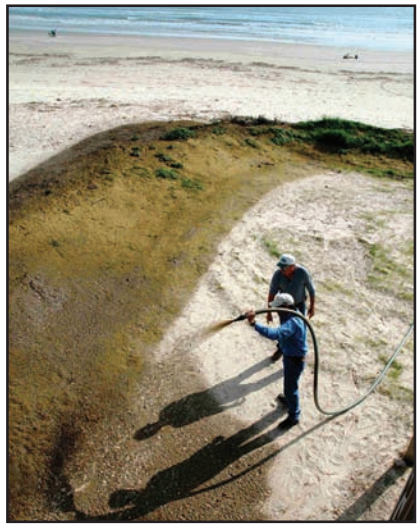

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