Teaming with microbes by jeff lowenfels

Groundbreaking book. No comprehensive gardening library should be without it. – American gardener When we use chemical fertilizers, we hurt the microbial life that sustains plants, and then we become more dependent on the arsenal of toxic substances. Working with Microbes offers an alternative to this erroneous circle and describes in detail how to garden in a way that strengthens, rather than destroys, the soil's food network. You will discover that healthy soil is bustling with life — not only earthworms and insects, but also a stunning multitude of bacteria, fungi and other microorganisms. This must-have guide is for everyone from those dedicated to organic gardening techniques to weekend gardeners who just want to grow healthy plants without resorting to chemicals. Jeff Lowenfels is a weekly columnist for the Anchorage Daily News. He is the founder of Plant a Row for The Hungry, a program that has created more than 14 million meals to feed the hungry. A popular national garden writer and leading proponent of gardening using the concept of soil food networks, Jeff is a former president of the Garden Writers of America and became a GWA Fellow in 1999. In 2005, he was inducted into the GWA Hall of Fame. He lives in Anchorage, Alaska. Wayne Lewis has been an Alaskan gardener all his life. He has worked with Jeff Lowenfels on a number of projects over the past 25 years, including the now national Plant a Row for the Hungry program (launched in Anchorage by Jeff), which encourages gardeners to donate some of their collections to charities in their communities. Organic Gardener's Guide to the Soil Food Web REVISED EDITION Jeff Lowenfels & Wayne Lewis Foreword by Elaine Ingham TIMBER PRESS PORTLAND • LONDON We dedicate this book to our wives, Judith Hoersting and Carol Lewis, which allowed us to work with microbes. They married gardeners and ended up with amateur microbiologists. They allow you to compost the infusion of tea in the kitchen. They clash with fungi, bacteria, venoms, spiders and worms. They were silent when we took molasses out of the cupboard. They learned to rotate piles of compost and appreciate mushrooms on our lawns. Fore wording by Dr Elaine Ingham, Ph.D., Introduction Part 1. Chapter 1 of primary education. What Is Soil Food Web and Why Do Gardeners Care? Chapter 2. Classic Soil Science Chapter 3. Bacteria Chapter 4. Archea Chapter 5. Mushrooms Chapter 6. Algae and slime forms Chapter 7. Protozoa Chapter 8. The Nod of Chapter 9. Arthrogae Chapter 10. Earthworms Chapter 11. Gastropods Chapter 12. Reptiles, Mammals and Birds Part 2. Application of Soil Food Web Science to Yard and Garden Care Chapter 13. How the Soil Food Web applies to horticulture chapter 14. What do your soil food networks look like? Chapter 15. Restoration and maintenance tools Chapter 16. Compost Chapter 17. Mulch 18. Tea Compost Chapter 19. 19. Mushrooms Chapter 20. Lawn Chapter 21. Maintenance of trees, shrubs and perelin Chapter 22. Annual cultivation and vegetables Chapter 23. Simple Soil Food Web Garden Calendar Chapter 24. No one has ever fertilized the Old Growth Forest. Soil Food Web Gardening Resource Rules Foresh Index If you go down in the dirt today, you better not go alone! For today, the nodulins have their picnic! Sung to the tune of The Teddy Bears' Picnic When you're bored looking at the soil from the city lawns, creating words for popular songs is always good! The soil should not be so boring, but urban landscapes mean dead dirt. This means that it is tilted over the microscope for long hours looking at ... nothing but inert particles. Boring. And yes, we come up with lyrics to songs. Real soil is active, lively, moving! Critters everywhere, doing interesting things! No need to invent new lyrics for old songs. There are no hours staring at the microscope looking at the micrometer after the micrometer of boredom- nothing happens. Instead, after just a few seconds— movement, life, action! City dwellers and other growers have been pouring toxic chemicals on their soils for years, not recognizing that these chemicals harm what makes the soil healthy. The use of toxic substances in any way creates habitat for the soil mafia, an urban war zone, killing the normal flora and fauna that compete with the bad guys and keep them under control. Recent work strongly indicates that toxic chemicals destroy water quality, soil health and food nutritional content, due to the loss, ultimately, of benefits in the soil. If toxic material had only been used once in our lives, the bad situation we have today would not have developed, but usually with this first use, thousands of organisms that were beneficial to plants were killed. A few bad guys have also died, but the good guys are gone, and they don't come back as fast as the bad guys. Think about your neighborhood: who would come back sooner if your neighborhood were transformed into a chemical war zone? Opportunistic marauders and looters, then who comes back after the disturbances. In the world of people, we send the National Guard to keep a line against criminals. But in soil, the level of inorganic fertilizers used, or the constant use of toxic sprayed pesticides, means that the National Guard soil has been killed, too. We must deliberately restore useful biology that has been lost. Where do the new rookies come from? You need to add them - bacteria, fungi, protozoa, blackworms, earthworms, micro-genies - back to the soil. Plant roots feed these benefits, but to make sure the benefits get restored, care packages may need to be delivered. Soil Foodweb, Inc., helps people quickly restore biology that creates a foothold for health return to these systems; and this book describes these hardworking members of the first line of defense for plants. Where do they live? Who are their families? How to send in dinner packages, not toxic, to help recruits? Recover soil health. I don't put anything on the ground if you don't know what it will do with life under my feet. If there is no information about how something affects life in the soil, or if the material has never been tested to determine what it does to organisms in the soil, do not use the material. If you've already purchased the product, test it yourself. Toxic are sometimes necessary to arouse a particularly bad invasion or disease, but toxic should be used as a last resort, and not as a first response to withering plants. If you use toxic substances, be sure to replace the good guys and immediately send some food. Restoring proper biology is crucial. You can lose several battles along the way. But persevere, and you can win. Think strategically: how can you help deliver troops, food, medicines and bandages on the front line of the fight between goodness and diseases and pests in the most effective way? The clues, at least to the best of our knowledge, are in this book. Most people have a lot to learn when it comes to soil. You need information that Jeff and Wayne have gathered. They also have their lessons on pleasant soil health! They depict what can be deadly boring and boring in a way that is exciting and understandable. Instead of working through the years, staring at microscopes like my colleagues and I in our efforts to understand soil biology, this book gives an overview of what we have learned! The work of many scientists is complex in this book, in a way that allows you to easily understand the complex history of life in the soil. I hope you will join us and help you learn how to restore soil health and thus the food you eat. The instructions are here. Dr Elaine Ingham, Ph.D. President, Worldwide, Soil Foodweb, Inc. www.soilfoodweb.com Preface, we were typical suburban gardeners. Every year, at the beginning of the growing season, the carpet bombarded our lawns with mega-doses of water-soluble fertilizers, fertilizers with high nitrogen content and watering like crazy; then strafed their weeds with the popular deciduous herbicide. Then we attacked our vegetable gardens and flower beds with a bag or two commercial fertilizers and leveled them with rototyller until the soil, color and texture of finely ground coffee lay as smooth and even as Bonneville Salt Flats. We did these things religiously, like most of our neighbors. Once, too, it was not enough. Throughout the season, we used chemical fertilizers as if we were competing in a large-scale competition in Alaska. Fair- and at the end of the season we have rototilled again, for some inexplicable reason. When necessary (and often so), we will fit into protective clothing - along with rubber gloves and a face mask - and paint our birchtrees to protect them from the invasion of aphids using some divine fragrant things that the listed ingredients of a non-normal person can pronounce, assuming he or she took the time to read an unusually small print on the chemical label. Then we sprayed our spruces with something that smelled even worse — something so strong, one app lasted not one, but two years. It is good that we have protected ourselves, because both spray products are now being withdrawn from the market, withdrawn as health risks. Don't get us wrong. At the same time, we practiced what we considered to be an appropriate measure of environmental responsibility and political correctness. We left grass felling on the lawn to spread out and the protruding leaves fell into garden beds, and from time to time we let loose batches of laces, ladybug beetles and mantises — our version of integrated pest management. We composted. Recycling our newspapers and aluminum cans. We fed the birds and allowed them to wander around our backyards. In our minds we were quite organic and environmentally friendly (if not downright responsible). In short, we were like most home gardeners, maintaining the right balance between a better life with chemistry and at least some of Rachel Carson's teachings. In addition, we mainly used water-soluble high-nitrogen fertilizers. How bad can it be for the environment? This made the plants grow. And we really only hired one weed killer, albeit non-selective, deciduous. Okay, from time to time we resorted to insecticide, but when we considered what was on the shelves of our favorite nurseries, they did not account for much in our minds. Surely we couldn't do harm when we were just trying to save spruce, help birch or prevent the world from being taken over by harmful dandelions and chickweed? Crucial to the way we cared about our gardens and shipyards was a concept shared by tens of millions of other gardeners and, until you finish this book, perhaps you too: nitrogen from an organic source is the same as nitrogen from an inorganic one. Plants really don't care if their nitrogen and other nutrients come from blue powder that mixed with water or aged manure. It's all nitrogen to them. Then one fall, after the gardens were put to bed and we settled down for the winter, looking for something to store our gardening interest in the cold months, a gardening friend emailed two stunning pictures of an electron microscope. The first showed in exquisite nooses trapped by one looped mushroom caterpillar or hypha. Wow! It was quite a picture- fungus taking out removing We never heard, much less saw something like this, and began to wonder: how did the fungus kill its prey? What attracted blind ness to the rings of the fungus in the first place? How do rings work? The second image showed what appeared to be similar to a gneas, only this one was undisturbed by fungal hyphae and entered the tomato root. This photo raised his own questions. Why was this worm not attacked and where were the fungal hyphae that killed the first blackworms? Forging, root-eating grin, trapped by fungal hypha. Courtesy H. H. Triantaphyllou. Reprinted, with consent, American Phytopathological Society, St. Paul, Minnesota. Without fungal hyphae banning the road, the nememe penetrates the root of the tomato feed. Photo: William Weryin and Richard Sayre, USDA-ARS. Examining the answers to these questions, we came across the work of Dr Elaine Ingham, a soil microbiologist famous for working with the life that is in the soil, and in particular who eats whom in the soil world. Since some organisms eat from more than one food chain or are consumed by more than one type of predator, the chains are connected into ribbons - soil food ribbons. Ingham, an excellent teacher, has become our guide to the world of complex communities in the soil. Thanks to her, we learned that the fungus in the first photo protects the roots of the plant; If it's not enough to stop us and think, we learned that the plant attracts the fungus to its roots in the first place! We also learned what killed the fungus, which would have prevented the worm from attacking the tomato root. Of course, we began to wonder what other previously invisible things were going on there in the soil. Can a world revealed to us by tools like electron microscopes affect how we care about plants in our gardens, shipyards and lawns? We were all blinded by Hubble images from deep space, incomprehensible, but few of us have ever had the opportunity to admire the images taken by the scanning electron microscope (SEM), which provides a window into an equally unknown universe literally just below our feet. We searched for answers and quickly realized that when we distributed fertilizer and rototilling our garden beds through rote, a growing group of scientists around the world made discoveries after the discovery that put these practices into question. Many scientific disciplines - microbiology, bacteriology, mycology (mushroom study), myrmecology (ant study), chemistry, agriculture - have come together in recent decades to focus together on understanding the world of soil. Slowly, their findings on what is happening in the soil are applied to commercial agriculture, silviculture and winemaking. It is time for us to apply this to the things we develop in our home and gardens. Most gardeners are stuck in traditional gardening land, a place where a mixture of old wives' stories, anecdotal teachings and slick commercial pitches designed to sell products dictates our seasonal activities. If there is any understanding of the basic science of gardening, it is almost always limited to npk soil chemistry and its physical structure. By reading these pages, you will learn how to use biology in soil — naturally or manipulated — to the benefit of your and your plants. Because chemical fertilizers kill soil microorganisms and chase larger animals, the system we adopt is organic, free of chemicals. Chemicals, in fact, are what killed the hyphae fungal root protecting, giving our friend of the worm access to the unprotected tomato root in the second photo. By necessity, this book is divided into two sections. The first is to clarify the soil and the digestive network of the soil. There's nothing around it. You need to know science before you can apply it. At least in this case, the science is fascinating and even astonishing, and we try not to make a textbook out of it. The second section is an explanation of how to work in the soil food network in favor of the soil and to yours as a gardener. What distinguishes this book from other texts on soil is our strong emphasis on soil biology and microbiology — the relationship between soil and soil organisms and their impact on plants. We do not abandon soil chemistry, pH, cation exchange, porosity, texture and other ways of describing the soil. Classical soil science is covered, but by the assumption that this is the stage at which biology works on many dramas. When you introduce players and tell their individual stories, what evolves is a set of predictable results from their relationships or lack thereof. In the second half of the book, these results are divided into a few simple principles, the rules that we apply in our shipyards and gardens, like many of our neighbors in Alaska, where we initiated these new practices. Like others, especially in the Pacific Northwest, but also in other parts of the world. We believe that learning about and then applying soil sciences (in particular the science of how different forms of life in the soil intertwine - the soil food network) has made us better gardeners. When you are aware and appreciate the beautiful synergisms between soil organisms, you will not only become a better gardener, but a better steward of the land. Home gardeners really don't have the business of using poisons, and yet apply them they do, to make food grow and eat (or worse, feed for their families) and the lawns on which they play. You may be tempted to move on to the second part of this book, but we strongly do not recommend it. It is important to know the science to really understand Of course, it takes a little effort (or a chapter on soiling there, yes), but for too long, for too many gardeners, all we needed to know came in a bottle or jar and all we had to do was mix with water and apply the hose to the end of the sprayer: instant cooking meets home gardening. Some hobby. Well, we want you to think gardeners, not mindless consumers who react because a magazine or TV ad says something to do. If you really want to be a good gardener, you need to understand what is happening in your soil. So, here it goes. Now we know that all nitrogen is not the same and that if you allow plants and biology in the soil to do their job, gardening becomes much easier and gardens much better. May your backyard and your gardens grow into their natural glory. We know ours now do. Part 1 basic science electron microscope photo of organic humus compost (brown), decomposing plant material (green), and some mineral particles (purple and yellow), 25x. Image copyright Dennis Kunkel Microscopy, Inc. Chapter 1 What is Soil Food Web and Why Do Gardeners Care? Given its importance to our hobby, it's amazing that most of us don't venture beyond understanding that good soil supports plant life, and poor soil doesn't. Without a doubt, you have seen worms in good soil, and if you do not use pesticides, you should come across other soil life: centipedes, springtails, ants, snails, larvae of ladybug beetles and others. Most of this life is on the surface, in the first 4 inches (10 centimeters); some soil microbes have even been discovered living comfortably an amazing two miles below the surface. Good soil, however, is not just a few animals. Good soil is absolutely teeming with life, but rarely does you realize that it is so trigger a satisfaction reaction. In addition to all the living organisms you can see in garden soils (for example, there are up to 50 earthworms in square feet [0.09 square meters] of good soil), there is a whole world of soil organisms that you can't see unless you use sophisticated and expensive optics. Only then do small, microscopic organisms appear - bacteria, fungi, protozoa, blackworms, and in numbers that are nothing more than astounding. Just a teaspoon of good garden soil, as measured by microbial geneticists, contains a billion invisible bacteria, a few feet of equally invisible fungal hyphae, several thousand protozoa and dozens of cloaks. The common denominator of all life in the soil is that every organism needs energy to survive. While several bacteria, known as chemosynthesis, draw energy from sulfur, nitrogen and even iron compounds, the rest must eat something containing carbon in order to obtain energy to maintain life. Carbon may come from organic materials supplied by plants, waste produced by other organisms or, or The first task of all soil life is to obtain carbon for fuel metabolism - it is the world of food and food, in the soil and on earth. Remember a child's song about an older lady who accidentally swallowed a fly? He then swallows the spider (which twisted and jiggled and tickled inside it) to catch the fly, then the bird caught the spider, and so on until he eats the horse and dies (of course!). If you did a scheme of who was supposed to eat whom, starting with a fly and ending with an unlikely horse, you would have what is known as the food chain. Soil Food Network, USDA-NRCS. Most organisms eat more than one type of prey, so if you make a scheme of who eats in the soil and on the ground, a simple food chain becomes a series of food chains connected to each other and connected to each other, forming a network of food chains or a food network of soil. Each soil environment has a different set of organisms and thus a different soil food network. This is a simple, graphical definition of the soil's food network, although as you can imagine, it and other diagrams represent complex and highly organized sets of interactions, relationships, and chemical and physical processes. The story everyone tells is simple and always starts with a plant. Plants are under the control most gardeners think of plants only making nutrients through root systems and feeding leaves. Few realize that much of the energy that results from photosynthesis in the leaves is actually used by plants to produce the chemicals they secrete through their roots. These secretions are known as yuths. A good analogy is sweat, human outing. Effusion.