ORGANIC ADDITIVES at WIND RIVER NURSERY

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Wind River Nursery was established in the early 1900's to reforest some devastating burns in southwestern Washington.

We are located in Washingtonclose to the Columbia River about 60 miles east of Portland, Oregon at an elevation of 1100 feet. Our weather is mild with average annual temperatures being 48° and average annual rainfall being about 90 inches. We do have snowfall at the Nursery, but the past few years little snow has fallen. This has certainly helped our dormant lifting of seedlings in January and February.

Wind River Nursery now produces and ships about 30 million seedlings annually. This was our record season with over 35 million conifer seedlings being packed and shipped. This has been accomplished on only 120 acres. You can then readily see that we have a huge problem of being short of ground and not being able to use the land properly. We are confident of obtaining an additional 60 acres in the near future.

Thus, to handle this problem we knew we had to really work hard and take care of our land. We feel we have been successful with annual soils testing, proper fertilizer, and lots of good organic material. It's exciting and I know we have only scratched the surface.

Portions of our Nursery have been tree farmed since 1909, close to 70 years. So naturally in some areas our organic content was getting below the required amount for growing conifer trees. We believe our soils organic content should be a least 3% and pH should be around 5.5. For us, this is a great stride forward since we started at an organic content of 1.8 - 2.2. Past years reveal that the Nursery has added sawdust, peat, cow and chicken manure as a means of supplying organic materials and maintaining soil fertility. Presently we use sawdust, peat, green manure, Milorganite (fertilizer produced from activated sewage), and our newest material - Fish Digester Sludge. We are also studying in cooperation with Crown Zellerbach, the applicability of wood and pulp sludge mixture as a mulch on top, incorporated into the soil or a combination of both to grow conifer seedlings. In additions, we have recently located two sources of chicken maure and are presently using it. Believe it or not, we had a hard time locating a good source of available sawdust. We didn't give up however, and have now found a cheap, local source. We continually are on the lookout for new organic material. At the present time, we are looking at Municipal Sludge. I will discuss primarily the Fish Sludge, Milorganite, and Municipal Sludge, as part of our Nursery fertilization program. They should be of most interest to you as Nurserymen.

I have been involved in our fish sludge project quite closely. It's very interesting and exciting to me. We have been working with this for two seasons. When we first became involved in this project our thoughts were to use the Fish Sludge in our Nursery Fertilization Program strictly as a slow-released nitrogen supplement to the soil and as a soil conditioner. If it proved feasible, we would apply directly to the trees and cover crop: this we are now doing. Contrary to what you may think, this product is almost odorless. It has been run through a primary and secondary digester. Our Nursery folks call it "Super Sludge". Time will tell whether it really is.

We began hauling the sludge in mid April oflast year following consumation of a memorandum of understanding with the U. S. Army Corps of Engineers at Bonneville Dam.

I will now go into some slides to tell the Fish Sludge Story.

Bonneville Fish Hatchery

I will begin by telling you the fish effluent comes from the Bonneville Fish Hatchery run by the Fish Commission in Oregon. It's mostly water, fish droppings and feed. Next year the effluent will include eggs and blood waste residues from the spawning operation. Here's two slides of the hatchery. It is located right along the Columbia River with the Bonneville Dam and the south shore sanitary facilities run by the Corps of Engineers. This is the real exciting aspect of this project. You don't often see three agencies like the Forest Service, Fish Commission and the Corps of Engineers working together. We have worked hard to get this project underway beginning about 3 years ago.

Bonneville Dam and Columbia River

Some of you have seen this scene of Bonneville Dam and the "mighty beautiful Columbia". I put in these slides just to note that the fish or other raw wastes can't be dumped into the Columbia River any more and that is where we came into the picture. One of the Corps Engineers - thought it might be a good fertilizer for Wind River Nursery. They asked Stu Slayton our Nurseryman and he said yes - we would certainly give it a try.

Primary Digester

This primary Digester is located right next door from the Fish Hatchery at what is called the South Shore Sanitary Facility. The fish sludge and small amounts of domestic sewage arrives here first. It is 36 feet across and when filled it hold 102,000 gallons. Time spent here depends on per cent of solid material and amount of room available in the secondary digester. When the effluent leaves this primary digester it should be about 1½ - 2% in solid material.

Secondary Digester

The engineering firm of Kramer, Chin and Mayo did extensive studies on the best method of treatment for the fish sludge. They determined that aerobic digestion was the answer. Aerobic digestion is different from the more conventional anaerobic digestion used in most treatment plants. Both of the Bonneville digesters are open to the atmosphere and are constantly supplied with oxygen through blowers and mixers. These digesters produce no obnoxious odors or methane gas. If the sludge is allowed to sit for a day or two without supplying oxygen to it or mixing, the sludge will become vile and odorous.

Both treatment systems are designed to work together. The operation of the digesters calls for 16 hours of mixing and oxygen, then 6 to 8 hours of settling. At the end of the settling period, they will draw the clear liquid, (called supernatant) off the top of the digesters and pump it into the oxidation ditch and back into the system. It is virtually bacteria free and is eventually disposed of in the river.

We have looked into the possibilities of using the supernatant which we were told was rich in nitrogen. We haven't used it because there is too much water and little nitrogen. The two digesters in the system add flexibility, reliability and additional storage at the site.

The actual reasons for the two digesters are to: (1) Treat and decompose the sludge into an inert, stable material; and (2) to increase the solids concentration thereby reducing the volume of sludge to dispose of ultimately. When the sludge goes into the primary digester, it should be about ½ - 1% solids and when it goes to the secondary digester, it is about 2% solids. The sludge will be approximately 3.2% solids after it leaves the secondary digester (just a slight slurry). Our analyses to date reveal that the solid content has been from 2 - 2½%. We need to work on this aspect as we want to haul as much solid material as possible.

The secondary digester holds 189,000 gallons when filled. It takes about 8 - 20 days for the sludge to reach proper solid per cent before we haul to the Nursery.

South Shore Facility Operator

This is the fellow that operates this two million dollar Sanitation Plant. He is a wealth of information and has helped us tremendously. The secret of an operation of this magnitude is complete cooperation and open communication. This has certainly taken place in this project. The only complaint we have had is our trouble in interpretation of the analyses we get from the Corps. We have concentrated on this aspect and new feel more confident in analysing the test results.

Loading Sludge at Bonneville

Here you see the loading of the fish sludge at Bonneville. They have devised a special spout with a lock which works great. This truck is a rented tractor and the trailer is supplied by the Corps of Engineers. The Corps of Engineers in the agreement supplied all the equipment including two trucks, pump and hose, irrigation pipe and Rainbird sprinkler gun. This truck hauls 2,500 gallons and we usually haul four loads or 10,000 gallons a day. The distance to the Nursery is 25 miles, so our drivers needs to hustle. Last year we hauled over 400,000 gallons or enough to cover 40 acres, at a 10,000 gallons per acre application. Continued Hatchery expansion could easily double this figure in two years. This year the Hatchery lost most of their fish so we lost most of the sludge and hauled about 125,000 gallons.

Wind River Nursery

This is a picture of the Nursery looking toward Stevenson Ridge. Stock looks excellent this year. So I threw this in to boast a bit.

Tanker Being Hooked Up to the Pump

This is a close up of our 2500 gallon tanker being hooked up to our

pump. Our pump is a Wisconsin pump designed for a discharge pressure of 100 PSI (pounds per square inch) or 230 TDH and 136 gallons per minute. This system of having the pump mounted on a trailer has proven to be quite mobile and flexible in the Nursery. Our irrigation crew can easily change location between load deliveries. Presently we are looking for a 4 or 5000 gallon tanker trailer to use for fish and other sludges.

Close-Up of Pump Mounted on Trailer

Here's two close-up shots of the Wisconsin pump mounted on a trailer. It has a 3" suction and 3" discharge hose. We raised the pump 4 inches off the trailer floor. It saves knuckles and is easier to start.

Rainbird - Rain Gun

On this slide, you can observe the large Rainbird Gun Impact Sprinkler that sprays on the effluent. The gun can be set for full circle or close to an acre, a ½ circle or a ¼ circle. The head has a 0.69" straight bore nozzle with 23 degree trajectory. Design pressure at head is 90 PSI at 150' radius, and a flow of 136 gpm water. We operate the pump so the generated pressure at the head is about 55-60 PSI. Here it is set up in a ½ circle to apply the sludge on our cover crop of Austrian peas and oats.

Applying Fish Effluent

Next, we observe a series of 1977 slides showing sludge application in mid June to cover crop, 1-1 transplants and 3-0 Noble and White fir seedlings. The cover crop and seedlings were very green and lush. The cover crop crop exceeded 3 feet in height. This was our first application to our seedlings, although we did have prior approval from DOE and EPA to do so from the start. We preceded quite cautiously, because we didn't know how our Nursery workers and the general public would react. Everybody urged us to spray directly on the seedlings and cover crop. So we did right away. The effluent landing on the seedlings does not burn or damage the seedlings in any way from our current observations.

On this area we applied 10,000 gallons per acre. Presently we have doubled this amount and now apply 20,000 gallons per acre. Present analysis reveals we are applying 200 pounds of solid nitrogen per acre in a solution of 2 - 2½ % solids. It's also very possible to run the effluent through our irrigation systems.

Overall View of Tanker Pump and Supervisors Sizing Up the Situation

This project has created a lot of interest for everyone. We have had quite a few visitors and some media coverage. Public reaction has been very favorable to this project. I think one reason for this is our country's strong environmental concern. We are taking a product that was formerly wasted and causing pollution and now using it to grow a useful project. The White and Noble fir look excellent in this slide.

Driver Raring to go for another Load of Fish "Super Sludge"

This rental tractor cost us about $190.00 a week. Thus we kept it busy and averaged 50,000 gallons a week.

It is our hope that the Corps of Engineers can get us a 4000 or 5000 gallon tanker. Then we can really make it pay. Our rough calculations compute to a cost of about a penny a gallon. Presently other hatcheries and three cities, Cascade Locks, Hood River, Oregon and Washougal, Washington have inquired about us using their fish and human waste. We will probably start hauling from the Fish Hatcheries only after we have first fulfilled our Bonneville obligation.

At the peak of the fish rearing season in the spring, May and June, it appears that we need to remove at least 20,000 gallons a week to keep the Bonneville system running smoothly.

Wind River Nursery Scenes -- Bunker Hill and Bedhouses

In general, we are quite satisfied with our second year in the Fish Sludge business. It is still quite experimental and we intend to find out much more. Just last month we found out that the Sludge solid content can be raised even higher and thus we will haul about half as much water as we have done in the past. This has definitely encouraged us to stay in the Fish Manure business. I know you are interested in the amounts of metals and other minerals. Presently, the analysis indicates metal amount to be quite minimal. We are quite concerned with this aspect of the sludge and will continue to monitor it closely. The following page is a tabulation of early test results in 1977.

	COE Lab Sample Data 10 May '77	Columbia Lab Sample Data 10 May '77	COE Lab Sample Data 1 June '77	Recommended Quantities for Irrigation Water (Wet Weight Basis)
Total Solids	0.40%	3500 ppm = 0.35%	0.35%	--
Volatile Solids	62.1%	2188 ppm = 62.5%	60%	--
TKN	54 gms/kg	2.2 ppm = .002 gms/kg[1]	34 g/kg	(2.2 ppm)
Hg	6.006 mg/kg[2]	.027 ppm = .027 mg/kg	0.029 mg/kg	Not known.
P	-	.09 ppm = .09 mg/kg	51 mg/kg	-
Pb	0.25 mg/kg	.10 ppm = .10 mg/kg	0.89 mg/kg	5.0 mg/liter
Cd	0.075 mg/kg	<.01 ppm = <.01 mg/kg	0.25 mg/kg	.010 mg/liter
Zn	1.24 mg/kg	2.12 ppm = 2.12 mg/kg	3.95 mg/kg[3]	2.0 mg/liter 1.0 mg/liter on acid soils
K	17 mg/kg	7.0 ppm = 7.0 mg/kg	Trace	-
As	-	.004 ppm = .004 mg/kg	-	0.10 mg/liter
Cr	-	.10 ppm = .10 mg/kg	-	0.1 mg/liter
Cu	-	.51 ppm = .51 mg/kg	-	0.20 mg/liter

1/Is probably NO_3 nitrogen.

2/Highly variable test, possible error.

3/Appears to be highly questionable data.

MILORGANITE 6-2-0

I will continue on and discuss another product that we at Wind River Nursery believe is another good fertilizer and source of organic material. We continually see the excellent results it produces for us in larger and higher quality seedlings. It is better known as "Milorganite" 6-2-0 (Milwaukee organic nitrogen).

This organic fertilizer is produced by the Milwaukee, Wisconsin Sewerage Commission. Stu discovered this product when he was a Nurseryman back at Toumey Nursery in Michigan. He observed that it really made golf courses green and lush. Also that it must be quite pure. At Toumey, he obtained good results in producing quality seedlings. Upon arrival at Wind River in 1974, he soon realized that our soil was marginal as far as organic matter was concerned. Thus the use of Milorganite was born at our Nursery. The Nursery began by experimenting with various application rates in 1974 through 1977.

In the summer of 1976, we applied about 2000 pounds per acre to all 2-0 and 3-0 seedling in 2 - 3 applications. We tried to time this just before a rapid growth period. We use two Farmall Cut 140's with a small Gandy spreader to apply the Milorganite. In additions, we again conducted tests with various rates of application throughout the Nursery on all ages, classes and species.

The 2000 pounds per acre application appears to be the best over all rate to use. You can add more or less Milorganite as needed and determined by your species condition and soils analysis. We add ample water after application to hold it in place. Since this is a slow release nitrogen fertilizer, we asked ourselves the question, why not apply it all at once. This will enable the seedling to use it whenever they want and need. It's too easy for us to miss the best period of application. Nature and the plant knows this better than any Nurseryman. So in the fall of 1976, we applied 2000 pounds per acre to all the 1-0 stock. Thus it was available in the spring when the seedlings were ready to make their big spurt of growth in May and June. In addition last summer we added 1000 pounds per acre to the rising 2-0's. Our present 2-0 stock looks real good. At the present time we feel in most cases the additional 1000 pounds is unnecessary.

This July we applied 500-700 pounds an acre to the rising 1-0 seedlings. This fall we will apply another 2000 pounds per acre. Overall for a 2-0 conifer seedling we are talking about a total application of about 3000 pounds or a ton and a half per acre.

I wish also to stress that in a ton of Milorganite, you get 75% organic matter. This is exactly what we are looking for. Milorganite comes in a granular form and costs us $160 a ton delivered to Wind River (this computes to 8 cents a pound or about 35 cents per thousand seedlings). This may or may not sound expensive to you. Let me continue on and I'll point out some other properties of this product.

Milorganite is not a simple product. It is probably the most complex fertilizer known. Experiment stations which report better results with Milorganite when compared to other nitrogen sources have been unable to pinpoint the reasons why. That is just how complicated Milorganite is.

Experiment stations have stated the possibility that the heavy metals, (Mercury, Cadmium, etc.) in Milorganite have direct fungicidal properties. It has been well documented that Milorganite fed turf plots have less dollar spot, snow mold and large brown patch disease when compared with other organic, systhetic and water soluble nitrogen materials. We believe it works in a similar manner in the Nursery, as we have very minor disease problems. We also attribute this to our fumigation program.

Other turf management people feel that the active bacterial populations fostered by the use of Milorganite depresses harmful fungi. This theory is based on a given volume of soil being capable of only supporting a given amount of organisms. In other words, if the good guys (bacteria) are active, there is insufficient air, water, food, etc., to support the bad guys (fungi).

Let's get back to cost. Many Nursery and Forest people tell us - Yes it's a good product but too expensive for us. Won't the cost of our seedlings go sky high? When we tell them it only amounts to about .35 - .40 cents a thousand, they feel much better.

The field continues to want larger size seedlings, mainly in the form of larger calipers and larger, more fiberous root systems. If that's what they need, we will give it to them. We are a service unit.

Milorganite has helped us to increase our minimum shipping caliper to 4 millimeters. We can achieve for most species in two growing seasons, just about any seedling height the field desires, dependent upon various cultural practices. Our size for Englemann Spruce and Western red cedar has increased and thus we are now producing 2-0 seedlings instead of the usual 3-0's. We have reduced our transplanting program from a 3½ million production to less than a million seedlings. Field Foresters have observed and reported informally to us of increased field survival, initial elongation and healthier looking trees upon out planting. We strongly believe Milorganite has really helped out in this success. So to us and for these reasons give, the cost is justified. It's too easy to over-simplify this cost factor. We feel whatever the reasons, the over-simplified "cost per unit of nitrogen" formula does not apply to Milorganite. As a matter of fact, unit costs fail to stand up as a very good buyer judgement decision with any fertilizer. You need to weigh the cost against your results and then make a decision whether to use or not.

I like what the Milwaukee Sewerage Commission has to say. I quote from one of their articles. "It can no longer be said that a pound of nitrogen is a pound of nitrogen irrespective of sources."

Some factors for you to consider in selecting a fertilizer in relation to Milorganite are as follows:

- Milorganite is 75% organic matter
- spreader calibration and handling is easy (44 lb. bags)
- has every growth element
- low salt index
- does not burn (very high application and high moisture might cause ammonia burn)
- long lasting
- high analysis - 6% nitrogen
  4.5% phosphoric acid
  .8% potash
  many other trace elements

Fertilizer manufacture at Milwaukee is a part of the plant operation and not an after thought. This isn't an endorsement of Milorganite. We can't do this as you know. My only intent is to tell you that this product gives us excellent results. There are many other fertilizers called 6-2-0 developed from sludge on the market. I caution you to check thoroughly the analysis to see if it truly contains 6% natural organic nitrogen. Also go slow at first and gradually build up applications as needed.

Disadvantages (very few)

1. Slight odor when seedlings are growing.
2. Humidity affects application rates.
3. Need to keep dry - if wet it becomes impossible to handle.

We will continue to monitor and to use Milorganite at Wind River Nursery. We don't know of any product presently on the market that can give us the excellent results in the color, size and quality of seedlings that Milorganite is now producing. Right now I'd say it's our bread and butter. I can't add any more. For us "the proof is in the puddin'". It may be what you are looking for.

MUNICIPAL SLUDGE

I previously mentioned we are working on the possibility of using Municipal Sludge at the Nursery. The University of Washington is putting Seattle Sludge on their conifer Nursery and I am working closely with them. They report that a 4-1 sawdust-sludge composite is giving them tremendous growth (better size and color) over their regular sand-peat mixture at their tree Nursery near Seattle.

I will list some points we have learned about sludge. They are as follows:

1) 100 million tons of sludge is produced annually in the US - only 25% of which is applied to land.

2) It has posed a disposal problem and municipalities are trying to come up with constructive places to put their sludge.

3) Sludge is a cheap but not yet efficient source of nitrogen (Example: to get 200 pounds of nitrogen per acre, you have to add about 50 wet tons of sludge per acre. This is about 14,000 gallons enough to cover the ground with a ½ inch of sludge).

4) Sludge is comparable to commercial fertilizers in terms of crop yield. There's not a shortage of fertilizer, but it takes energy to make. Natural gas is turned into ammonia which contains nitrogen. It's a question of how much can be saved? What can be your benefits by not using commercial fertilizer?

5) Advantages - I will list some that I have learned.

   a. Poorly structured, highly erosive soil can experience sizeable increase in the number of large soil pores after application of sludge at moderates. (Large pores provide oxygen for plant roots.)

   b. Sludge contains many essential plant nutrients and can be used to replace or supplement conventional fertilizer.

   c. Sludge affects physical properties of the soil:

      1. The rate at which water moves in the soil surface is greater for sludge-treated soils than for soils without sludge. This is very important to good plant growth and erosion control.

      2. Improved Structure and Soil Stability - This is important for good root growth and development, plus erosion control.

      3. Organic Matter Content is greater.

6) Disadvantages

   a. Nitrogen wears out - heavy metals like cadmium, zinc, copper, molybdenum, nickel o f some sludges don't.

   b. Water pollution through run off of nitrates. However, nitrates which run off into ground water aren't as noxious as the heavy metals.

c. Aesthetics - odor

d. Diseases

3. Increased browsing on the healthier seedlings - University of Washington has observed this from meadow mice and deer selectively browsing on the seedlings.

7) On environmental questions, sludge is looking very good, but on management questions noted in the problems, the jury is still out. The following management options are available to you to keep the dangerout metals at a relatively low level on sludge-tested land:

a. Maintain soil pH at/or above 6.5 - (We feel we should be between 5.5 and 6.0 for growing conifers at WRN. If soil is allowed to become too acid, the solubility of the heavy metals increases.

b. Grow crops which tend to exclude cadmium from the whole plant or from reproductive tissues.

c. Use sludges which have low cadmium and other heavy metal concentrations.

d. Grow non-edible crops - seedlings

If Federal and State guidelines put the application rates at too low a level, sludge will not be economical to use.

Thus, I feel we need to study sludge to find out the best types and safest way to use on our seedlings and edible crops. If we are knowledge-able about sludge and how to handle, they won't take it away from us.

In summary, if it appears we are going organic at WRN, I would say yes, we are rapidly heading that direction. We need to keep our soils organic content at an acceptable level if we are going to continue to grow the quality and quantity of conifer seedlings the field is asking for. I think that some of the organic farming techniques the Chinese people have employed successfully for over 4,000 years, is part of the answer to restoring the fertility, productivity and organic content of our soils. It certainly will help the waste and pollution problems in our country, and in the future the scarcity and high cost of synthetic fertilizers.

Literature Cited

Memorandum of Understanding between the Corps of Engineers, Department of Army and the United States Forest Service, Department of Agriculture for disposal of digester sludge from South Shore Sanitary Facilities and Fish Hatchery, Bonneville Lock and Dame, OR. 1976, 3 pp.

Sewerage Commission of the City of Milwaukee. 1968. Milwaukee Waste Water Treatment Facilities. 30 pp.

Boyer, D., and L. C. Meyer. 1973. Soil Management Plans for the Wind River Nursery. pp 1 - 26.

Aspitarte, T. R. 1946. Experimental Design for Evaluating Douglas-fir Seedling Growth in Plots Amended with Wauna Primary-Secondary Sludge. Crown Zellerbach Research Study. 4 pp.

The Reader's Digest Association. 1968. Reader's Digest Complete Book of the Garden. Chapters 41 and 42. pp 749 - 765.

Slayton, S. H., D. Boyer and B. Warner. 1977. Personal Communications in Regard to Organic Fertilizer and Chemical Anlysis.

Steavenson, H. 1978. American Nurseryman. Proper Manuring for Improved Production.

American Society of Agronomy 1977. Crops and Soils Magazine. April and May. pp 5 - 7.

Cole, D. W. and R. L. Edmonds. 1977. Use of Dewatered Sludge as an Amendment for Forest Growth. University of Washington and Municipality of Metropolitan Seattle Study. pp 129.