The Use of Fertilizers in Nursery Management

By Todd Tremblay

"Thanks a lot. First of all, I'd like to say, I'm very happy to be here today and meet with this group. I want to tell you I'm just a beaten up agronomist and I don't know anything about forestry to speak of. I really don't have any claim to know anything about nurseries, soils, and nursery management. I think the only practical experience I ever had was some time ago with Bill Hagenstein down at the Col. Greeley Tree Farm where we threw on some oddball fertilizer mixes. After I left for the experiment station and Hagenstein went to Portland, I think things went along pretty well down there. We did get into fertility work down there the following summer, 1944, soil testing versus some fertilizer treatments. I think we might have done a little good and I hope they're a lot better job than when we started out. During the last few years, I've been following Stan Gessel around, mainly on the effect of fertilizers on the second growth stands of Douglas-fir, but during that time I had a chance to observe some effects of fertilizers on young trees, not necessarily nursery stock, but in some cases it was nursery stock. What I'm going to present to you today is just some observations of an agronomist on what I'm seeing in the forestry problem. I really don't know trees, as such, but I've had a little bit of background on fertilizers. One thing I had noticed is that you folks are certainly regarding trees as a crop and I think that whoever started the movement to regard trees as a crop rather than as just something that's out there in the woods started a good movement. And certainly I think that producing trees in nurseries is very very similar to producing an agronomic crop. In other words, you fellows are plowing or rotovating or whatever you're doing, you're seeding, cultivating. These fellows here are trying to show you how to use herbicides, fumigants, etc. At most nurseries where I've been you irrigate and I think you are using fertilizers. I think we can certainly regard nursery grown trees as a crop, not necessarily an agronomic crop. They are removing tremendous quantities of material from the soil. This is something I'd like to get from you fellows some day. I hope some day I'll be able to send out some kind of a questionnaire. We would like to know, for instance, what you are using at the present time for a fertilizer program in your nurseries. I think that if we are ever going to be able to help you at all, and I hope that one of these days were going to be able to give you some help, we first of all would want to know what type of program you already have on your

nursery. I think that with the help of Gessel, we may be able to work out a little questionnaire and get it out to you, so that we can find out what's actually going on. I do know this. If you're doing a good job in the nursery business you're depleting your soil. It's the same thing as in agriculture. If these farmers out here are doing a good job on growing corn and sugar beets, they're depleting their soil. I think this is one thing you have to remember. It's not like it is out in the woods where you have that recycling of the needles and falling to the ground and the recycling of the nutrients. You don't have that in your forest nursery. So, if you're doing a bang-up job, you're really depleting your soil nutrients. And of course, if you're depleting your soil, you're going to have to put these things back in. Now to give you an idea of that. I'm sure maybe some of this is old hat to some of you, but I went through some of the literature, and you'll notice this on your tables. We'll just go through it roughly. Youngberg went through a good number of nurseries here a few years ago. I haven't begun to put them all in here, except to take out some of the widely diverted ones. I think I want to bring out a few points here. For instance, on the Wind River Nursery, the dry weight that was being grown on an acre was roughly about 7,000 pounds. The nutrient content was about .78 percent nitrogen, .20 percent phosphorus, .57 percent potash; and then, of course, multiplying phosphorus, you get the nutrient removal per acre in terms of N, P_2O_5 which is phosphate, and K20. In the fertilizer business we have some screwy symbols yet, and when we're talking about fertilizer, we're talking about phosphate as P_2O5 and we talk about potash as K_2O. So I changed the figures that Chet had from P to P205 and from K to K_2O- You'll notice here that there's pretty good removal of plant food on even this low dry weight per acre production. You go to the Greeley Farm, you're not sure what crop they are growing this year. (Mr. Tremblay was corrected on nomenclature at this point. The Greeley Tree Farm he refers to is actually the Greeley Nursery.)

',With the Greeley Nursery we have 1,400 pounds roughly of dry matter per acre, and you'll also notice in this case that their nitrogen content is quite a bit higher than at the Wind River. It happens to be a 1.2 percent in here, a little bit higher in phosphorus and a little bit higher in potash so that your nutrient removal on the Greeley Nursery is 169 pounds of nitrogen, CO pounds of $P20_5$, and 125 pounds of P_20 which almost beat a really good crop of field corn grown in the Columbia Basin. You can see that there's certainly something to remember there. That is the amount of dry matter is, or you might put it in other terms, the number of plants per acre you fellows are growing out here has a direct relation to depletion of soil materials. Certainly if you're going to have an efficient operation, I would think at least that you'd want to grow as many plants per acre as possible. When you do that--I'm trying to get back to this point again--if you are doing a really good job you're really pulling nutrients out of the soil. So you can figure that the Greeley Nursery is doing a very good job. But again it depends on the type of trees that you're growing. Another thing I want to

point out that is common in agriculture is that the tops of the plants have fair variation of contents and also that the tops remove quite a bit more stuff than the roots. The other thing I want to bring out is that different species will remove different amounts of nutrients. There is some stuff on white spruce, red pine and white pine and also I want to bring out again that nitrogen can vary from .6 up to 2 percent. This is one of the things we'll get to a little bit later. One of the things we want to pin down is: Should a plant contain .8 percent nitrogen or should it contain 1.8 percent nitrogen? In other words, this is where I think maybe you fellows. should be making a little more use of leaf analysis. And of course your phosphorus variations are wider than they are on the table. I didn't go through the whole literature. The potash content will vary quite a bit, too. From table four you'll notice there that they have variation in what they think the nutrient requirements of these various crops are, Now, I'm not sure if they are talking about 1-0 stock or 2-0 stock or what. Another thing we must remember is that the older the tree, the greater the nutrients removed. In other words, you're going to have a lot more plant food in a 2-0 tree than you will in a 1,0 tree. That's elementary. I noticed several places in the literature where, for various types of seedlings, they recommended about 50 seedlings. In this particular case it was 2-0, 50 seedlings per square foot. Roughly, they're talking about 100 grams of dry matter per square foot. I noticed also that when you get to analyze this literature, it may vary in the amount of dry matter per square foot. It may vary from 22 to 255 grams per square foot. In other words, there's a tremendous variation in your nurseries on the amount of dry matter you are producing. But in many cases the recommendation seems to be, roughly, that you should be growing about 100 grams per square foot which would make about 10,000 pounds of dry matter per acre. or 5 tons of dry matter, and that's a lot of dry matter.

"It gets to this point again. When you're growing the stuff in the nursery, you're growing stuff very much like an agrcultural crop and you're really removing the nutrients. So consequently, I think it behooves anybody in this room who is in the nursery business to keep a constant watch on their soil nutrients supply. I don't know how you folks are doing this now, whether you're doing it yourself, by soil analysis, or whether you're sending it to a lab. Just because you did it one year or maybe even two years, I certainly wouldn't skip running a soil analysis for 3 or 4 or 5. years, because you've got a very expensive crop. As I understand it you're talking about 3, 4, 5,000 dollars an acre. I'm not sure of the figures. That's some of the figures I saw, probably more as time goes on, so when you're talking about a very, very expensive crop, I think it certainly behooves you to look into the nutrient content of your soil. Looking at it from an agronomist standpoint, it seems to me that the yield and quality of nursery stock is vitally affected by:

1. (I stress this), I think the number of plants per acre or, as you call it, the density of stocking.

2. Your soil fertility level.
3. Certainly your moisture supply.

"You don't talk about fertilizers very much unless you also refer to soil moisture supply. I think also, possibly another factor that we don't measure too easily is soil air supply. I think that in some of these nurseries, the aeration of your -soil, the amount of air that is available to those heavily stocked plants, probably will be a more important factor than you may be aware of. I'd like to get into soil analyses briefly. I think they're good, but I think, also, that we should all be aware that soil analyses, particularly in relation to trees, have quite a few limitations. I think, the number one limitation is certainly the same limitation in agriculture and that is for nitrogen. We don't have a very good test in most places for nitrogen and, for instance, in the City College in Washington we analyze for organic matter and we try to estimate the amount of nitrogen that's going to come from that organic matter. This is a very clumsy way to estimate how much nitrogen is going to be available to a crop. I think, in the nursery, if you're doing a pretty thorough job and you're doing the job yourself, you could go to the nitrate quick test, such as Diphenolamine, if any of you are familiar with that.. And you could follow it through from week to week on the nitrate end of it and be a lot closer to what the status was in your soil. Particularly, when you're putting on fertilizer, we think that, for instance, 'in agriculture, if we're to get it all, we want to get about a 70 or 80 percent use out of the nitrogen that we've put on. In other words, if we put on a hundred pounds of nitrogen, we expect the crop to get back approximately 70 to 80 pounds of it. And that's very good efficiency; 70 to 80 percent is very goods I've seen in some of the literature here on the nurseries that they're getting back maybe ..only 30 to 40 percent of the amount of nitrogen they're putting on. I think this is all a matter of timing. I think we'll have a little shop talk about some of that in a few minutes. When you put on nitrates, when you put on ammonium sulphate, that changes over to nitrate and this moves through the soil. If you're irrigating, you'll probably run those nitrates down as low as your irrigation level. I think with a quick test for nitrates you could follow this' nitrate and make sure you're not leaching it out beyond the roots. If you put nitrogen on it too early in the spring before the roots are active, you're again liable to lose the nitrogen. I think this is something you might be able to :do with soil analyses. We have some very good tests for soil phosphorus. Again, the soil test is only as good as the correlation with the yields. You can't, for instance, take a test for phosphorus, as such, in relation to corn and expect that to relate to trees. You must run your own individual plots and check that yield against soil analyses in order to get a proper figure. The same applies to potash. We do have some good methods for analyzina for these nutrients. I'm a great advocate of plant analysis particularly in trees--and certainly in trees that are 30 to 40 years old. It will be a tremendous tool for us to work out the nutrient requirement of trees. I think a soil analysis in the

woods, by and large, is for the birds. We don't have enough data by a long snot to make soil analysis mean anything in the woods. I hope we do one of these days, but we certainly don't have now. I think, by taking the needle analysis, for instance, on Douglas-fir, from some work that Gessell's done on loblolly pine in the Southeast, we're getting closer and closer to figures that really mean something to us. You may or may not know how we take a sample. When we sample Douglas-fir, we take the new growth off the top of the plant. We separate the new growth here (by the way, I think Stan figures the best time to sample is in the fall or winter) and after they've pretty well Stabilized themselves, we take these needles off and separate them. We take them off the petiole or stem. Anyhow, you take the needles off, dry them and run a sample. The only thing we haven't figured out is how to get the samples off some of these 200-foot trees. Nevertheless, we're talking about nurseries today. I would think that you fellows could do a real bang-up job in the nurseries on needle analysis to find out where you are, from a nutrient standpoint. It seems to me it would be a good thesis for some young guy to do, if it hasn't already been done, to go around to all the nurseries and check them again. Instead of taking the whole plant, take a part of the plant that would be sensitive to the nutrient uptake. In other words, on this particular thing I'm sure we wouldn't want a sample of any of this stuff down here (pointing to lower portions of the. stem). We'd probably want to get up closer to the top. We would take the new growth and take the needles off. I'm sure we have done enough work on Douglas-fir to know where to sample those things. In getting back to this Figure 1, which I haven't really touched on here, if you'd plot the yield on the one axis against the percent nutrient content, you nearly always get a curve of this particular shape. It curves up and then gradually fades out and becomes level. Beyond the left hand side of that one dotted line, usually in this area on agricultural crops, we can see deficiency systems. As far as nitrogen on Douglas-fir, we can tell whether it's yellow or not, and we go through the various stages from yellow, to yellow-green to green, etc. This is the way the leaf analysis really helps you out. In this so-called hidden hunger zone, there comes a point where you don't see any visual deficiency systems. We get into an area where we're still low on that particular nutrient, but we can't tell by visual symptoms, so we have to analyze the plant for the nutrient in order to pick it up. In other words, taking this particular diagram here, the nitrogen on the one dotted line might be 1 percent nitrogen and that would mean anything below 1 percent nitrogen would probably be in the deficiency zone, but from 1 to 1.5 percent nitrogen we might call that the hidden hunger zone. In other words, we might want to have over 1.5 percent nitrogen in order for this crop to be growing at maximum efficiency; and this is where leaf analysis comes in. Soil analysis won't tell you this and visual symptoms won't tell it to you. You have to analyze the plant itself to find out what's going on. I think, as time goes on, as we get more critical and we want to grow more stuff per acre, you fellows are going to find that you're going to go into this kind of program in order to find out where you are.

"Now the only other thing I want (I'll use the blackboard) to talk a little bit about today is nitrogen material and other material. This

is what I should have talked to you about all the time, because this is the only thing I know, nitrogen compounds, and we have quite a few of them. That's one thing I can say about the fertilizer business. In the last ten years we've come through with a lot of different compounds, but we have a lot of different things that can add to your problems. One of the things is, for instance, NH3. You're all familiar with that--it's the, basis of all. our nitrogen material. It's ammonia, anhydrous ammonia. I think they're using it in the nursery over near Missoula. It's a gas that has to be injected in the soil. Some of the ones that you'll probably. use, though, are ammonium nitrate which has a 33.5 percent nitrogen. Ammonium nitrate is a very common one. It has the ammonium ion and .the nitrate ion. Ammonium ..sulphate, NHS, 21 percent nitrogen, and urea, those are probably the ones you'll be concerned with mainly. In other words, these are all different nitrogen compounds. They all react differently, and one of the most important things is the difference between, NH_4 plus and NO_3 minus.. This is a negative ion and, as such, it's freely- soluble in water and goes right through the soil. It is not attracted to the colloidal particles. In the soil, of course, we have colloidal particles as organic matter or clays that are negatively charged, and any positive ions, either calcium or potash, will be attracted to the clay, particles and be held there. In other words, if we spread ammonium sulphate on the surface of the soil, it won't penetrate any more than a quarter of an inch or a half an inch or whatever it can physically before it goes down and gets tied up with the clay particles. If things are right, it's not too cold, and it's fairly moist, this ammonium ion will change over to nitrate rather rapidly through the microorganisms. Then it's free to mow in the soil. Sometimes you can broadcast the ammonium form of nitrogen on the soil and put the sprinklers on, and it may not go into the soil very far at all for two weeks. Whereas, if you put the nitrate form., on, .it will get into the soil and be used right away. Once. they're under the soil, once they're down safe two or three inches, the ammonium ion and nitrate ion will probably be used as such. In other words, both of these ions mould go up into the plant. This is .a very important thing. Anything has to be in the root zone before it is absorbed. (Here a slide of strawberry plants was shown.) I have some strawberries here that were side dressed with some fertilizer on them. They may have some side roots on them. They were Put into the soil in.a row about an inch. deep. These roots will never see the phosphate and probably never see the nitrogen or the potash. We might mention also the nitrogen carriers, urea and formaldehyde. A mixture of urea and formaldehyde can be made• at different levels of availability so that you can tie up .the nitrogen in the urea and it will become less soluble, depending on how they make it. These forms of nitrogen are rather expensive. I think that when we get our technology down, they'll cane down within reason, but certainly they're within reason in the type of pellets Ted Wadsley is putting out, in a small amount like that. For general use in the nursery, although you might want to fool around with them, I don't think you're going to find it economical to use them as such right at the moment. Now, for

phosphate compounds, you're probably all familiar with triple super, which is 45 percent P205 and single super which is 18 percent The main difference between these two materials is that one contains an awful lot of sulphur. By the way, if you're comparing ammonium sulphate with ammonium nitrate, you might get a better response from ammonium sulphate. This might be another reason you get a better reaction from the two fertilizers, because ammonium sulphate doesn't contain sulphur. And then there's the NP compounds, such as 1148-0, 1620-0, 2153-0, and a host of others. We have almost any combination that you would want; for instance, we have 2714-0, and these are what we call ammonium phosphates. They're quite water soluble. They go into solution rather easily. We have the dynitro phosphates. I won't get into all this folderol here, because I know you aren't too interested. You can get dynitric phosphates which are mainly dicalcioam phosphates; in 2020-0, 2010-0, etc. on down the line. I just want to point out to you that we do have a good number of fertilizer materials to suit your particular needs. If you're in the soil analysis business, and if you want a particular fertilizer we can nearly always get it for you. Of course, one of the basic things about phosphate, is that it doesn't move in the soil very much. And if you really want to get the use out of phosphate again you've got to get it down in the root zone. Don't broadcast it over the soil and work it in an inch or two deep and expect it to do too much good for you. You've got to get it down there so the roots can grow into it. There's a principle again of some of these pellets. You put the pellets into the root zone so that when the roots get active they're right there with the fertilizer."

Question: "Does that mean the liquid fertilizer, the liquid phosphate, that you inject into the ground might be more readily available?"

Answer: "No, not very much, unless they're in a very dry soil. If you're in a very dry soil, the liquid phosphate would be moist, but it won't move very far, by the same token; it won't leach and acts the same almost. If you put a granule of 1620 or 1148 in the soil, in two days it would be liquid ammonium phosphate anyway. The only advantage of liquid fertilizer is easier application. Most of you fellows are set up probably to run the stuff through the sprinklers, aren't you? You could anyway if you had a sprinkler, and you wanted to put on a little touch of nitrogen."

"The last one we'll talk about is potash. The two main sources of potash are muriate of potash, about 60 percent of K20 and K2SO4 and 50 percent K20. Now, in most cases, since your stock is so important and so valuable per acre, I wouldn't even take a chance in using this. I think potassium sulphate is a little more expensive, but in most cases you'll got a Tittle more burn and the chlorine will be a little toxic. I would stick to this in most cases. You go over to the potassium sulphate form. It's just as available as the other forms. It costs a little more. You also get a little sulphur in it. If you need a little magnesium, there's another fertilizer called sulpho-mag which also has some MGSO4. That's magnesium and potash together. *Fur* young stock there some material that we don't find readily on the market, potassium phosphate. There are some compounds of potash

that are a lot **less** soluble. I think this is one of the critical problems in the nursery and something that you fellows are going to have to watch all the time. That is, you've got to watch that you don't get your soluble salts so concentrated that you're hurting. I think that you should always be sure you have enough on but not so much that you're hurting the crops."

Some slides were shown showing the beneficial effect of fertilizer on a number of plots of older trees of various species.

Homer Ward

"Thank. you. I wonder if we can give Jack another couple of minutes here; he has a source of some very interesting written work. .I want to thank Todd **very** Much for his presentation. That was very educa-.

Jack Fisher

"I have another couple of points..You all have the "Tree Planters' Notes". Is that correct? You see the various things that are in there. I. have here a file I maintain of various publications pertaining to soil fumigation in forest nurseries. I don't know if any of you get "The Plant Disease Reporter" or not. It's a free publication by the USDA, but. I'll be very happy to have my office duplicate copies of these various articles concerned with soil fumigation and the problems that these various other nurseries are working with. They have nematodes and diseases and have been testing various soil fumigants. This presents their data. If you are interested, I'll be very glad to send them out next week to the various nurseries. There are some from the southern nurseries, the northeastern nurseries, the Chittenden Nursery, etc. Would that be helpful?"

Homer Ward

"I think they would be interested, Jack. I think we'd all appreciate that very much."

Jack Fisher then showed some slides illustrating the use of the soil fumigator. It is difficult to describe these without the slides.

(to Todd Tremblay)

"In your foliar analysis referring to your curve, I'd say there's a slight deficiency which puts it in the hidden hunger zone and then you boost up your nitrogen supply. Will the plant take up what they call a "luxury amount" of that?"

Answers "This, is something I think is a horrible term, "luxury amount." A plant may take up an excessive amount of fertilizer for the present moment but there's a time when that plant is going to need that nutrient, and as long as we're not hurting that plant, as long as you don't get so much in there that your excess salt, or whatever

you want to call it, is giving you trouble. I wouldn't call it "luxury consumption," because sometime that plant is going to use that and take off. For instance, we know that field corn or sweet corn in the spring will soak up phosphorus very early. In fact, when I was running a plant analysis on corn, I was running it on corn about three feet high and I wasn't getting any phosphorus difference on the plot. The corn plant took up that real excess. Then when the time was right for the thing to grow it just took off. Of course, as it grew, we got more tissue, we diluted the phosphorus content, but it took off and *grew.* You've seen in the literature the term "luxury consumption," but I prefer to think of it as temporary storage of the nutrient until it can be used to advantage. When a corn crop is growing, it's using about a pound of nitrogen a day at a certain time; it's really using the nitrogen."

(There was a question about the time of application.)

Homer Ward

"In late application it's about the same thing. The uptake is there and a plant to which the fertilizer was applied held its superiority and growth for over four years."

Comment by Tremblay: "It's the same thing on pastures. You can put a late application on pastures. You'll green it up quite a bit, but you won't get any more growth. That's the first stuff to take off in the spring."

Comment by Ad[a]ms: "In one of our nurseries we applied 200 pounds each of nitrogen and phosphorus on plots in the nursery, 400 pounds of each and then controls. There were just two plots of white fir, 1-0, very small stock, that we compared. The M4P4 showed about twice the growth of M2P2. Pines didn't show that response."

Tremblay: "By the way, there's one point that I didn't make. I think that somewhere in your farm, like we have at a lot of agriculture plots, you should have a screwball plot, maybe only five by five feet, where you put the whole works out, where you have same zinc and manganese and boron and iron and just everything. When we were putting plots out on the farm, we used to sneak off and try some of these screwball things and wouldn't tell anyone about it until they turned out pretty good, just five by five plot, something small, where you know you've got a limiting factor, and I think you can trace down the nutrient."

Another question: "In this figure one, growth yield curve, you give some figures 1 and 1.5 percent in the foliar analysis. What's the basis for that figure?"

Answer: "The only basis I have for this is that Gessell seems to think that what we think of as the critical nutrient level is about one percent, and he's not sure from there on out. Whether 1.5 is good, we're not sure when we get up there. We know that anything below one percent is slow."

Question to Homer Ward: "Have you made a study of the growth response to fumigation?"

Answer: : We haven't as yet done that. I appreciate your asking the question, because I did not bring it out. We will, at the conclusion of our fumigation plots, make measurements to see if we do get increased growth rates. Perhaps the cost of fumigation will be offset by the additional superior growth rate."

Augenstein commented that in one case he did get a definite increase in growth.

Adams: "Well, on fumigation again, one of our nurseries had trouble with Fusarium. The experiment station suggested we try some different chemicals, one of which was Methylbromide, another Vapam. The Methyl-bromide showed excellent results as far as germination went. We got a heavy stand in many of the plots, but at the end of the first growing season, they began to look a little chlorotic and by the time they were too old they were just about dead. I don't know what it would be unless it upset the ion exchange there or something. It was killing the mycorrhizae. That would do. it."

Adams: "Do I Understand that at one year it began to turn?"

Answer: "Yes,--at the end of the first growing season."

There was side discussion about the effect of chemicals on mycorrhizae which the recorder did not pick up.

Question: "What about kelated iron? Have you had any experience on that?"

Answer by Tremblay: "Kelates is a wonderful way to put on some of the minor elements. It doesn't get tied up in the soil. I don't have any experience with it but I know that in agriculture it's worked very well. The only thing is the expense."