CURRENT STUDIES ON CLAY SLURRY ROOT DIPS

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The preceeding paper has presented a discussion of the history and status of the use of clay slurry root dips in North Carolina nurseries. This paper will present some of the research and evaluation work currently underwayllon this interesting procedure Which appears to be only partly developed at the present time.

The work to be discussed falls into tun general categories: (a) laboratory and greenhouse studies, and (b) field evaluation studies.

Laboratory and greenhouse studies

The main reason for adopting the dipping procedure was to prevent drying or exposure damage to lifted seedlings. The first research was designed to assess the protective value of the clay then being used in the nurseries and to compare it to two other clays which might also be of value.

The seedlings used in these exposure trials were 4-month-old loblolly pine seedlings which were very carefully graded as to stem height, root collar diameter, and root system development. They were lifted and graded by hand and protected from exposure until the time of the experiment.

The clays included the material then being collected at Spout Springs, North Carolina, and two commercially available clays called Volcay and Panther Creek Clay. The commercial clays were both known to be bentonites and X-ray analysis indicated that the Spout Springs material was mostly kaolinite. The differences in these clays will be discussed later in this paper.

Treatments involved momentary dipping of root systems of seedlings in one of nine clay slurries (three clays each at three concentrations) or distilled water. Non-dipped seedlings served as controls. The entire seedlings were exposed to direct sunlight at a temperature of 90° F. in calm air for various times ranging from 0 to 180 minutes.

The water dipped and non-dipped seedlings all perished if exposed to the sunlight and heat. All three clays at all three concentrations gave excellent protection from exposure for 30 minutes and a few individual trees survived more than 60 minutes of exposure.

1/A M. S. Thesis concerning clay root dips will be completed before the end of 1964 by C. A. Tabor at North Carolina State.

These tests were intentionally extreme as to the use of succulent young seedlings and high temperatures. However, the only possible control over wind was to eliminate it and, therefore, drying conditions were not at the maximum possible. The results indicated that the clay slurry root dips do give seedlings protection from exposure to drying conditions prior to being planted in the field.

The next step in the investigation was to determine whether the clay root coatings provided any lasting protection from moisture stress after the seedlings were planted in field soil.

The same three clays were again used but at two concentrations each. The seedlings used were carefully graded 9-month-old loblolly pines. In this study the seedlings were dipped in the clays and planted in soil in large plastic pails. Non-dipped controls were also included. All seedlings were then grown under conditions simulating either low moisture stress (50 cm. to 3 atmospheres of tension) or high moisture stress (50 cm. to 15 atmospheres of tension) and checked for height growth and increase in root collar diameter. Each seedling was individually measured at the beginning and end of the experiment.

The results indicated, that regardless of clay treatment, abundant available soil moisture significantly increased both height growth and root collar diameter. Clay treatments did not affect height growth significantly and they were only slightly related to differences in root collar diameter. The kaolinite (the clay then currently in use in the nurseries) was inferior to both of the bentonites at both concentrations and at both moisture levels. In general the seedlings whose roots had been dipped in the Panther Creek clay exhibited the best root collar diameter growth. Survival was not a factor in this study and only one seedling failed to survive.

The two foregoing studies dealt with the potential physical attributes of the clays but neglected any possible chemical factors of value or detriment.

The clay initially used in the nurseries from Spout Springs, North Carolina, and the clay from Spruce Pine, North Carolina, which is currently being employed were both found to be predominately kaolinite. Clays of this type have a small negative charge on their surface and can, therefore, hold small amounts of certain positively charged elements against leaching by water. Elements so held are available to plants. The bentonites are structurally different from the kaclinite clays and as a consequence of this difference they possess a relatively large negative charge and can retain larger amounts of elements against leaching.

It was hypothesized that perhaps it would be possible to saturate the negative charges of the clays with positively charged nutrient elements (cations) such as calcium, magnesium, or potassium, and then obtain both the physical protection from exposure prior to planting and a growth stimulation from the clay source of some needed nutrient. Because of their relatively higher negative charge, the bentonites would be able to hold higher concentrations of the nutrient elements.

In this study, a commercially fractionated kaolinite and the Volclay bentonite were saturated with calcium, magnesium, potassium, or sodium. Then roots of seedlings of loblolly pines grown from seeds from three known mother trees were dipped in the variously saturated clays and grown in subirrigated nutrient cultures. In each case, the nutrient element present on the clay was omitted from the nutrient solution, thus forcing the seedlings to obtain that element from the clay on its roots.

The seedlings in this study were harvested just a few days ago and some of the chemical analyses are not yet complete. However, certain results are available. The calcium saturated clays stimulated growth, the magnesium saturated clays neither stimulated nor suppressed growth, and the potassium saturated clays suppressed growth. The sodium saturated clays were used as controls in these comparisons since sodium is not essential for growth. The bentonite clay was superior to the kaolinite clay in 10 of 12 comparisons. The seedlings did take up the nutrients from the clays and there were very pronounced differences attributable to the three different mother trees or families.

Field studies

In the summer of 1963, large scale plantings of American beach grass were begun on the Outer Banks of North Carolina. Since the clay slurry root dips appeared to increase survival of coniferous nursery stock when planted on adverse sites, it was decided to select a very severe site on the Outer Banks and run comparisons of dipped and non-dipped grass plants. Two plantings of grass were made on the site under very adverse climatic conditions. The first planting was a complete failure but the second planting provided some very useful information. In the second planting, the non-dipped grass had a Survival rate of less than 2 percent while the dipped plants survived in excess of 80 percent.

A second and more comprehensive field evaluation study is currently underway in cooperation with a paper company on land in Alabama. In this case, the clay was either used alone or was saturated with calcium, calcium and superphosphate, or calcium and 10-10-10 fertilizer. Non-dipped seedlings served as controls. This has been an excellent year for new plantings in Alabama and consequently survival has been excellent in all treatments. The plots included 3,000 seedlings of which 2,866 have survived. If the small losses which did occur are considered, there is again the suggestion that the calcium saturated clay was the best. It will probably be another year before growth differences in the seedlings are detectable. Further tests are being planned for next spring which we hope will be a somewhat sterner test of the value of the root dips.

Conclusions

The results of these laboratory, greenhouse, and field studies allow us to draw some conclusions on the value of clay slurry root dips even though some of the studies are not yet complete.

Both kaolinite and bentonite clays do give positive protection from exposure prior to outplanting. Growth stimulation after outplanting was not detected and growth rate was not significantly increased over non-dipped controls when plants were under moisture stress. Thus it seems that the clay slurries serve to protect the roots from excessive water loss but are of little value in aiding the plant in moisture uptake from the soil.

The clays can also serve as reservoirs of nutrients while in contact with the roots. Bentonite clays such as the Panther Creek clay appear to be best adapted to this process and the present information available indicates that young trees respond most favorably to calcium saturated clays. This is a very reasonable result since it has long been accepted by plant physiologists that a high level of calcium in the solution surrounding roots is stimulatory to the uptake of several other nutrients.

The field results offer one bit of experience which is worth considering. The climatic conditions existing when the first beach grass planting was made were so severe that all plants died. The second planting was done under somewhat less severe conditions and large differences between dipped and non-dipped plants were observed. In contrast to these results are those from Alabama where nearly ideal climatic conditions existed and survival was above 90 percent in all cases. The point to be remembered here is that a survival or growth advantage, such as is offered by the clay slurry root dips, is only a relative thing and that no observable differences can be expected between dipped and non-dipped stock under either ideal or extreme conditions. As an insurance against less than ideal conditions, however, the standard use of a clay slurry root dip now seems advisable.

DISCUSSION TO: Bill Bland and C. B. Davey

Q. Did you use any special method of suspending the clay in the water?
A. (Bland) Actually what we intend to do is install a vat overhead where we can use some form of agitation.

Q. How many seedlings do you think a ton of that prepared clay might pack?
A. (Brenneman) Roughly a million to the ton.

COMMENTS by Mr. Brenneman:

We held some for 3 months at room temperature which was the same as outside. They were left just as they were packed. It seems that the clay eliminates any need for a coolant. It might be possible to hold them anywhere for a month without any coolant.

COMMENTS by Mr. Claridge:

Back before mudding, we ran out of moss one year. Somewhere in the literature we read that you could dip these roots in clay and get by with it, so we went out and got some red clay and dipped these seedlings and shipped them out. Unfortunately, we didn't have the initiative you folks have today. The clay matted all of the seedling roots together and tore the roots off when we pulled them apart. So we gave up the idea. That shows just what advances you folks have made in the last few years.

COMMENTS by Dr. Duffield:

Several years ago the vermiculite company gave us very fine milled vermiculite, almost a colloidal preparation, to test in this manner and I would just like to remark we got negative results with Douglas-fir using it in this manner, but there is one significant thing that came out of this study. A number of our people and contractors at the nursery had been opposed to any messing around with the roots, such as washing off the good soil that is already there. You may find this resistance with people when you talk about dipping roots. So we had three types of affects - we had freshly lifted trees, freshly lifted trees we dipped in water, and freshly lifted trees we dipped in water and then in the vermiculite slurry. The latter two, the water dip and the vermiculite dip, came out the same under a very severe drying and heating regime. The fresh lifted, unmodified trees came out very poor. In other words, water was just as good as the vermiculite slurry but better than leaving the trees alone, which I think is significant to those people who persist in the idea of resisting.

COMMENTS by Hr. Davey:

The vermiculite as it would naturally come, I presume, would be potassium saturated; and this was the clay that gave us the poorest results.

COMMENTS by Mr. Swofford:

When you are washing your seedling roots with water you are also destroying some of your mycorrhiza, as well as some of your rootlets. As Wakeley pointed out, you're reducing the chance of survival.

Q. When you plant these in the field, do you still protect the roots from exposure with moss or someother media or do you just put these in the tray the way they are?
A. (Bland) Ho moss is used. Just take than as they come. Carry than in a bucket without moss.

Q. Have you ever saturated them with awmonia ions, or can you?
A. (Davey) This is something we can do and we intend to do in the future but the ammonia ion is a little different to work with than either the calcium, magnesium, potassium, or sodium, and so this will have to wait a little bit. It is true this will serve as a nitrogen source.

Q. Have you tried sphagnum moss as a carrier?
A. (Davey) No, coming from the Lake States where most of the sphagnum industry is, I think I can safely report that sphagnum is becoming a scarce commodity unless you use alkaline sphagnum which most nurserymen can't afford. So this may come at a convenient time. Good acid sphagnum is becoming a problem.

Q. Did I understand you to say that you didn't notice any difference in the dipped seedlings; that is, in the survival between those in water and those in clay?
A. (Davey) Oh, very much difference. Those dipped in water were just like those not dipped at all. In the exposure study, I mentioned they died in less than 15 minutes exposure, the same as those which had not been dipped at all. All three clays in **ell** three concentrations gave excellent exposure control up to more than 30 minutes. The very minimum we can say is that they doubled survival of seedlings that had been exposed.

Q. I want to know if he will describe the technique of dippi**ng** and how you prevent matting?
A. (Bland) If your trees are very muddy, it is possible that some of them will mat. We bring the trees directly from the field in wooden boxes and weigh the trees. In the process of weighing we have, the workers just pull the seedlings apart and lay than on the scales. If they pull them apart that much they won't mat up

unless they have been in the bales too long. (Those showed the audience had been baled since March - 5 months - and they were slightly matted).

Q. You dip 150 all at the same time?
A. (Bland) Yes.

COMMENTS by Mr. Davey:

This matting problem is partly related to the concentration of clay that you use and the concentration you use depends on the kind you use. Thus, we can't say exactly what concentration to use; because sure as shooting you'll get a different clay and they'll come out like a brick. There is also one other factor. If you ever do this, be sure to put the clay into the water because if you think mom's gravey used to be lumpy, you want to do this the wrong way.

Q. Suppose you had only the kaolinite clay available, is there anything you can do to make it more effective; perhaps, increase the negative charge?
A. (Davey) No, at the present time, I wouldn't hesitate to use it at all because that's what all this is. As far as protection from drying goes, kaolinite works every bit as good as bentonite.

Q. How about adding calcium to it in some form?
A. (Davey) This is what we are working on now with one paper company in Alabama. We have plans to repeat and modify this experiment next spring and we hope that next spring won't be quite such a good spring so that we may see some significance. tie had no luck with survival at all on our first grass study. The conditions obviously were too extreme. With the second one we got the sort of results we like to see, you know, the with and without type pictures. In Alabama where the conditions were real good, again we saw no differences. Everything survived. So these sort of treatments are an irrelative sort of thing. They are only going to do us the most good on something less than the best site. But, obviously, conditions can be made so extreme that even they can't save the trees.

Q. How much of the kaolinite do you use to how much water?
A. (Davey) To make the consistency of about a heavy cream.