HYBRID POPLAR PLANTINGS ON STRIP-MINE SITES IN PENNSYLVANIA

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The strip-mine areas of Pennsylvania, Ohio, Kentucky, and West Virginia offer as great a challenge to reforestation efforts as can be imagined. Soil, if that is the proper name for it, in the bituminous coal regions of Pennsylvania consists of broken sandstone full of pyrites. The area is exposed to wind and weather and, consequently, the surface layers tend to be extremely dry. The pH varies widely from a high of near 7.0 to a low of 3.0.

The need to provide vegetative cover on thousands of acres of this type of land resulted from large-scale open-pit mining operations in central Pennsylvania. In 1946, I purchased an abandoned farm in the region and started to plant many different species of trees and shrubs. When the Bituminous Open Pit Reclamation Act requiring backfilling to approximate the original contours and the establishment of a forest cover went into effect in 1948, I was in a position to advise the coal operators on species and planting techniques to use. The prevailing attitude seemed to be -- "nothing will grow on such hostile sites, but the law says we must make an effort." Our first successful demonstration of survival and growth with pitch pine (Pinus rigida Mill.) and white spruce (Picea glauca (Moench) Voss.) on sites with pH's as low as 3.5 has changed the attitudes of many operators and much of the area now supports fully-stocked stands of hardwoods and conifers.

While we were able to demonstrate that various species of trees and shrubs would survive and grow on strip-mine lands, we were not satisfied with the results on some of the "poorest" sites. In an attempt to find a more suitable tree, we tried the hybrid poplars. The story would not be complete without briefly outlining the history of these fine trees and the contribution that Ernie Schreiner has made in developing the particular hybrids that are now so widely planted in the coal mining areas of eastern United States and in foreign countries around the world. In 1924, he joined a project devoted to the production of a fast-growing hybrid poplar. After crossing a large number of exotic and native species, the progenies were screened for rooting ability and juvenile growth (three years in a nursery). From these initial selections, field plantings were established in a number of locations and clones were distributed to a number of cooperators. By the time we became interested in trials of hybrid poplars in the late 1950's, we could already be assured of nearly 100 percent rooting of cuttings and satisfactory growth on "poplar sites." What we didn't know was how these clones would perform on our low pH sites.

Our initial attempts in planting poplar cuttings occurred in 1960, but it had to be on a limited scale because the supply of cuttings at that time was not plentiful. We were able to obtain 20 cuttings each from 12 clones from the Northeastern Forest Experiment Station, and these were tested on some of our acid spoils where previous plantings with other species had failed. Our information was that the hybrid poplars were extremely intolerant of such acid conditions (pH 3-5) so we gave them the acid test -- literally. Survival on these severe locations was about 50

percent and today, twelve years after planting, about 100 of the original 240 are doing well and growing vigorously.

Having proved to our own satisfaction that hybrid poplars, at least some clones, would not only survive, but would grow well on acid sites, we were anxious to try some plantings on a much larger scale. Larry Cook, Director of the Ohio Reclamation Association, supplied us with 10,000 cuttings in 1962. About half of these were planted on a stripped area of my Rollingstone Tree Farm with excellent survival, but only moderate growth, which I attributed to poor site fertility. The other 5,000 trees were planted on a reclaimed strip-mine area of the Hoffman Coal Company near Karthaus, Pennsylvania, with some rather astonishing results. A few of the trees in this plantation measure 20 inches d.b.h. in ten growing seasons on a soil with a pH of 3.8. We suspect that the soil is extremely favorable in terms of available nutrients, but lack of funds has prevented us from making a complete analysis.

The volume of wood produced at the spacing we used in the 1962 plantings (8 X 8 feet) is rather remarkable. I would like to read you a quote from an article of mine that appeared in the November 1971 issue of COAL AGE:

> Based on accurate measurements by D. K. Wary, Service Forester with the State of Pennsylvania, Department of Environmental Resources, the yield of a thinning cut at present would provide almost 11 cords of pulpwood per acre. As lumber, this long-fiber wood also makes excellent sheathing. Return to the land-owner on such a cutting would currently bring $3.75 per cord, or better than $40.00 per acre.

I have since learned, by accident, that these figures have been double checked and verified by Grant Davis of the United States Forest Service. A "thinning cut" would remove only half of the trees in the stand. Once cut, the trees would immediately sprout from the stump and a new stand would develop without the trouble of site preparation or planting. In six of the nine growing seasons, precipitation was only a little more than one-fourth normal for this area. Had rainfall been near normal for the entire period, one can only imagine what the growth might have been.

Todd Bowersox, Research Assistant at Pennsylvania State University, has presented some interesting data for growing the same hybrids on close spacing and on a short rotation cycle. Trees of clone NE-388, spaced one foot apart with 2 feet between rows, produced 29,500 pounds of main-stem wood fiber per acre on a five-year rotation. Total tree utilization -- including main-stem wood,branchwood, and bark -- would yield 40,000 pounds of oven-dried fiber per acre.

Since our initial experiences in the 1960-62 seasons, I have planted close to 500,000 hybrid poplar cuttings in the central Pennsylvania area, which takes in portions of 17 countries. Success has not been as good as that cited above in each and every instance, but the overall picture is good, and we have many remarkable stands as proof. Those who were able to participate in the show-me tours of July and August saw a few of these but, unfortunately, time limitations only permitted us to visit about a dozen sites.

In my opinion, what is needed at this point in our program of hybrid poplar planting on spoil banks is some rather thorough soil analysis in the areas where the most successful stands occur and on the not-so-successful areas. This should be a complete analysis because we know that the stripped areas have been "deep-plowed" in effect (to depths that often exceed 100 feet) and that certain trace elements have been brought to the surface in the process. Some of these elements are now completely lacking in our present worn-out topsoil in this region of Pennsylvania. In his planting recommendations, the Pennsylvania Department of Mines Forester has been guided, up to the present time, solely by the pH factor, which we find to be very misleading at best.

A second recommendation would be the establishment of a full-scale experimental test, using proper designs and checks, of a large number of the hybrid poplar clones now being grown in the State Nursery. Perhaps a number of the clones not previously tested on the spoils will grow even faster and have greater immunity to the canker diseases that show up occasionally on a few clones. There are rumors that Tom DeLong may have something like this in the planning stage and we look forward to seeing his results.

Most of the cuttings planted, other than the 10,000 supplied by the Ohio Reclamation Association, have been propagated by the State of Pennsylvania, Department of Environmental Resources, Forest Nursery. I have personally made about 95,000 cuttings, and we have purchased a limited number from private nurseries.

There is no question in my mind that the hybrid poplar clones developed by Ernie Schreiner will continue to generate a great deal of enthusiasm in our region. We look forward to the time when new hybrids will be generated using the present hybrids and infusing new germ plasm from selected native P. deltoides and the better clones used in the South.

When all of the factors in our present state of so-called civilization are considered, along with the increasingly acute shortage of wood fiber, we all have to agree that our present world and the world of the future (if any) will owe a tremendous debt to the skill, the knowledge, and the foresight of one of the few great men I have known -- my good friend, Ernie Schreiner, "The most Poplar guy in the World."

LITERATURE CITED

Jones, W. G. 1971. On reclaiming spoil banks ... TINIER: and in nine years, at that Coal Age. McGraw-Hill Publ., November. 4 p.

Bowersox, T. W. 1972. Hybrid poplars in rows superior in fiber yield. Science in Agri., Vol. XIX(4):4-5. Penn. State Univ., Agric. Exp. Sta.

Figure 1.--Strip mine planting (1961) of hybrid poplar on pH 5.5 site near Pikesdale, Pennsylvania. Ten years from planting.

Figure 2.--Hybrid poplar NE-388 (P. maximowiczii X P. trichocarpa). Three-year-old planting on 2- x 2-foot spacing. (Penn. State Univ., Agr. Exp. Sta. Photo.)

DISCUSSION

Hocker - Has anybody tried to figure out whether it would be possible to put together a breeding program which would alter fiber length? What the relationship is between fiber length and cell-wall thickness- - is there a relationship or are they independent?

Wahlgren - Consensus is that fiber length and wall thickness are two characteristics that can be controlled genetically. Within a conifer, the tendency is for fiber length and cell-wall thickness to increase from pith to bark, but this does not mean they are dependent on each other. I don't know of any research which elaborates on this dependence. My best guess is that they are dependent.

Rocker - As cell-wall thickness increases, does fiber length increase?

Wahlgren - Yes, I think there would be a tendency for this to happen.

Hocker - Is research emphasis now not on density per se, but rather on the genetic control of other traits?

Wahlgren - I think it is. This is not to say we are selling density short. All I'm maintaining is don't go off the deep end on it. From some of our work at the Forest Products Laboratory, we have found for 12 softwood species, that with the exception of tearing strength, pulp quality was adversely affected beyond a wood density of 0.45 grams per cubic centimeters. So while specific gravity is meaningful, it is not the entire answer. We are suggesting that the ratio of pulp fiber length to cell-wall thickness (L/T), as I mentioned in my presentation, is a more meaningful index to pulp quality, particularly where kraft pulp is concerned.

Fowler - You say as far as kraft paper is concerned, this is possibly a relatively short term thing in relation to our breeding programs. Pulping processes are going to change in the next ten years. Maybe it's quite conceivable that we could use something with the specific gravity of .6. Is there anything that says a .5 won't be good?

Wahlgren - Absolutely not. I wouldn't worry about the fact that because of economics or something else that .5 specific gravity will not be accepted in the future. I'd go for it myself. The pulping process is not changing, we're making paper the same way the Chinese did. The only thing I think subject to change, and it's apt to change very rapidly, is to curtail pollution. One of the brightest avenues I know is going into biochemical degredation. All pollution problems come from the chemicals that are used to disolve the lignin. And I think you will see this in the not-too-distant future. Just keep increasing the growth of those trees, produce uniformity in the wood, take the cellulose out of the secondary wall and put it back in the middle lamella. You don't have to make fibers eight and nine millimeters long, or as some people say, make the fibers in southern pine like spruce. I don't think that is necessary. I think you could shorten the juvenile period. This lack of uniformity gives us all kinds of problems. Thinning experiments and so on, where you get an abrupt change from slow growth to fast growth will produce all kinds of problems as far as using that wood is concerned.

Zufa--In other words, you say the most important thing is to produce a large volume of uniform wood? That's what we should aim for?

Wahlgren - I think at this stage of the game this is exactly what I'd recommend.

Fowler - One thing that bothers me is that our larch and larch hybrids all have a specific gravity of over .5. There are several of us putting effort into this on the assumption that it will be useful as fiber. Are we wrong?

Wahlgren - No, I don't think you are. It was about five years ago that Western hemlock was considered a weed species. Look at the demand for it today. We thought it had characteristics that were undesirable--not at all.

Schreiner - In that connection the late Ed Ehrhart, President of the Armstrong Forest Company in Johnsonbury, Pennsylvania, who was our first NEFTIC Chairman, told us (at the 5th NEFTIC in 1957) that his company would not take any hemlock in Pennsylvania, but they were purchasing from a company in Maine that was using hemlock.

Wahlgren - How many years ago did people start poisoning all hardwoods in the South? Only a few years. Now we are getting all kinds of questions like why can't you perpetuate these species? I'm talking of slow grown southern hardwoods. Number one, they're there because they are on extremely poor sites, and I don't know what else would grow there. The only reason they are using them now is because of an economic advantage. They use them in a blend and it's working just fine.

Schreiner - The Oxford Paper Company started breeding poplars in 1924 because they were using about 60,000 cords of aspen per year, and aspen was coming into short supply. The research department was also working on the use of hardwoods, beech, birch, and maple. I remember that the Director of Research was advised that if he couldn't think of anything better to do than to work with hardwoods, they would have to get a new Director of Research. He was told that during the war the Oxford Paper Company bought hardwood that was rotting in the piles because they couldn't use it. But the Director went ahead with the research. That was 1929; in 1931 we were told to forget poplar because the Company was using 50,000 cord of hardwood and only 10,000 cord of aspen. And that's what ended the poplar work for the Oxford Paper Company. But I am certain that poplar will come into its place in the sun, even in the Northeast. I've always argued that one forest product that will always have value is clear wood, produced rapidly. And the faster the terminal growth and the fewer the intermediate branches, the cheaper it's going to be to get such clear wood.

Wahlgren - Right, for example, even within a species the difference between the strongest and the weakest piece may be only 2 or 3 times--I'm talking about clear wood. The minute we consider knots and some of the other defects, then the difference may become tenfold. This is the problem we have when trying to associate some of the anatomical characteristics with the mechanical properties of wood. I can associate it with the clear wood samples, but I have a hard time equating them to the real world because all defects make this other facet fairly insignificant. So this clear wood idea will always be important in that light.

Schreiner - As soon as you say clear wood, practically everybody wants to select for natural pruning. But there is no possibility of satisfactory natural pruning on short timber rotations. Even in Maine, with a heavy snow load, the stubs on our pines and hardwoods are visible for many years after the branches have died.

I can understand why the Oxford Paper Company discontinued the poplar research. I made a reconnaissance in 1930 of the forest lands within a 25-mile radius of the mill. On the basis of an annual increment of 1/5 cord per acre, I estimated that the forest lands in ownerships under 500 acres could produce the Company's annual estimated requirement of 50,000 cords of hardwoods. This eliminated reliance on the large corporate ownerships who could easily withhold their wood from the market to push up the price.

Wahlgren - Someone wanted to know how to make a million. Try to figure out a use for the 13 million tons of bark that the industry generates every year.

Hocker - What has happened to all the preact spoil bank lands, lands which were not required to be revegetated. Is this land being revegetated?

Jones - There is very little preact land left because of the fact that the preact stuff was stripped originally with small equipment, one-yard and half-yard shovels, and as bigger equipment came along, they restripped and buried the first spoil. That spoil was included in the reclamation of the postact strip mine land. I don't think there are 5,000 acres of preact strip land now in the entire State.

Hocker - All strip mine land then should have come under the regulation and should then be planted?

Jones - Right.

Dorn - Ink Arnold isn't able to be here today, and he asked me to ask you poplar experts if some of these poplar clones that grow on spoil banks would also be suitable for planting on gravel or borrow pits? Apparently, he has some of those that he wants to try out.

Jones - It is my opinion it would grow there. How about it, Ernie?

Schreiner - I agree; unfortunately we haven't been able to get Ink interested enough to produce cuttings for commercial trials in New Hampshire.

Carlaw - We are doing that in New York.

Schreiner - The native cottonwoods do seed in naturally on gravel and borrow pits along highways. From Albany down to New York along the New York Throughway you will find cottonwood seedlings in borrow pits and fills. They have come up out of the Hudson River Valley to upland sites where there was never any cottonwood before; and they appear to be growing very well.

Forbes - You made mention of the high variability of the spoil bank sites. Even though the sites are so variable, the hybrid poplar does do well no matter where you put it?

Jones - Just about. There is a difference in the diameter of trees eight to ten feet apart, one will be 15 inches and the other will be six inches.

Gabriel - Are they the same clone?

Jones - It might be the same clone, although variability within clones is far less than between clones on a given site. Unfortunately the big and highly successful plantings were mixed clones that we got from the Ohio Reclamation Association before our own Department of Forests and Waters started to propagate them, so in some cases we don't know which clone they are.

Gabriel - In other words you have a mixture of clones. It could be due to clonal rather than site factors?

Jones - I would expect that would be the case.

Forbes - This has been one of the big problems, trying to find a catchall species that will grow just about anywhere on any type of spoil material.

Jones - As I say, we probably approach this in a nonscientific way. We use the shotgun approach and plant a hell of a lot of trees and hope they will grow. We have found out some rather interesting things in that process, unscientific though it is. We know which are the most acid tolerant, which are the most drought resistant, and which are the fastest growers. If you are the least bit observant, you can't help but find things out when you plant almost 50 million trees.

Forbes - How about the steep slopes, not the highwall but the higher slopes of your deposit?

Jones - We have tried an experiment with the steep slope. The nursery runs stuff through the buzzsaw to make cuttings. There is usually a stake left over about 2.5 feet long and about 1.5 inches thick that we chop to a point. We don't plant it, we drive it in to those steep slopes with a mallet. It does a terrific job of holding back those steep slopes because if you put a seedling in there, the sliding shale and the sandrock will just bury it. I've seen one-year-old trees coming out of these steep slopes that were bent 15-20 degrees from the vertical position. At the age of three, they were bent 30-40 degrees. At the age of four some of them actually bent down and then tried to resume a vertical position all because of the pressure from material shifting and sliding down. This trick with the hybrid poplar stakes that were previously discarded is working beautifully.

Davidson - There was one comment brought up this morning about the possibility that hybrid poplars might not grow so well on some of these poorer sites. Our experience, and I thought Mr. Jones might bring this out, indicates that they do well. On some of our poorer sites we are very satisfied with the performance of the hybrid poplars because they are doing so much better than anything else we had planted. They are not reaching the growth that we saw in one of the slides this afternoon, but they are so much better than the pines and other species that we recommend hybrid poplars for all but the most adverse sites.