TRENDS IN TREE PLANTING ON MINE RECLAMATION SITES

By Rufus Allen, Research Forester, U.S. Forest Service

The following article is excerpted from a talk given by Mr. Allen at a meeting of the Council for Surface Mining and Reclamation in Appalachia, held in Madisonville, Ky. Mr. Allen joined the staff of Northeast Regional Forest Research Experiment Station in Berea, Ky., in 1961. He is currently conducting tree planting research on reclaimed surface mines in western Kentucky.

It would appear that after 40 years of research, we in the forest service should know what trees to plant on surface mines and how to plant them. If all we want is trees just to say we have trees, the above statement can be assumed to be true. However, if we are thinking in terms of high-value tree species that will yield a high monetary amount in return, then we're still back in the dark ages.

Many sites have been replanted successfully with Virginia and Loblolly pine and several species of hardwood, namely Black Locust. The Loblolly pine grows well in Kentucky but is apparently subject to ice damage and winter burn from the extreme cold that we've had for the last 2 years. Virginia pine is an excellent pulpwood species, but will there be a market for it when it is matured?

And lastly, what are we going to do with the thousands of acres of Black Locust? Most of the disturbed areas in western Kentucky were hardwood sites, as were most of the disturbed areas in the surrounding states. It is natural then to reclaim these areas to their original status. This has been attempted on many areas over the years. Some of these attempts have been notable successes, others failures, and some just mediocre.

Overall, we have had about a 35% survival rate on hardwood plantations since we started planting hardwood trees several years ago. This rate even extends to our newer studies, recently installed. The notable successes in the past continue to encourage us and to give us hope that we can consistently get good results from present and future plants.

What are some of the problems that face us on getting good survival and growth of trees? Well, first and foremost is the fact that mining spoil is not agricultural or silvicultural soil as we know it. I would say that many of our problems arise from this fact.

I'm going to add another category, biological factors. And under this I have the lack of micro and macro organisms. Not only are these items problems in themselves, but their interaction problems are many. In many cases we don't know the answers because we don't even know the questions. Willis Vogle, our range scientist in Berea (Ky.) has found it necessary to fertilize a site in order to get satisfactory grass and legume growth, but we in the forestry picture have found that, most of the time, the application of nitrogen and phosphorus is detrimental to tree survival, if we apply them at the time of planting. There are studies going on; planting with fertilization before the fact, during the fact and after the fact.

Another subject that affects us is the problem of allelopathy, the toxicity or inhibiting factors of one plant on another. This problem is not new in literature, but it is new to us. At the present time there's only one book on the subject in the English language. Not only are these items problems in themselves, their interrelationships compound our problems.

For instance, we know that some seeds are allelopathic in the absence of micro organisms. We also know that the presence of fescue grass inhibits the germination of some pine seeds. We know that crownvetch inhibits new root growth of year old Red Oak seedlings. The allelopathic role is still not completely understood, but some substances have been identified that apparently are inhibiting agents. One of these is in the realm of phenolic compounds. Interestingly, our research geologist in Berea highly suspects the presence of some phenolic compounds in some spoils that he has analyzed. It is noteworthy to add that the difference between allelopathy and competition is difficult to separate scientifically. These factors that we've just talked about form the basis of our tree planting research in western Kentucky.

The first of our recent plantations was established in 1976 with the cooperation of the Pittsburgh and Midway Mining Company. This study and a subsequent study established in 1977 are much the same. Now we have more variables than we had seasons to plant, so we made up. We used Black Walnut, White Ash, Green Ash, Sycamore, Sweet Gum, Cottonwood, White Oak and Yellow Poplar. We wanted to test some of the seedlings that we've had good luck with in the past and some that we've had back luck with in the past. We also wanted to test tree-grass competition at the same time so we used control plots, fertilizer only plots, fertilizer and legumes, and fertilizer with grass. And we also used nurse trees as a nitrogen fixer. We used Black Locust, European Black Olive, and we also used both. We substituted for both in 1977. We used Autumn Olive which is also an excellent nitrogen fixer. And of course we had a control of none. We used hardwood bark mulch, with control trees with no mulch and, of course, trees with mulch.

The 1977 study was installed to check the differences in planting years and the possible consequences of different weather conditions. Following the 1976 planting we had an extremely long dry spell, about 6 weeks. We expected the worst. The spring of 1977 was more nearly normal than that of 1976 and we expected better. But you never get what you expect especially in silviculture.

In our study established in 1976 on the P & M land we used White Ash, 1-0 stock and 2-0 stock. We used 2-0 Black Walnut stock. I've never seen such huge 2-0 stock in all my life. No wonder they wanted to get rid of it; they knew they couldn't

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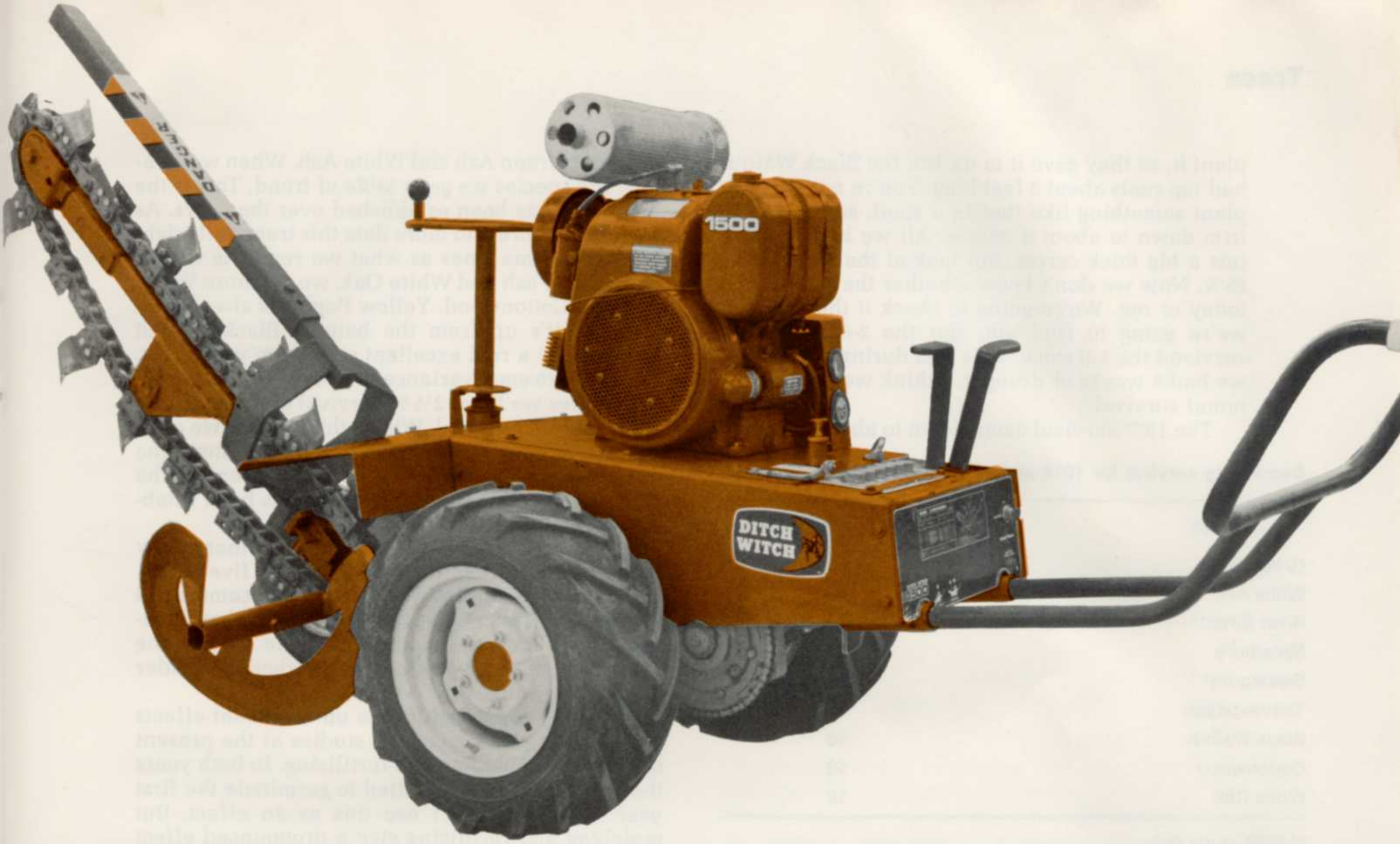
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plant it, so they gave it to us. But the Black Walnut had tap roots about 3 feet long. You're not about to plant something like that in a spoil, so we had to trim down to about 6 inches. All we had left was just a big thick carrot. But look at the survival — 65%. Now we don't know whether that holds true today or not. We're going to check it this fall and we're going to find out. But the 2-0 stock out-survived the 1-0 stock. This was during a year that we had 6 weeks of drought. I think we had exceptional survival.

The 1977 survival came down to about the same

Combining survival for 1976 and 77 begins to show a trend:

Species	Percent Survival
Green Ash	53
White Ash	42
River Birch**	39
Sycamore	20
Sweetgum*	20
Yellow-poplar	17
Black Walnut	16
Cottonwood	16
White Oak	12

**1976 study only
*1977 study only

again for Green Ash and White Ash. When we combine the species we get a table of trend. This is the trend that has been established over the years. As we look at more and more data this trend falls right along the same lines as what we read. As we get more green ash and White Oak, we get more White Ash and Cottonwood. Yellow Poplar is always, not last, but it's up from the bottom. Black Walnut seems to be a real excellent species to work with. We get extreme variance in our Black Walnut. Sometimes we'll get 2½% survival and sometimes we'll get 65% survival. Why is this? Again, we can't give an answer because we don't even know the questions yet. As we will note from observing the previous survival count, the trend has been established.

Recent studies by Willis Vogle and others show that Sycamore dies back after about five years. Some people's studies will show that Sycamore did real good. Most of the time we found that Sycamore died back and would just come back in the same root stock year after year. Either the leader dies or the entire stem dies.

The only meaningful data on treatment effects that we can glean from our studies at the present time are on mulching and fertilizing. In both years the grass and legumes failed to germinate the first year. So we couldn't use this as an effect. But mulching and fertilizing give a pronounced effect

Effects of mulching on survival:

Species	Percent Survival 1976 Mulched	Unmulched	1977 Mulched	Unmulched
Green Ash	48	44	68	44
White Ash	35	23	62	49
White Ash (2-0)	50	32	—	—
River Birch	42	35	—	—
Sycamore	13	14	30	24
Sweetgum	—	—	26	13
Black Walnut	52	43	8	3
Black Walnut (2-0)	70	60	—	—
White Oak	34	29	24	5
Cottonwood	33	27	6	4
Yellow-poplar	9	7	.4	.2
AVERAGE	38	30	28	18

on survival. In both 1976 and 1977 mulching the trees increased survival. In the 1976 and 1977 studies we mulched alternate trees in every row. Evidently mulching helped retain moisture and reduce micro-site temperatures because survival was increased for most species.

We used about a bushel of mulch for every tree. This is about 4 inches thick and reaches out to about 15 inches from the center of the pile or the seedling itself. In the earlier study of 1976 we had used about half this much mulch and, within a year, it had flattened out and almost deteriorated. We can go back to the ones where we used 4 inches of mulch and it does look substantial, even today.

Fertilization effects on species survival:

Species	Percent Survival 1976 Fertilized	Unfertilized	1977 Fertilized	Unfertilized
Green Ash	38	61	61	64
White Ash	26	46	62	63
Sycamore	14	16	29	35
Sweetgum	—	—	24	30
Black Walnut	43	54	6	13
White Oak	31	44	14	20
Cottonwood	25	38	5	5
Yellow-poplar	6	13	.5	.5
AVERAGE	26	39	50	56

Fertilization

We have found in the past that addition of nitrogen and phosphorous fertilizer has decreased survival. In some studies we have found this decrease to be significant. The decrease in survival, due to fertilizer, effects hardwood as well as pine seed. This effect has also been found on whole fields and forest sites as well as surface-mined lands.

Fertilizer rate was 400 pounds of 18-46-0 and 100 pounds of 0-0-60. In an early study on bush lespedeza, the decrease in survival was thought to be from the common phosphate. We found that dicalcium and triple-super phosphates significantly reduced survival. After studying data and survival results from the past several decades, we come to the conclusion that we haven't really increased survival over this period.

We have several thoughts along this line. One thought is that perhaps our planting crews are becoming less efficient. If the crewman is paid by the ceiling, his thoughts are on quantity rather than quality. If he gets paid by the hour and a minimum wage, he thinks he's just doing a job that's not very important. Since our desired end result is good reforestation, tree planting is a very important part of the total picture.

Another thought is of the conditions under which we plant with our present technology, expertise and species adaptation. These are becoming less conducive to survival than they were several decades ago. For instance, studies of 30 years ago showed evidence that survival was greater on ungraded spoil than on spoil compacted by grading machinery. Also, at that time, over-

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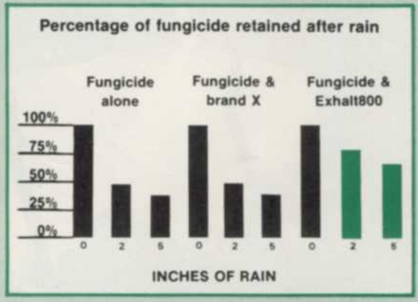
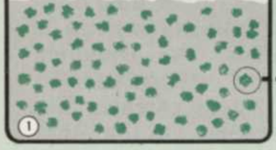


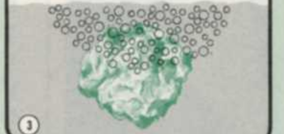
Chart shows how Exhalt800 resisted wash-off in a laboratory test. Spray coatings were applied to glass panels and dried 10 minutes at approximately 70° F. Retention after erosion by rain was measured by solvent stripping the panels and determining the residual fungicide by quantitative ultraviolet spectroscopy.

A closer look at Exhalt® 800 — the reason it works

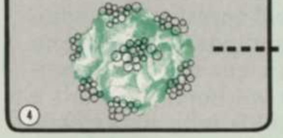


1) Microscopic particles of fungicide are suspended in water in spray tank.

2) One minute fungicide particle, greatly magnified. Countless millions of such particles in water become the spray solution.

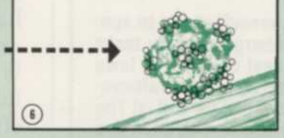


3) Exhalt800 liquid enters spray tank. Hydrophobic (repelled by water), it breaks into a myriad of tiny droplets and attaches to fungicide.



4) Tiny Exhalt800 droplets form a porous, flexible "fabric" that encapsulates each fungicide particle (enlarged to show detail).

5) Turf, when sprayed, becomes coated with millions of fungicide particles, each particle encapsulated within the porous "fabric" of Exhalt800 droplets.



6) Encapsulated fungicide particles on blade of grass (magnified portion). The Exhalt "fabric" around each particle is porous and flexible; it lets plant "breathe", flex and grow, releases fungicide slowly.

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Trees

burden removed was not as deep as it is now. Maybe our increase in expertise is just keeping pace with the increase in adverse spoil conditions, hence no net increase in seedling survival.

This spring, with the cooperation of AMAX Coal Company's Ayrgem and Pittsburgh and Midway's Colonial mines, we installed a study that's combined the old with the new. We plowed the planting areas with a disc harrow or chiselplow. We did use both the chiselplow and the disc harrow. We used the chisel plow on P & M Colonial Mine and we had to go with the disc harrow on the Ayrgem mine because there was old log grass that clogged the chisel up and lifted it right out of the ground after about 10 feet. We had to go to the disc harrow to get the job done. After we plowed it once, we plowed it again 90 degrees from the first direction. Then we called on our most experienced personnel to plant with planting hoes and a, I'd say relatively new in design, planting bar.

We also used our tractor with an auger operated from the power takeoff to mechanically dig the planting holes. Half of these holes was backfilled with spoil and the remaining half was backfilled with top soil from a forest. As nearly as possible we simulated the loose spoil conditions of yesterday, along with some of the planting methods, technology, and expertise of today. We did have some problems with the auger. We broke one universal joint and we broke one shear pin. What really gave us a problem was that the point on the end of the auger would hit a small rock right dead center. That rock wouldn't move and neither would the point.

We mulched every other row of trees with hardwood bark mulch and we did not fertilize. We used Black Walnut as a starting species because of its potentially high value and the trouble we've had with survival in the past. We also interplanted Autumn Olive as a nitrogen fixture.

In the past few years much work has been done and knowledge gained in successfully inoculating the seedlings with mycorrhiza. Most hardwoods have endomycorrhizal associates rather than ectomycorrhizal. The research of endomycorrhiza is much different, more difficult. The isolation, growth, inoculation, testing and reinoculation of species is time consuming. Ectomycorrhiza has visible and collectible spore forms. On the other hand, most of the endomycorrhiza have no visible or collectible spore forms and is not evident on visible inspection of the roots.

Our microbiologist at Berea has been attempting to isolate endomycorrhiza from high value hardwoods grown in a natural forest in the nursery and on surface mine plantations. At present he is growing these associates in quantity for inoculation. In the spring of 1979 we hope to install a study in the western coal fields with hardwoods inoculated with different endomycorrhizal fungi. Our last study concerns planting methods. We have a hundred extra Black Walnut trees that we can sacrifice each year and study their roots for mycorrhiza and their tops for nutrient growth and the presence of essential nutrients and toxic elements. **WTT**

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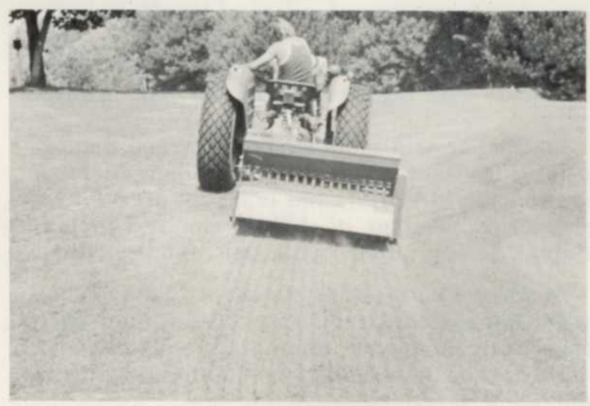
Twenty-one cultivars were planted in September 74. Varying management regimes were imposed to measure their competitiveness against the infestation of Poa annua.

They concluded: *"The most impressive differences among cultivars were observed under close mowing (0.75") and high fertilization (8 lb./N per 1000 sq. ft.). Several of the cultivars were virtually overrun by Annual bluegrass while others remained nearly weed free. Those cultivars which are apparently best adapted to this cultural intensity include A34, Brunswick and Touchdown".*

Touchdown fights Poa annua two ways: First — its superior disease resistance means it won't thin out from Crown rot (Leaf spot) Leaf rust, Stripe smut or today's Fusarium so Poa can't get a foothold . . . and secondly it's so aggressive and dense in growth habit it just keeps on fighting Poa.

Touchdown is ideal for overseeding . . . it germinates fast and quickly develops a healthy, mature turf.



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Alva P. Burkhalter, Ph.D.

Dr. Burkhalter is chief of the Bureau of Aquatic Plant Research and Control in Tallahassee, a division of the Florida Department of Natural Resources.

Burkhalter received his Ph.D. in plant physiology from Auburn University in 1970. His B.S. in forestry and M.S. in genetics were earned at the University of Georgia.

Burkhalter's latest research explores the use of the white amur for aquatic weed control in landlocked lakes used for irrigation. The exotic fish is banned in many states for fear of its effect on the ecological balance of the aquatic environment. Burkhalter thinks research on the fish will dispel such fears and legalize use of the fish in more states.

Burkhalter is a member of the Weed Science Society of America, the Aquatic Plant Management Society, (APMS), and is a past president of the Florida Chapter of APMS. Hobbies include hunting, fishing, guitar, banjo, golf, and basketball.

Aquatic Plant Management — the science, profession and the problems — is still in the early stages of development. Compared to childhood, it would now be in its rapidly expanding and growing adolescent years.

The science of Aquatic Plant Control has developed as branch or support function of many other major areas. Its earliest function was to assist commercial efforts by controlling plants that caused problems to navigation. From here it has expanded to other areas of concern — Fish and Wildlife, Public Health (Mosquito Control), agricultural irrigation and potable waters.

With the growing population of our nation and the increased emphasis on multiple usage of water, the aquatic plant managers of today must understand the various facets of aquatic plant control and how they differ, while at the same time relate to each other. This is becoming increasingly important because water used today for one purpose may be used tomorrow for another.

Aquatic plant problems are generally directly attributable to man's activities as he progresses. Man's increased mobility and world traveling have led to the introduction of exotic noxious aquatic plants that now plague many of our waterways. His pollution either from industrial, agricultural or domestic waste often provides excessive food stuff for their growth and mans designated usages of waters and conservation practices (navigation, irrigation, etc.) often mean that even the native plants that were heretofore no problem have subsequently become a problem in these types of waters.

Current trends in control necessitate that the aquatic plant manager of today be a "jack of all trades." Early aquatic plant control centers mainly on the use of machines of which similar methods are still used today. The most commonly used method of control at present is chemical, but rapid development is taking place in the area of biological control. Therefore, the managers of today must be part engineer, chemist, and biologist, and adapt rapidly as changes take place.

The nature of the problems are also rapidly changing. Early plant problems centered around floating and emergent species such as water hyacinth and alligatorweed, but submerged plants, such as Eurasian watermilfoil and hydrilla, are posing greater threats.

In summary, aquatic plant problems and control technology are rapidly changing, the future of aquatic plant management belongs to individuals who will do likewise.

Harry D. Niemczyk, Ph.D.

Dr. Niemczyk is Professor of Entomology for the Ohio Agricultural Research and Development Center in Wooster, a research facility of Ohio State University. He is also a consultant for Chem-Lawn Corp.

Niemczyk's research centers on insects of turf. Two examples of his research are the life cycle of the ataenius beetle and the characteristics of the winter grain mite. Both pests are not found on any registered pesticide label even though they can cause significant damage to turf. Niemczyk is working to collect information to make registration of pesticides for these minor pests more likely.

Niemczyk received his Ph.D. from Michigan State University. In 1974, he was presented with the Ohio Turfgrass Foundation Professional Excellence Award. He is a member of the Entomological Society of America, the American Society of Agronomy, the International Turfgrass Society, and the Ohio Turfgrass Foundation.

An ardent fisherman, Niemczyk often returns to Michigan with his wife and four children to fish for steelhead.

The single most significant event in turfgrass entomology was the labeling of DDT and later the chlorinated cyclodiene insecticides (aldrin, dieldrin, heptachlor, chlordane) for control of turf insects and, in the case of chlordane, crabgrass.