

Chairman Webster: Our next topic, which is vital to the operation of all nurseries, is "Weed Control." It will be presented by James W. Augenstein, Nurseryman from Savenac Nursery, Region 1.

WEED CONTROL
by
James W. Augenstein

Weed control has undoubtedly been the most costly project in tree nurseries in past years. Hand weeding and cultivation has been the sole means of controlling weeds. In nurseries where drill sowing was possible, power cultivation helped minimize the cost; however, broadcast sowing and hand transplanting made power cultivation impossible.

Before the C.C.C. days in 1933, there were very few tree nurseries throughout the United States, and these few were operating on low production schedules compared to present schedules. Many tree nurseries, however, mushroomed when the C.C.C. program was initiated. The use of machinery was discouraged during the C.C.C. days because sufficient cheap labor was available to carry on all nursery projects. Inasmuch as the C.C.C. program was liquidated in 1942, and there was a shortage of labor after the war, those nurseries that remained in production found hand labor too costly and not sufficient to control the weeds. Neither was machinery available to do the job. This necessity was the mother of invention for many new methods of controlling weeds, thus initiating a new evolution in that phase of nursery practice.

Various herbicides were introduced during the war and early post-war years. These were grasped by nurserymen as means for a cheap control of weeds. Possibly the first of these that was introduced was common number one stove oil. Then came 2-4D and various other types of petroleum products known as Stanisol, Sovasel, Varsol, and other mineral spirits sold under numerous trade names. One of the latest herbicides introduced is the Iscoweed Killer. Through years of experimenting, some of these have proven successful and others have not.

2-4D, Burning, Cultivation and Iscoweed

The various 2-4D compounds sold on the market under trade names such as Weedmaster, Weedicide, Weed Killer, etc., were given a trial but proved unsatisfactory for weed control in tree nurseries. The 2-4D compounds are harmful to both conifer and hardwood seedlings. Considerable experimenting was done with this herbicide, but all in vain.

Other weed control methods that are being used are burning and power and hand cultivation. Inasmuch as the weed seeds usually germinate before the tree seeds, it is possible to go over the beds with a gasoline or bottle gas torch and burn the weeds off prior to the germination of the tree seeds. This method, it is understood, is being used successfully in controlling weeds in seed beds in British Columbia nurseries. This control method is only possible on pre-germinated seed beds and will not work on transplant beds. Cultivation, both hand and power, has been a means of reducing hand weeding, but does not eliminate it. Cultivation merely destroys part of the weeds between the rows of trees, and hand weeding is necessary around the trees.

One of the latest chemicals to be placed on the market for weed control is the "Isco AA Weed Killer" produced by the Innis, Speiden & Co., Yonkers, N.Y. Applied as a drench 7 to 10 days before sowing, it will kill the weed seed as well as any weeds that may be present. Iscoweed is also recommended as a fungicide for controlling damping off. There are two objections the writer has found to its use:

(1) It must be applied at least one week before sowing, and (2) Extreme care is advised in handling concentrated solutions, inasmuch as it is a lachrymator, is inflammable, and the liquid can readily be absorbed through the skin.

The writer treated a small plot with Iscoweed in 1948. It proved very successful as a weed killer and was not harmful to the tree seeds or seedlings when they germinated. Iscoweed may prove very beneficial as a weed control for first year seed beds since oil sprays are not too satisfactory for very young seedlings. More extensive tests are planned at the Savenac Nursery for 1949. The writer does not feel qualified to report very extensively on Iscoweed since tests thus far have been limited and have only proven that it has possibilities. The costs per acre for treating with Iscoweed are not at hand.

Oil Sprays

Oil sprays were first introduced to tree nurserymen in 1942 on the Emergency Rubber Project. The Hardie Oil Co. of California was conducting experiments with common number one stove oil for controlling weeds in carrot fields. Nurseryman B.J. Abrahams became interested in these experiments and started tests of his own. Within two months from the time Mr. Abrahams' tests were first started, equipment was purchased, and oil spray was put to use as a control of weeds in the Guayule nurseries and proved very satisfactory. Various petroleum companies, as well as numerous nurserymen operating tree nurseries, started experimenting with oil sprays in 1944 and 1945, and they are rapidly becoming a standard nursery tool.

It will be noted that stove oil is emphasized more in this report than the other oils because the writer has experimented more with it and feels that stove oil is superior to the other oils.

1. Materials Used

There are various oils that are proving to be satisfactory for controlling weeds in tree nurseries. Most commercial experimenting with oil sprays for weed control has been done on farm crops and not on conifer or deciduous seedlings. Various oil companies have introduced numerous oil weed sprays on the market under trade names such as Varsol, Stanisol, Sohio Weed Killer and Sovasol. Besides these, number one stove oil and deisel oil have been used very successfully. Past tests have indicated a naphthenic oil containing a high percentage of aromatic hydrocarbons is best suited. To a nurseryman these standards mean nothing. It is hoped that some simple test can be discovered before another field season, so that each lot of oil can be tested before using. Each refinery apparently produces a slightly different grade of oil. The various oils afford a variety of results.

2. Method of Application

Not enough emphasis has been placed on application of oil sprays. Poor results have been connected with the material used and rate of application. Spotty results were achieved on both the Guayule project and at the Savenac Nursery regardless of the concentration used. In 1947, at Savenac, emphasis was placed on methods of application, and the rate of kill moved up from 70% to 99%. As long as certain methods of application were followed in 1948, a constant kill of 99% was received.

It has been indicated that as long as straight oil is used, it can be applied with most any kind of a sprayer. The writer does not feel that this is true if a maximum kill is expected. An absolute fog has proved more satisfactory than a coarse spray. This also saves material. Small hand sprayers should not be depended upon as the results are not always constant, thus giving a false impression.

Power spray machines are best suited for oil spraying and will pay for themselves in one year. Any type power sprayer that will produce 300 to 600 pound pressure can be adapted for applying oil sprays.

Two or three sets of booms can be attached to the spray machine so that one, two, or three beds can be sprayed at the same time. The number of booms will be determined by the size of pump on the spray machine.

Fan type nozzles have been used most extensively in past experiments, however, were discarded at Savenac in 1948 for the "Iron Age" round type nozzles. It has been impossible to find a fan shaped nozzle that did not throw heavier spray at the edge of the fan than at the center. The round type nozzle with whirl discs throws a finer spray thus using less material. Best results have been obtained at Savenac with two spray booms in tandem. The front boom was fitted with five No. 2 nozzles, spaced 14 inches apart, and the rear boom with six No. 3 nozzles, also spaced 14 inches apart. The nozzles were spaced so that each spray overlapped one-half thus giving a double coverage from each boom. In case one nozzle plugs, the second boom applies enough spray so all areas are covered assuring a complete kill.

There are numerous types of nozzles on the market. One of the latest developments is the jet type atomizing nozzle. This nozzle produces an absolute fog. The jet nozzle is manufactured by the Spraying Systems Co., 4021 Lake St., Chicago 24, Illinois.

When stove oil is mixed with water, it must be kept in an emulsion. This is easily accomplished by adding from one to two pints of neutral liquid soap to 200 gallons of spray. The spray tank must also be fitted with agitators. The soap and agitators are not necessary when pure oil such as Stanisol is applied. These lighter oils have also been applied in a water mix at various nurseries, but the writer has not learned if it is advisable.

3. Rate of Application

It is difficult to set a certain rate of application that will fit all nurseries. There are various elements such as climatic conditions and type of weeds which determine the rate of application needed for each nursery. Tests are necessary to determine the proper rate for each nursery.

Past experience indicates a mixture of one gallon of number one stove oil to three gallons of water is best suited for killing most weeds. This solution, when applied with eleven nozzles, as mentioned above, at 300 lbs. pressure and traveling over the bed at approximately one mile per hour will apply from 240 to 280 gallons of emulsion per acre, or 60 to 70 gallons of oil per acre. Various tests by nurserymen and oil companies throughout the country have recommended from 60 to 120 gallons per acre where the lighter undiluted oil, such as Varsol or Stanisol, is applied.

4. When to Apply

Oil has been a known killer of plant life for many years. Light applications of oil will kill young tender plants; however, a heavier application is required to kill a plant when it becomes woody. This is the answer to controlling weeds in the tree seedling beds. The young tree seedlings are more woody than the small weeds; thus if a light application of oil is applied, the weeds are killed without injuring the tree seedlings. The weeds should be sprayed shortly after they have germinated. Once the weeds have established a tap root, the leaves may die back when sprayed; however, the root remains alive and will send out new leaves. This is true with dandelion and clover. Frequent light applications are

less likely to cause injury to the trees than one heavy application.

There are varying reports as to the best time of day and climatic conditions for applying oil sprays. On the Guayule project and at Savenac, the writer has found a high temperature and a low humidity to be the ideal conditions. Some of the eastern nurseries have indicated best results were obtained on cloudy days. Apparently the best climatic conditions must be determined at each nursery. It was found at Savenac that overcast skies within two hours after spraying will cause the tips of the needles on the trees to turn brown and die and usually an irregular kill results on the weeds. The ideal time for spraying at Savenac is between 10:00 A.M. and 3:00 P.M. The areas to be oil sprayed should not be sprinkled or irrigated immediately prior to the oil treatment. The ground surface should be slightly on the dry side.

5. Effects on Weeds

Within a few minutes after spraying, the weeds take on a very dark green transparent appearance similar to a plant that has been frozen. On a good hot day, the plants will turn a tan color the first day. They completely dry up the second day.

Weeds with a pubescent covering are more difficult to kill. The weed known as ground coli, belonging to the Senecio family, has a pubescent covering and is very hard to kill with oil. The various weeds such as pigweed, lamb's quarter, sand spray and small grasses are easily killed. Grasses that start in the fall should be sprayed as soon as they germinate. By spring they will have developed a heavy root system and will be difficult to kill. Again, each nursery must work out standards best suited to fit the kind of weeds they have to combat.

6. Effects on Tree Species

The writer has experimented solely with oil sprays on conifer beds so is unable to offer any suggestions as to what can be expected in this type of weed control in deciduous seedlings. As mentioned above, the tree seedlings are more woody than the weed seedlings so are less likely to be injured by the light applications of oil. All past experiments at Savenac indicate oil spray is injurious to 1-0 conifer seedlings if sprayed within one month after complete germination. As the 1-0 seedlings become more woody, the larger species such as *Pinus ponderosa* and *Pinus monticola* can be sprayed without injury. It is not advisable to spray 1-0 *Picea Engelmanni*, 1-0 *Thuja plicata*, or 1-0 *Pseudotsuga taxifolia*. The following species have been successfully sprayed at Savenac:

2-1 and 2-2 *Pseudotsuga taxifolia*, *Picea Engelmanni*, and *Thuja plicata*; 1-0, 1-1, and 1-2 *Pinus ponderosa*; and 1-0, 2-0, 2-1, and 2-2 *Pinus monticola*.

The large transplant stock is not easily killed by oil spray; however, too heavy an application may cause a defoliation which will retard the growth of the tree. This is more true with one species than another.

It is very doubtful if 1-0 deciduous seedlings would withstand the oil spray. It is very likely though that deciduous transplants could be sprayed providing the spray nozzles are carried below the leafy crown so that very little oil is sprayed directly on the leaves.

An overdose of oil spray will cause the conifer needles to turn brown within two days after spraying. Occasionally only the tips of the needles will become brown. These injured seedlings will usually stay dormant until the following spring when they will put out new needles. It is suggested that extreme care be

used when spraying 1-0 or 2-0 seedlings until favorable results have been obtained.

7. Costs

The costs of controlling weeds in conifer transplant beds at Savenac with oil sprays will average between \$30.00 to \$40.00 per acre. This allows for two sprayings per growing season which is usually sufficient to keep them free of weeds. Hand weeding and cultivating will cost between \$400 and \$500 per acre for the same period. Practically no hand weeding was necessary in this year's transplant beds. Oil spray gave a 99% control.

Inasmuch as weeds do not get a chance to go to seed when sprayed with oil, eventually the need for spraying will be minimized due to a smaller crop of weeds. The present price of number one stove oil at Savenac is 19¢ per gallon. The price of Stanisol, Varsol and Sovasol is not known, but undoubtedly is higher than stove oil. This is one reason why stove oil has continued to be used at Savenac in preference to the lighter oils.

Experiments carried on at Savenac for the past four years have proven two things in regard to successfully controlling weeds with oil sprays:

(1) The method of application is possibly the most outstanding factor in securing a 100% kill.

(2) The next important factor is the ideal climatic condition just before, during and after the spray is applied.

Once these factors are determined, weeds will no longer be a problem in tree culture.

Augenstein: What about burning of beds prior to germination for the purpose of weeding?

McWilliams: We do not have to transplant. We sow our seeds in the beds. We use Hock burners to burn weeds that are germinated before seedlings are up. We used a torch on a trailer pulled by a tractor. It has a fan-type nozzle and in this way burns the beds.

Question: How fast does this cover the bed? Answer: Two or three miles per hour.

Augenstein: We tried burning beds with a burning torch, but results were poor. You are apt to cook the seed as well as the weeds.

Lanquist: In the treatment of oil spray, is it the oil spray or the lack of oxygen that kills the weeds? How does the oil kill?

Augenstein: On leaves that have fine hairs on them, we find that the oil does not kill as it does not reach the leaf. I do not think it is the smothering effect. I think it is the burning effect. Have never seen anything on this subject. The Shell Oil Company says oil is a killer because it will kill anything by putting it on a small plant. The oil will not kill a larger plant.

Rindt: If it is solution we would get a more uniform kill. It appears that a variation of different types of oil were tried.

Augenstein: What happens to the soil? We had a dozen pathologists going over the soil on the Guayule project. The question came up whether an accumulation of oil would cause the soil to go dead. They proved that oil in large amounts over long periods of time would change the nitrogen compound in the soil. In small amounts it is not dangerous.

Lanquist: Isco AA has been used in Mt. Shasta Nursery. I got a barrel of it from New Jersey and put it on. I spent only \$60 for weeding that summer. It killed all the weeds and I think it killed all the weed seed. That cost \$18 or \$20 an acre. It is like magic.

Augenstein: What is the price? Answer: 40 cents a pound liquid. We used gas masks to put it on.

Augenstein: It has possibilities for 1-0 seedlings. I saw tests with Stanisol that did show harmful effects.

Chairman Webster: How do you apply Isco AA? Answer: We mix it with water and drench the soil. The more water, the deeper the kill.

McDermitt: I have a letter from the company stating that they cannot sell it; they have lost interest in it.

Lanquist: I also had a letter from the company saying they cannot sell it, but would supply our needs.

Question: What kind of chemical is it? Augenstein: Alcal alcohol.

Question: How long does it stay on the ground? Answer: It has to be applied from 7 to 10 days before seed beds are put in.

Lanquist: I tried it on weed seeds and it killed everything.

Augenstein: It kills grass and will kill anything.

Rindt: In the letter they state they were not allowed to put it out as it is dangerous. It bears some investigation. (Isco AA weed killer) The secret of oil spray is to have a fog rather than needle point spray as that could be harmful.

Chairman Webster: Can you see any difference in the use of oil spray on pine and fir? Answer: A fir leaf is a lighter green and there is no effect on the seedling so far as killing the leaf is concerned. We noticed some defoliation on a few apparently due to the shading and denseness. But that comes back the next spring. This is in transplant stock. We figured we saved \$35,000 over the cost of hand weeding. We have a lot to learn in the use of soil spraying, etc.

Rindt: I believe it would be worth while for us to try and find out how oil sprays kill.

Augenstein: We would find out whether to use lighter oils. Is there a research agency that would do this for us? A fellow from California Standard Oil asked to send us five gallons of weed killer. I wrote back in favor of it, and inquired about cost. He plans a trip through the Northwest and would stop in to see us in February. He may know as he is with California Research. We might be able to get information from him.

Chairman Webster: What brand of stove oil do you use in the nursery?

Augenstein: Just any brand. We buy from the Shell Oil Company. There must be some way to find out what is best suited for weed killing. It should not take more than a day or so to get a test.

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Further discussion on the problem of weed killer.

McDermitt: We use Sinox each year, for the first crop of weeds. It is applied after sowing seed and before the trees come up. Spray $2\frac{1}{2}$ gallons to a bed of 250 feet.

Augenstein: Does it kill the seed or the entire plant? Answer: The plant. The weeds come up before tree seed does and in this way you get most of the weeds. We have a problem with grass. It comes up in the fall. There is farm land all around the nursery and seed will blow in rather than seed that is left in from year to year. We till with rototiller for some weeding.

Chairman Webster: Do you know what percentage of your nursery cost is for weeding?

McDermitt: I think not much over 15 or 20 percent for actual weeding. We have the mechanical weeder. The most of the weeds are taken out that way and saves 50% of weeding costs. But it has to be used when the soil is dry. In the fall when it rains, the grass starts coming and it is almost impossible to keep it out.

Chairman Webster: To go back to oil spray. Because of possible damage to 1-0 stock you favor the use of oil spray primarily on 2-0 stock. Is that correct?

Augenstein: Yes. It is not the fact that 1-0 is smaller stock, but because the trees are very succulent. The more succulent the easier it is to kill with oil. How large does Douglas fir get in the first year?

Chairman Webster: About 4 inches in our west side nurseries which produce 2-0 stock and 6 to 8 inches in the nursery producing 1-0 stock.

Deffenbacher: We used Stoddard solvent for weed control and irrigated with overhead sprinkler system for $\frac{1}{2}$ hour before and $\frac{1}{2}$ hour after application of the solvent and secured from 60% to 90% weed kill. This method was successful for 1-0 Douglas fir, Ponderosa pine, Port Orford cedar, and Sitka spruce; also for 2-0 Douglas fir, Sitka spruce, Noble fir, and Port Orford cedar. Application of solvent on dry beds was unsuccessful. There was excessive injury to the seedlings.

Schroeder: Why does one oil work one way and another does it another way? Can some committee get in touch with a research Laboratory and work out more of this type of information?

Rindt: I think if we take action as a group representing a number of nurseries, the Research organization would be more apt to pick it up. These are some of the things that should come out of the meeting.

Chairman Webster: Thank you, Jim, for your excellent contribution on weed control measures. Our next topic is devoted to nursery irrigation and will be presented by Walter Engstrom.