Forest Management for Small Landowners

Site Preparation

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2020

Site Preparation

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By the 1860s mills had been established in the Pacific Northwest and loggers were vigorously cutting timber to supply the growing economy. At that time no one considered site preparation or planting. Nature had regenerated the land for thousands of years with very little vegetative competition and it did the job for those loggers of the 1860s. At that time the surrounding trees were 300 to 1000 years old, and they produced heavier seed crops than many of the younger trees we raise and harvest today. Few of what we call weed species were around to seed into the logging units and out-compete the natural tree seedlings. But by the mid-20th century, this had changed and many weed species competed with tree seedlings after logging.

5-year-old plantation with very few seedlings surviving

6-year-old plantation with approximately 20% of the original planted seedlings left

In the 1970s, site preparation to aid seedling survival was done with large D-7 and D-8 dozers with a scarification blade (more like a rake to allow soil to sift through the openings). It became a game of who could get the ground the cleanest. One of the byproducts of this kind of scarification was all the fluffed-up soil that made planting trees very easy in many kinds of soils.

By the 1980s we had transitioned into smaller and lighter dozers of the D-4 to D-6 size range. The “old-growth forest” of the Pacific Northwest had mostly been logged and companies were rapidly moving into plantation management. With the end of the older timber stands went the end of huge amounts of logging slash, which led to less need for mechanical site preparation and broadcast burning. However, the resulting increase in vegetative competition required more use of chemical site preparation.

Very few landowners scarify now, or even use a logging shovel to pile unless the brush is very heavy. The few who do it are mostly small landowners who want to intensively manage their land, and landowners like me who want to be able to walk across logged units without falling all the time! One exception to the above would be where Washington State requires clean-up of logging debris along county and state highways and near structures to reduce fire hazard.

Mechanical Site Preparation

Logging Shovel

Shovel piling

In today's world most of the logging is done with a logging shovel and most mechanical site preparation is done by the shovel during the yarding process or before the operator leaves the site. Many of the loggers have an attachment they can easily install on the shovel grapples that gives them a much wider tool for scarification. Think of an oversize rake, 3-5 feet wide and 3-4 feet in height, with a thumb device that can come down and hold a bunch of logging debris tightly against the rake. The operator will normally lift up the bunched debris and drop it to let the dirt sift out. This can be done several times if the debris is dirty. After sifting the dirt, the excavator throws the load up on the pile. Piles can easily be made twice as high as with a dozer and will burn down much faster due to lack of dirt.

Detachable scarification rake

Dirt is the downfall of any mechanical scarification process. Any dirt left in the pile acts like a sponge, soaking up the moisture and in turn saturating the limbs and debris in the pile. The Washington Department of Natural Resources will want the piles to burn down to nothing in a short time, sometimes in just a few days. You can do this with piles built by a logging shovel.

Soil scientists tell us that we need to leave as much of the logging debris as possible, as a future soil base for the next generation of seedlings. This is easy to sell to large forest landowners because they don't want to spend any more than necessary on the establishment of the next stand. However, many small forest landowners like to use their dozer to do the piling, and many want the site clean enough to easily walk through.

Dozer Piling

If you have a dozer and want to do your own scarification after logging, then be sure it is large enough to do the job. The Caterpillar D-4, John Deere JD-550, or mini excavator are about the smallest you will want to use. With anything smaller, the process causes very hard wear and tear on the machine. The second thing needed is a scarification rake. You can get one to replace the regular blade or, more commonly, use what is referred to as a slip-on blade. This fits in front of the solid blade with raking teeth that

protrude below the main blade, and a protective screen that fits above the main blade to help protect the operator. Additionally, you will want some form of screening around the cab to help prevent limbs and small treetops from jill-poking the operator. Don't skimp on protective screening! The equipment operator can be pushing a pile of limbs and looking to the right when a long branch or log comes in from the left. It will happen so fast the operator will likely be unable to react fast enough to prevent severe injury.

We logged 16 acres in the spring of 2018, and I scarified the unit that summer. I had protective screening on the sides and rear of the dozer cab but didn't want to look through a screen out the front so did not cover it.
As I worked one morning, something came flying out of the pile I was pushing and hit me in the eyebrow. It was fast and small enough that I only sensed it was coming. I started to duck when it hit me hard enough to knock me back into the seat and almost knocked me out. It took a little while to bring myself out of a semi-conscious situation, stop the dozer, and determine what had happened. After 4 internal and 9 external stitches and a week of down time, I was back at work. Now I have a piece of Lexan plastic installed as a windshield!

Shovel Piling

Most logging contractors will have an excavator that they can use to pile your logging debris if you want it piled.

If you own forest land and are thinking of purchasing a dozer for scarification, then you may want to think twice about the decision. It is almost impossible to pile logging debris without picking up topsoil. Especially if the soil or the debris is wet. Dirt in your pile means several things:

1. The soil in your piles gets wet (rain) and acts like a sponge to all the woody debris in your piles. Again, it will be harder to burn and create more smoke.
2. The longer the DNR and your local County wait to declare an end to restricted burning, then the longer it takes to get the pile(s) to burn.
3. Wet piles mean more smoke, more smoke means unhappy neighbors and the public.

Other concerns include:

- Don't let your logger build the debris pile on top of old stumps. The older the stump, the more rotten wood that will continue to burn, even for several months and in some cases into the winter season.
- Don't build your piles near a road or your unit boundaries. When the piles are burning the heat from the fire will carry embers down wind. The hotter the fire the higher the embers will travel

- In 2021 while burning piles in a 15 acre unit I was surprised by how far some embers traveled with very little wind and not that aggressive of a fire. The County made us wait until there was no chance of a secondary fire before allowing us to light our piles. Due to the delay, our piles were wet, put up a lot of smoke and did not burn all that hot. Yet with a slight wind, the embers were carried to a rotten old growth stump, full of pitch, that I had left it along the road 100 yards from any of the piles. 100 yards was not enough!

Scarification Process

1997 JD-550A dozer with winch

1997 JD-550A dozer with scarification rake

Ideally the operator will rake the logging debris with the rake teeth as shallow as possible to prevent dirt from entering the pile -- an almost impossible task with uneven ground. Even the flattest ground is made uneven by the stumps and roots left after logging. With a dozer there are two ways to keep as much dirt as possible out of the pile:

1. Roll the debris pile as it is pushed into the main pile.
2. Roll the main pile as more debris is added to it. If the main pile can't be rolled, then lift it up and let it settle (*another reason for a larger dozer*).

I am one of those who likes to do my own scarification. I can't afford to buy a logging shovel for the every-other-year logging I do, so I have a JD-550 dozer. Also, I really do enjoy building piles! This job is no different than any other -- some people will enjoy doing it while others would never entertain the thought. When I burn my piles, the DNR wants them to be out in 2 days, which is impossible if the piles are full of dirt. Since I know the dozer piles will have some dirt in them, I hire the logging shovel to re-pile my piles or windrows. A shovel can sit in the middle of 3-5 piles and re-pile them into one clean pile in a fraction of the time (*and cost*) it would be to have them do the entire job from scratch. I get the joy of doing my own scarification and they polish my job so the piles will burn better than any dozer-built piles will burn.

All of this has been said as if you are going to pile and burn your post-logging debris. However, another approach is just to scatter the logging debris without building piles. This will create planting spots but will not make it any easier to walk through the young plantation for future spraying or land exams.

I am a classic example of someone who goes overboard to do a simple job. It is not necessary to re-pile each burning pile by hand just to get every chunk of wood burned. Yet I enjoy doing it and I really enjoy being able to walk across the ground in later years without falling. I have a knee injury from Vietnam and now a replacement knee, but it still is not as good as a healthy knee, so I still tend to fall in uneven ground or in a unit with lots of logging slash.

Shovel re-piling 3 dozer piles into 1 large pile

These are not things that forest landowners can afford to do if they are still working for a living, but they are excellent retirement exercise (*and hopefully something you enjoy doing*).

Broadcast Burning

Broadcast burning 100% of a unit is almost a thing of the past for both large and small landowners in western Washington because of the Federal Clean Air Act and other regulations. Even if you could do it, there are no crews available to light the fire, drive water tankers, and be on hand to put it out! However, it is likely that burning will increase on the east side of Washington where they can do controlled ground burning in winter for hazard reduction.

Chemical Site Preparation

Introduction (*Chapter 9, "Plant Competition") has more information on spraying*)
If you were to ask, "what is the most important thing I can do to ensure my planted seedlings make it to harvest, and I have a good to better chance of maximizing my yield," my answer would be to conduct a site preparation spray before or after you plant!

In some cases, you may need to do some later spot spraying, but in most cases no further chemical use will be needed.

If you follow my advice you will want to use chemicals that will kill the competition but not damage the seedlings to be planted, or that have been planted. There is no chemical prescription that fits all circumstances and situations. The best source of accurate information on what chemical to use is a chemical sales representative who specializes in forest land chemical use. They put in their own research plots to better learn just how low a dose the landowner can use and still have an effective spray operation. They are geared to helping people make the best decision for what they need at the lowest price possible. It may sound a bit unusual to say a private company wants to sell you something at less than what you think they will charge but it's true. With the

ongoing concern about chemical usage in all agricultural crops, it is in their best interest to make sure that their customers use chemicals at a safe level.

Also, remember the saying "Nature abhors a vacuum!" In other words, if you spray and kill everything, then nature will do all it can to re-introduce new weed seed into the site. As the chemical begins to break down (*generally by the end of the first summer*), new weed seed will be able to germinate and begin to fill in the site. If you are lucky, control will last for one growing season and sometimes there is partial control into the second year.

Why Do I Need to Do a Site Preparation Spray?

All too often tree farmers will say something like: "My father or grandfather logged this land and did not spray it so why should I need to do so now?"

One hundred years ago, logged land would regenerate naturally without site preparation spray. Now large areas have been converted to farmland or untended open space where competitive weed seed has become well established and spreads to adjacent forest land. It is almost impossible now to log in the lowlands and not have major competition develop on our newly logged land.

5-year-old failed plantation

Research on Raising Douglas-fir Seedlings with Chemical Site Preparation

- We know if the competition is too dense a newly planted seedling will be outcompeted for light, water, and nutrients. The result will be reduced growth or death of your newly planted seedlings.
- We also know if you can get a site 100% free of weed competition, the greatest amount of seedling growth will occur. However, almost all landowners and chemical salesmen are more into controlling the problem and not total removal. We also know from field studies that if we can keep the competition to 30% of the surrounding space, then we generally will get sufficient growth to outgrow the competition.
- We also know that if a good site preparation formula is used at the right time with good coverage of the logged unit, then that is often all that is needed to get the new stand started with minimal competition.
- Many of the forest chemicals we use today will act as inhibitors to seed germination of woody competitors like scotch broom, vine maple, and evergreen blackberry. It is very important to keep out the competition that will overtop the seedlings.

Even if you, the landowner, do not personally do any spraying, it would benefit you to take a Pesticide Licensing Course. In Washington State you will want the "Private

Applicator License". You will not need the Commercial or Consultant License. There is a lot of risk in using chemicals and the more you know the better protected you will be. Also, you will be libel for any accidents you or your operator have. Having a license will not relieve you of that responsibility, but it should help you to know and recognize when you or a contractor are doing something wrong.

If you do end up applying your own forest chemicals, there is no question about it – **you need to get your applicators license before you go any further**! There are too many rules, regulations, and potential pitfalls for a landowner to go into something like this without the proper knowledge and protection.

Mixing Chemicals

Always read the label of the chemical(s) you are using! Look for level of danger of the mixing and/or application process. In some cases, the chemicals are safer than the material they are dissolved in. Also read closely the personal protective clothing requirements.

Some chemicals will be in a water-based solution while others are dissolved in a petroleum product or vegetable oil. They will be packaged in different ways -- water solutions, powder, granular, slurry, and dissolved in a diesel-like mix.

- True Solutions
  Roundup (*glyphosate*) is an example of a chemical that when mixed in water goes into a true solution. It will stay in this condition until it is sprayed or evaporates. Your only concern is to use it up before it begins to break down. Glyphosate will be captured by organic material or compounds and be unavailable for the plant it is sprayed on if it is mixed in dirty water or left to sit more than a few days.

- Emulsion
  Some chemicals (*Garlon 4 [triclopyr]) is an example*] are dissolved in a petroleum product or a vegetable oil during the manufacturing process. These chemicals will not normally mix with water into a true solution and will separate into their individual components if allowed to sit too long. When they are mixed with water, they form an emulsion, which is a droplet of oil containing the chemical surrounded by a droplet of water. Any time you mix two ingredients together and the mix turns white, it is most likely an emulsion.

- Suspended Chemicals
  Some chemicals, like Atrazine (*atrazine*), may come in a slurry-like liquid formulation, or a powder like Oust (*sulfometuron*), Velpar (*hexazinone*) and powder formulations of Atrazine. None of these will go into a true liquid solution, but instead they go into a suspended state. As long as the chemical mix is properly agitated, the small amount of chemical will stay suspended. However, if a suspension mix is left overnight, the suspended chemical will settle to the bottom of the tank. This will normally create lots of problems getting the chemicals back off the tank bottom and

suspended again. When using any of the powder formulas, ask if it will go into a true solution state and if it won't, inquire about additives to help it stay in suspension.

Chemical mixing tips for powdered chemicals

1. Many chemicals such as Roundup will mix and go into a solution very easily. However, some of the site preparation chemicals will come in a powder, granular, or slurry form. For these you will need to take other actions to mix your chemical batch.
2. I pre-soak the chemical in a 5-gallon bucket with 1-to 2-gallons of water, then mix it into a slurry to put into the backpack sprayer and top it off with water.
3. Additionally, I use the additives to help keep the chemical suspended.
4. I also use a portable drill and mixing auger that can be purchased at paint stores. Be careful doing this as a lot of chemical and water can be thrown all over by operating the drill/auger at too high of a speed.
5. The mixing process for powders and slurries is not like water and Roundup that easily goes into solution. This process may take 10-30 minutes to get it mixed.
6. If the weather looks like I will be able to apply another backpack load, I will do step #1 and leave the slurry or powder to soak up as much water as possible while I am applying the first mixed load. When I come back for my next load, all of the chemical powder will easily go into its slurry/suspension mode.

Mixing equipment for a day at the tree farm

- Invert
  An invert solution is a drop of water containing the chemical, surrounded by a drop of oil. This type of mix will make a much thicker mix than the emulsion. If mixed wrong, it can be the thickness of toothpaste! It was used in the 1970s and 1980s but is rarely used now because of mixing difficulties. The advantage of this formulation was that the chemical could be sprayed during the dormant period when the individual droplet of oil surrounding a water droplet could dissolve its way through the waxy coating of bark, leaves and needles. Once inside the plant, the chemical could be translocated to the roots and bud tips.

Three Ways to Do a Site Preparation Spray

- The first way is to hire a helicopter company to do an aerial spray. This is the most effective for accurate ground coverage, but there are too few helicopter companies

available, and they are usually committed to spraying for the large companies. Also, small landowners don't have the knowledge to organize a helicopter operation and most often find they are left out of the process, partially because there are not enough helicopters, and secondly because of the spray window closing on them. Spray too soon or too late and the chemical efficacy is diminished or damage to seedlings results.

- The second way is to hire a ground crew to do a manual spray using a team of workers individually spraying the desired chemical formula. Some issues are:
    - Workers will walk at different speeds. If the formula is supposed to be 32 ounces active ingredient per acre of the desired chemical and some workers go faster than the calibration trial, then the actual "on-ground rate" may be 26 ounces. Or the actual "on-ground rate" may be 46 ounces if they go too slow. With 26 ounces there may not be enough chemical applied, allowing competitive vegetation to get started sooner than expected. With 46 ounces, there may be damage to newly planted seedlings depending on the type of chemical used and, at the very least, the landowner paid for excess chemical that was not needed.

Contract hand crew doing a site preparation spray after planting

    - The worker's paths won't cover all the ground. The worker's goal is to walk parallel to each other. But because of stumps or logging debris or plain carelessness, they may be 30 feet apart, then 20 feet, then 40 or 50 feet apart. In this case the landowner is likely paying by the acre but not all the unit gets treated. You will be able to see the untreated portions 1-2 months later.

    - If you hire a contractor, be sure that:
        - The contractor has a license to apply chemicals issued by the Washington Department of Agriculture.
        - The contractor has insurance and their carrier issues you a Certificate of Insurance.
        - You have a written contract with the contractor specifying what they will do.
- The third option is to do it yourself! Most landowners will take time to do the job right. If you are in good enough physical condition and have the time, this is a job you can do and save yourself a lot of money. The preferred hand method used is called "waving wand" and consultant foresters, extension foresters, or chemical representatives can provide more information than what follows.

Doing the Spray Treatment Yourself

- Read Chapter 9, "Plant Competition", for more about methods to hand spray, types of chemical formulations, and seasonal timing of doing a spray project.
- Get your license as mentioned above.
- Get a chemical prescription based on the competing plants you find on the unit.
- Acquire your chemical.
- Purchase a good quality sprayer. I like the 4 gallon "Wil Gro" brand that Wilbur-Ellis sells. It has a padded back that really does help when you are past retirement age.
- Calibrate the sprayer for each of the different types of spraying you intend to do. (*More on calibration follows.*)
    - Site preparation spray
    - Foliar release
    - Hand spot spray
- Get your paperwork lined up to record temperatures, humidity, wind speed and direction, and comments.
- Pick the days to do the spraying based on weather forecast and conditions.
- Triple rinse all empty containers at day's end and properly store your chemical out of reach of children.

Calibration

- It is essential to calibrate your equipment before spraying in order to know how much chemical to mix in your backpack sprayer.
- You will cover these same techniques in the Pesticide Licensing Course mentioned above.
- Mark out a known distance on a road or in your area to be sprayed. Use something simple like 100 feet or 200 feet.
- Assuming you are using the waving wand technique, put some water in your backpack, and practice spraying. Use a slight "U" shape of swing with the ends slightly upturned. If whatever direction you are traveling is 12 o'clock, then swing from 10 to 2 o'clock" on your arc. You don't want to bring the swing to your perpendicular left and right position. You want to be spraying in a straight line

that is perpendicular to your direction of travel and about 10 feet in front of you, with no bent edges headed back to you. (*See Waving Wand Technique" for nozzle adjustment*).

- Once you have your spraying technique and pattern down, then go to a new place on dry ground and spray the same spray pattern enough to allow you to put your backpack down and measure the length of your spray swath (*width as you spray and travel across the unit)*.
- Make sure your backpack is about ½ full and position yourself at your starting point. You are going to be timing how long in seconds it takes to walk and spray the designated spray strip. When you are doing this, watch your spray pattern for skips or gaps. You will not be able to do this in the field as you will be trying to stay on your line, not trip over debris, and concentrating on accuracy.
    - You can start at the "0" point of your line and end at the 100 or 200 foot mark, or
    - You can start prior to your starting point so that your first swing of the wand is spraying the "0" point of the swath and end the actual spray at the end of the swath.
    - I prefer to start at the "0" with the spray starting about 10 feet in front of me and end at the 200 foot mark with the spray about 10 feet in front of me. You decide what will work best for you.
- A stopwatch works best for the timing but a smart phone or having someone else timing also works (*Remember, you are timing in seconds, and it takes time to start a phone and put it away*.) Spray a swath and record in seconds. Turn around and spray back on your line, recording that time interval. Do this several times until you can spray the swath several times in a row at or near the same length of time.
- You now need to measure how much water you sprayed in your swath. Ideally you will have a 1-2 gallon measuring container, that measures in ounces (*If not, collect in a bucket and transfer into a smaller measuring container.*) Keep your backpack pumped and spray into the container for the average time it took you to walk the spray swath. Measure and record the ounces sprayed.
- Table 4-1 is an example of how to do the calculations to know how much chemical to put into your spray tank for the recommended dose of chemical. Table 4-2 is the same table but with blanks for you to fill in to do your own calculations.

Waving Wand Spraying – Equipment

- First check to be sure the spray tank is clean and will pump water with no leaks. After a long winter, hoses may crack from water left in the tank or parts may just fail. Find them before you mix a load of chemical!

- I use the GUNJET Spray Gun, made by Spraying Systems Company, Wheaten, IL. On their web page are several handle options, all with different descriptions than my older model (*Mine has 30 GUNJET on the handle and the numbers 30L.*) Chemical company representatives (*like Wilbur Ellis*) or farm stores that sell spraying supplies may be able to put you in touch with sources or vendors that sell Gunjets and nozzle tips. The Gunjet has two nozzles, 180 degrees apart that can be rotated with the option to use either one.

Gunjet nozzle

Straight stream breaking up

  - I use one nozzle tip that produces a straight stream for waving wand spray. The nozzle is a #1506. The numbers have changed in the past 30 years, but your vendor should be able to tell you the current identification numbers. If you are unable to get the above straight nozzle, then ask for one that will spray about 10-15 feet before it begins to break up.
  - The second nozzle tip produces a fan-shaped spray pattern about 2- to 3-feet wide for spraying over a seedling. I can walk and hold the handgun in a vertical position along my leg and spray over seedlings in the spring on foliar and site preparation projects. My nozzle for this is number 8004.
- If you use a GUNJET then remember to calibrate each nozzle, and not use the same spray mix for both nozzles – it's easy to forget! And write your calculation information down so the next time you will remember how much chemical you need to mix.

Waving Wand Technique

- Refer to the label and wear proper spray gear clothing.
- The nozzle tip needs to be adjusted so it is spraying about 10-15 feet in front of you. At about the 10-foot range it should begin to break-up, so the spray pattern is dispersed in an even pattern. Practice your technique on a dry road surface (*with water only*) to insure you are effectively spraying everything with no skips or gaps.
- The nozzle tip should be the same adjustment you used to calibrate. If not, then go back and re-calibrate to the setting you want to use.
- Start at one edge of the unit and walk across it at the same speed you did your calibration.

- When you reach the opposite side of the unit, turn and start back on a parallel line. Flag your center line or one edge of your spray swath to keep lines straight.
    - The center line works best for most people. You don't have to leave the center line to mark the spot and judging 30 feet (*center line to center line*) is relatively easy for most people.(Your spray swath may be different.)
    - Your other option is to mark your outside line (*the one you will come back on*) and then you only have to stay 15 feet from your flag line. The disadvantage to this is finding your center line again. It's amazing how a scuff mark will disappear when you walk back to it and are looking for it from a different direction!

Waving wand spray on an abandoned road

- Take extreme care to maintain your ground speed, waving wand speed, and distance between center lines!
    - Walk too fast and you under-spray the unit.
    - Walk too slow and you over-spray the unit.
    - Swing your spray wand too fast or slow and it will affect the chemical coverage.
    - You will have to walk around obstacles but try hard to get back on your parallel course. Do everything possible to eliminate skips.

This is a job that anyone can do with a little practice and look back on the job 2 months later with pride.

Look on the internet for report forms available from the Washington Department of Agriculture. You are required to record selected information daily and maintain records of your spraying activities.

1-2 months after a site preparation spray

New site prep on left; 2-year-old site preparation on right and foreground

Table 4-1: Example of Sprayer Calibration

Measure a distance in your plantation to be sprayed	**200 feet**
Measure time in seconds to spray the lineal length	**60 seconds**
Measure spray width	**30 feet**
Measure amount sprayed in ounces	***65 oz.**

*(After your trial spray run, spray into a measuring container for the same time period it took to spray the distance sprayed)

Calculation of gallons per acre sprayed per 4 gallon backpack sprayer

- Length (200 feet) X width (30 feet) = **6,000** sq. ft.
- 43,560 sq. ft. per ac. / **6,000** sq. ft. =1/**7.26** acre
- **65** oz. sprayed X **7.26** (*denominator of fraction of an acre)* = **471.9** oz. per ac. sprayed
- **471.9** oz. per ac. sprayed / 128 oz. per gallon = **3.69** gal. per ac. sprayed *(If you need to spray more gallons per acre, you need to walk slower, adjust your nozzle, or get a nozzle with a larger orifice.)*

Calculation of how much chemical to use in a 4-gallon sprayer

- In this example the chemical Westar, a mixture of sulfoneturon methyl (Oust) & hexazinone (Velpar), is being used at 1.5 pounds per acre or 24 dry ounces of chemical per acre.
- **4.0** gallons (*sprayer capacity*) / **3.69** gal. per ac. sprayed = **1.08** acres per full backpack load
- **1.5 lb.** chemical per acre to apply X **1.08** ac. per backpack = **1.62** pounds of Westar to put in each backpack load
- **1.62 lb**. of Westar X **16 oz./lb.** = **25.9 oz.** of Westar per backpack load

After doing the calibration process, if you change how fast you swing the wand back and forth, how fast or slow you walk, the width of the spray pattern, size of your nozzle, or the size of your backpack sprayer, then you will need to re-calibrate to correct the amount of chemical you are mixing in each load.

Table 4-2: Sprayer Calibration

Measure a distance in your plantation to be sprayed _____feet
Measure time in seconds to spray the lineal length _____seconds
Measure spray width _____feet
Measure amount sprayed in ounces _____oz.

Calculation of gallons per acre sprayed per 4 gallon backpack sprayer

- Length (_____ feet) X width (_____feet) = _____sq. ft.
- 43,560 sq. ft. per ac. / _____ sq. ft. =1/_____ acre
- _____ oz. sprayed X *denominator of "fraction of an acre*" _____ = _____oz. per ac. sprayed
- _____ oz. per ac. sprayed / 128 oz. per gallon = _____ gal. per ac. sprayed

Calculation of how much chemical to use in a 4-gallon sprayer

- **Need the rate of chemical to be applied per area (*dose*) _____ / acre
- _____gallons (*sprayer capacity*) / _____ gal. per ac. sprayed = _____ acres per full backpack load.
- _____ chemical per acre to apply X _____ ac. per backpack = _____ dry or liquid amount of chemical to put in each backpack load.

  ***The rate to apply per acre will be in dry or liquid ounces, pounds, quarts or pints per acre.*
  Dry Pounds = 16 oz. / dry pound
  Gallon = 128 liquid oz.
  Quart = 32 liquid oz.
  Pint = 16 liquid oz.

  If you change anything with your spray process:
  How fast you swing the wand back and forth.
  How fast you walk.
  The width of the spray pattern.
  The size of the nozzle.
  Increase or decrease the size of the sprayer, then You will need to repeat the calibration process.

Sources of Further Information

- The Washington Department of Agriculture teaches a two-day course that provides you with information you need to take your license exam.
- Washington Department of Natural Resources and Washington State University Extension Service offer a Forest Stewardship Coached Planning Course at various times and places around the state. Weed control is one of the topics covered.
- Chemical sales representatives are one of your best sources for honest and accurate information. They are geared to helping people make the best decision for what they need at the lowest price possible.

Chapter 9, "Plant Competition" has additional information on different release treatments