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Preliminary experiments on the destruction of tree stumps by various methods involving the use of chemicals and burning, indicate that the latter alone is cheap and effective. Chemical reagents of the type known to react with finely divided wood in the laboratory, were found to be unsatisfactory and costly when applied on stumps in the field. A burning process appeared to be the most practical and efficient method of destroying tree stumps. This involved the use of a stump burning outfit consisting of a heavy gauge, sheet iron, cylindrical furnace of suitable size equipped with a long draft pipe at the base and a chimney at the top. A power driven blower supplied the necessary draft to the furnace. Before placing the furnace over a stump, it was found advantageous to start the fire by using straw and wood scrap, waste crank-case oil, kerosene, or small amounts of certain chemical reagents.

It is hoped that the present memorandum, although preliminary in nature, may be of assistance to those who wish to make immediate application of the methods recommended herein.

Introduction

While investigating the effect of sulphur dioxide fumes on coniferous trees under controlled conditions in the vicinity of the Dominion Experimental Station at Summerland, B.C. in connection with the Trail Smelter Smoke Investigation, the writer was requested in the spring of 1931 to carry out some experiments on the destruction of tree stumps by chemicals and burning. The work discussed in this memorandum was carried out during part of April, May, and September, 1931 near the site of the sulphur dioxide fumigation experiments. The stumps available were those of yellow pine and douglas fir, about 2 feet to three feet in diameter and the age of the stumps varied from 8 to 15 years. The soil was dry, light, and sandy in character, since this part of the Okanagan Valley has a very low yearly precipitation.

The stumps selected for treatment were in all cases firm and free from cracks, fungus diseases, etc. The chemicals applied to the stumps were selected because of

their relative cheapness, since any effective method for the eradication of stumps must necessarily be governed by the cost of application of such a method. The burning of the stumps was carried out by means of a "stump burner" of very simple construction. This consisted of a cylindrical furnace of heavy gauge sheet iron three feet six inches in diameter and about six feet high, provided with a chimney at the top made from stove pipe and an opening near the bottom to which several lengths of galvanized iron pipe about nine inches in diameter could be attached. The burner could be operated with an air blast obtained from a blower of about one horse power. Electric power was available driving the blower in these experiments, but any suitable source of power may be used such as a small gasoline engine.

Effect of Chemicals

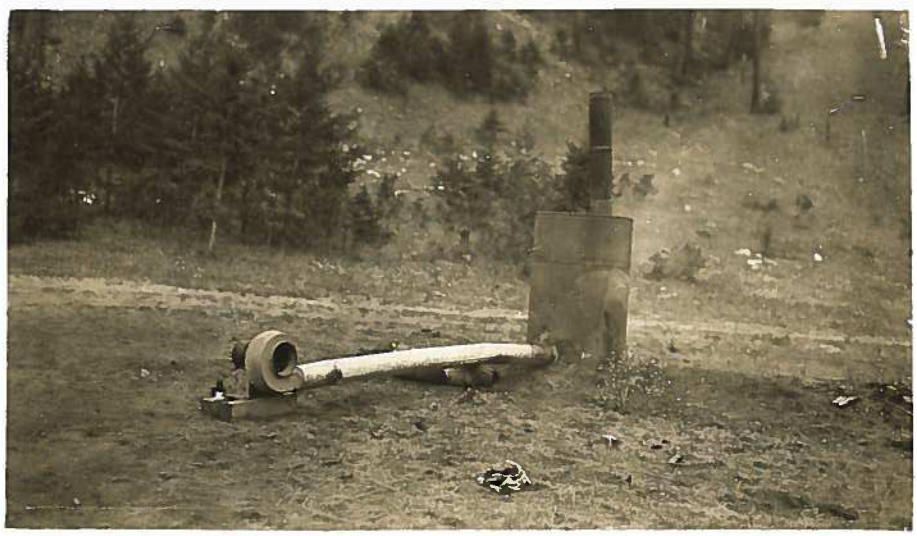
Various experiments were carried out using such chemicals as sulphuric acid, hydrochloric acid, alkali, nitric acid, sodium chlorate, sodium nitrate and others, but without obtaining results of practical value, since the application of the most effective chemical reagents was far too expensive and furthermore it was found that known reagents which actively disintegrate wood in a finely divided state in the laboratory, had little effect on solid stumps in the field. Of the chemicals investigated, nitric acid was found to be the most promising. The effect of this acid was to cause an immediate reaction with the wood, fumes of oxides of nitrogen being evolved. The wood was disintegrated to such an extent that a hole appeared in the stump and the wood surrounding this hole became soft and crumbled readily. Stumps treated with twenty pounds of this acid were burned about one week later by means of the stump burner using natural draft and were found to burn more readily than untreated stumps. The cost of application of twenty pounds of nitric acid would be at least $2.00. Nitric acid has the property of reacting completely with the wood and any quantity which would be likely to find its way into the soil would be present as nitrates or nitrites and actually fertilize the soil.

Effect of Improved Burning Methods

The various methods of burning stumps investigated, involved the use of forced draft and materials which acted as aids in the process of combustion, such as sodium nitrate, sodium chlorate, straw and crude oil, and also preliminary treatment of the stump with small amounts of dynamite or "stumping powder", the latter being a mixture

of sawdust and about 35% dynamite. It was found, as illustrated in the following selected experiments, that the most effective aid to the burning of stumps was a blast of about 200 cubic feet of air per minute. By means of the "stump burner" and this forced draft, stumps of douglas fir and yellow pine of the size encountered at Summerland, could be effectively burned in from two to four hours, whereas without the forced draft, the oil-treated stumps required from 14 to 18 hours to burn. The heat produced by the application of forced draft was so intense that the roots of the stumps were burned off for some distance below the ground, a hole being left. Stumps could be burned in this manner quite readily in rainy weather as well as during high winds.

The general procedure recommended for burning stumps is first to start the fire by any suitable means such as by igniting a mixture of straw and wood scrap heaped over the stump, pouring a little kerosene over the wood scrap placed around the stump, using waste oil and, if desired, other aids to combustion such as nitrate of soda or sodium chlorate. After starting the fire in this simple manner, the furnace is placed over the stump, the draft and chimney pipes attached and then the end of the draft pipe connected to the power driven blower. The forced draft causes the stump to burn vigorously. It is not always necessary to apply the air-blast throughout the time that the stump is burning since in most cases it will continue to burn without the forced draft after the stump has been partially consumed.



The following examples illustrate the methods employed in detail.

Example I - Straw, one gallon of crude oil, and two pounds of sodium nitrate were used to start the burning process, the sodium nitrate being put into holes drilled in the stump. The sheet iron stump furnace was then placed over the stump and a blast applied of from 200 to 250 cubic feet per minute. The stump burnt out in about three hours. A similarly treated stump was burnt by means of the stump burner but without the artificial draft and took fifteen hours to burn out. A similar experiment was carried out without using the stump burner, but oil and wood scrap were added every three hours to keep the fire going. The stump burned out in about 15 hours. The oil used in these experiments was waste crank-case oil which was obtained free at a garage.

Example II - A stump about 2 feet 6 inches in diameter was treated with two gallons of waste crank-case oil and the oil allowed to soak into the wood for two days. Two pounds of nitric acid were added just before ignition of the stump, a little more oil added, the latter was ignited and the sheet iron furnace placed over the burning stump. A blast of air was applied from the electrically driven blower. The stump burned out almost entirely in about two hours. A similarly treated stump took 12 hours to burn out in the stump furnace when an artificial blast was not applied.

Example III - One pound each of sodium chlorate and sodium nitrate were placed in holes drilled in a stump and the mixture ignited. After ten minutes, waste wood and about one gallon of oil were added and the stump furnace placed in position. By using a blast of about 250 cubic feet of air per minute, the stump burnt out in about four hours. A control stump, burned in the open, was only partially destroyed after burning for 18 hours.

Example IV - Two sticks of 35% dynamite ("stumping powder") were set off at the base of a stump and split the latter badly, opening up the base. One gallon of crude oil and waste wood were added and the mixture ignited. The stump burner was placed in position and a blast of air applied as above. This stump was completely destroyed in a few hours.

The 35% dynamite-sawdust mixture was found to be quite effective in blowing up small stumps, one stick of this dynamite being sufficient to effectively remove stumps less than one foot in diameter. Bearing in mind

that the method of using a sheet iron furnace with a blast of air as outlined above, burns most of the roots as well as the stump, it is probable if a cheap source of power is available that this method is preferable to that of blasting with dynamite (with its attendant dangers) in the clearing of land containing large tree stumps.

Costs

For clearing land containing about 100 fir and pine stumps to the acre, it is desirable to secure the removal of these at a cost of about $50.00 per acre, or 50 cents per stump. The use of chemicals which disintegrate the wood when used in large quantities, is immediately ruled out on grounds of expense, since, taking the case of nitric acid, if as little as ten pounds per stump were applied, this treatment alone would bring up the cost to over $1.00 per stump as it is doubtful if nitric acid could be obtained for less than 10 cents a pound bearing in mind transportation costs. To this must be added the subsequent expense involved in burning the treated stump. Large quantities of sodium nitrate at 4 cents per pound or sodium chlorate at 10 cents per pound merely serve to accelerate the process of burning and are not necessary when an artificial blast can be applied to the burning stump. Crude oil such as waste crank-case oil constitutes an effective aid to burning and is available at practically the cost of removal from garages, etc. No other additional costs except that of operating the type of equipment used herein, need therefore be considered.

The equipment consists of one or more cylindrical sheet iron furnaces containing a stove pipe chimney at the top and an opening at the side near the base for connecting several lengths of galvanized iron piping. Such a furnace can be built quite cheaply, one about 3 feet 6 inches in diameter and 6 feet high costing $10.00 to build. The main item of expense is the machinery necessary to provide the air blast. This consists of a blower or fan equipped with a belt drive and pulley, which could be run by a kerosene engine of suitable type such as "Type Z" engine of the Fairbanks-Morse Company. This is available in 1-1/2, 3, or 5 H.P. sizes at a cost of $86, $136 and $178 respectively. The same firm also supply the Canadian "B" volume blower at a cost of $33 for the one Horse Power size.

Since it is possible for one man to look after three of these stump furnaces at the same time and the blast of over 800 cubic feet per minute from the above, one H.P. blower is sufficient to supply forced draft to the three furnaces at one time by a suitable arrangement

of galvanized iron connecting pipes, the total expense of installing a unit of this type would be distributed as follows: -

3 Sheet-iron furnaces	$30.00
1 H.P. blower	33.00
1-1/2 H.P. Type "Z" engine	86.00
1 Hand truck for engine	25.00
Miscellaneous piping	10.00
	$184.00

The cost of gasoline or kerosene for operating this experiment would be about $1.00 per day. With three stump burners in operation it would be possible to destroy about 6 stumps per day of the type experimented with in this work. If the work of clearing land is undertaken by the owner of the farm himself, the labour charges may be left out of the consideration of costs. The expense of clearing land by this method would then depend entirely on the number of stumps per acre, which figure would vary considerably. Assuming an average of 100 stumps to the acre which is rather high for some timber areas, the operating cost would be about $17.00 per acre plus labour charges. If a man were employed to do the work at $3.00 per day the cost of clearing an acre field on this basis would be $68.00. For very large stumps of about six feet in diameter or over the cost would be considerably higher. Stumps of this size have not been experimented with by the writer. It is reasonable to believe that not all the stumps in a particular field would require this special treatment, some could be removed by burning using natural draft.

A burning method would seem to constitute the most practical means of removing very large douglas fir and cedar stumps such as are found in British Columbia on the Pacific coast. Blasting with dynamite or removal by means of a gas engine capstan puller or tractor puller is too costly in such cases. One of the best of the bulletins which have been issued by investigators in this work, is that of Bulletin 195 of the Oregon Agricultural College Experiment Station at Corvallis, Oregon, written by H.D. Scudder and entitled "Stump Land Reclamation in Oregon." There is here advocated for the removal of the large stumps found on the Pacific coast, a modification of the old char-pitting method which involves the use of a furnace and pipes for natural draft. The method is claimed to be economical and practicable on large tree stumps, although somewhat slow.

It is hoped that further experiments will be carried out on more representative stump lands, involving work on larger stumps located in areas of higher soil moisture than was found possible at Summerland, B.C. The present memorandum may therefore be looked upon as in the nature of a preliminary report.