TECHNICAL NOTES

A Portable Burner for Evaluating Effects of Fire on Plants

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Abstract

A portable propane plant burner was constructed for use in evaluating the effects of fire on individual plants. The plant burner is inexpensive to build and allows application of specific time-temperature heat treatments. Moreover, careful calibration of the plant burner allows simulation of a variety of burn treatments.

Concern over environmental quality and increasing costs of conventional vegetation manipulation methods have provided the impetus for detailed investigations of the potential use of prescribed fire as an improvement tool for natural resource management. The effects of fire on existing vegetation must be quantified before prescribed burns can be designed. Although limited data exist for most vegetation types, detailed predictive information is needed for most natural vegetation systems. This information should emphasize season, soil moisture, and intensity of burn as related to response of individual species.

The portable propane plant burner described herein can be used to apply a wide variety of treatments on individual plants at different seasons of the year with control of time-temperature exposures. The method is inexpensive, and can easily be used to simulate natural fires (Wright et al. 1976). Propane burners have been used successfully in several plant communities to evaluate fire effects (Skovlin 1971; Wright 1971; Wright et al. 1976; Britton et al. 1978). Earlier versions of plant burners used shredded paper or excelsior as fuel (Wright and Klemmedson 1965), but were replaced with propane burners to avoid variation caused by environmental factors which affect the burning rate of shredded paper or excelsior fuels.

Construction

Propane plant burners can be built in a variety of sizes. The most important consideration is that the burners be larger than the species to be treated. For burning bunchgrasses, an oil barrel was adequate in size (Fig. 1). This type barrel is 58 cm (23 inches) in diameter and was cut to a height of 58 cm (23 inches). A larger burner is required for burning shrubs. A burner 107 cm (42 inches) in diameter and 81 cm (32 inches) high was suitable for burning rabbitbrush (*Chrysothamnus nauseosus*) and bitterbrush (*Purshia tridentata*). Steel (2 mm thickness) is recommended for constructing large burners. Aluminum ca be used for low fire intensities, but will melt when the temperature reaches 660°C (1,220°F).

Once a suitable size barrel has been selected, the number and location of the jet assemblies must be decided. Three jets were used in the 58-cm (23-inch) diameter barrel. An odd number of jets provides for the development of a circular vortex of hot gases, a common occurrence in natural fires. The 107-cm (42-inch) diameter burn barrel

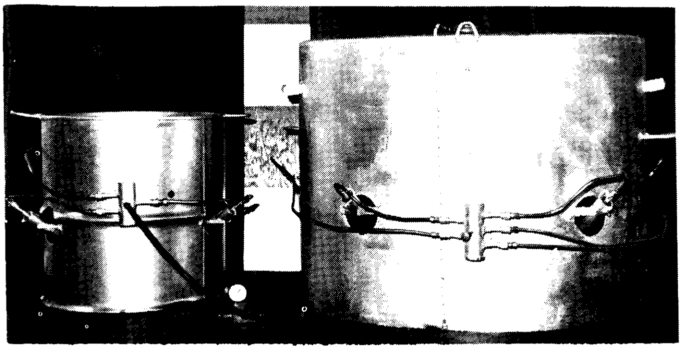

Fig. 1. *Two sizes of individual plant burners. Variable pressure regulator located between the burners.*

was constructed with five jets. Jets were placed at a height of 25-cm (10-inch) through 10-cm (4-inch) diameter holes in the side of a barrel (Fig. 2). The jets were attached with angle iron strips at an angle such that the heat was concentrated in a 400-cm² (64-inch²) area. The area where the heat is placed should be adjusted to the approximate size of the vegetation treated.

Construction of the jet assembly was accomplished with materials commonly available from most hardward stores. A 20-cm (8-inch) length of 3-cm (1.25-inch) diameter iron pipe is adequate for the cylinder around each jet (Fig. 2). A 0.64-cm (0.25-inch) piece of pipe with a gas jet attached should be centered into one end of this pipe. The gas jet with a 0.16-cm (0.0625-inch) orifice should be inserted at least 2 cm (1 inch) into the 3-cm (1.25-inch) pipe. This will help

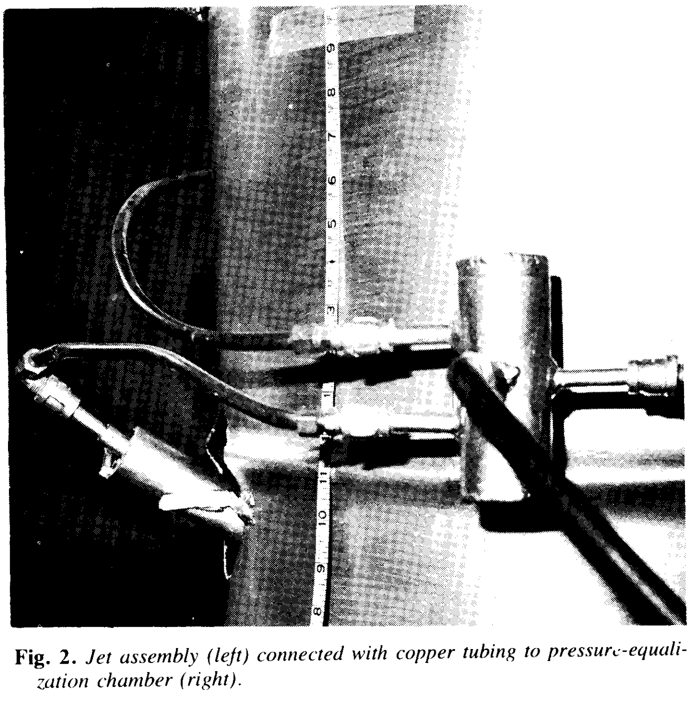

Fig. 2. *Jet assembly (left) connected with copper tubing to pressure-equalization chamber (right).*

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prevent ambient winds from extinguishing the flame. The 0.64-cm (0.25-inch) pipe can then be fitted on the opposite end from the gas jet with a copper elbow. Copper tubing (0.64 cm [0.25 inch] inside diameter) is used to connect each jet assembly to a gas-pressure-equalization chamber.

The pressure-equalization chamber is a 15-cm (6-inch) section of pipe with both ends welded closed (Fig. 2). The copper tubing from each jet assembly is connected to the chamber as well as the hose from the primary propane supply. A quick-couple connector can be used to connect the rubber gas hose to the pressure-equalization chamber.

A small propane bottle (9 kg [20 lb]) has proven effective as a propane source. A variable pressure regulator with pressure gage is also required. The pressure gage should not exceed 2,060 mb (30 psi) full scale as the pressure delivered to each jet will generally not exceed 690 mb (10 psi) for most treatments.

Depending on the material being burned, a 0.64-cm (0.25-inch) wire mesh screen can be placed over the barrel while material is burning. This is especially necessary when burning volatile material such as shrubs. After the burning treatment has been applied, remove the screen. The barrel should be left in place for 1 minute to simulate natural cooling conditions.

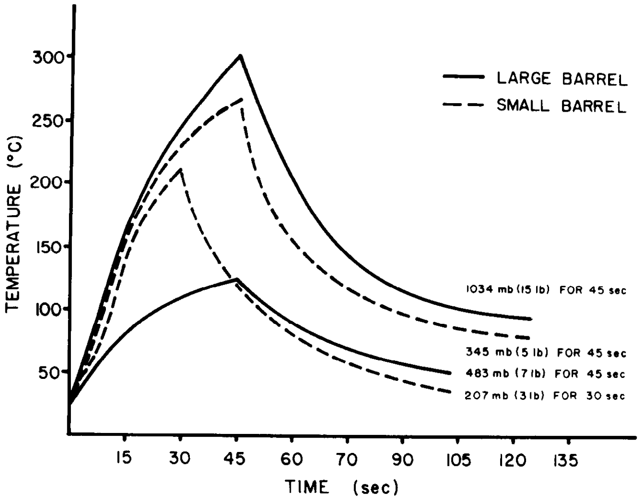

Fig. 3. *Examples of time-temperature curves generated by various combinations of propane pressure and burn time for the large (107 cm) and small (58 cm) burn barrels.*

Calibration

Careful calibration is the key to the successful use of a burn barrel. Since the purpose of the burn barrel is to simulate specific time-temperature treatments, each burn barrel should be calibrated even if two are built identically.

Most accurate time-temperature relationships are obtained from thermocouples placed at the soil surface located in vegetation of interest. When the vegetation is burned, the output from the thermocouples is recorded and the time-temperature relationship generated. Wright et al. (1976) gave examples of time-temperature curves for different grass fuel loads. These curves can be used as general examples in grass fuels, but when the fuel matrix contains appreciable quantities of shrubs the period of time over 93°C (200°F) can be longer. Once a time-temperature curve is obtained for a specific composition of vegetation, the burner can be calibrated to provide a similar burn treatment.

Thermocouples should be placed in the direct path of jet output and should be located with the junction at the soil surface (Stinson and Wright 1969). It is best to use the mean output of at least six thermocouples for constructing the time-temperature curve. A variation of 20% among thermocouple readings can be expected. Wright et al. (1976) gave examples of gas pressures and lengths of burn time for simulating four fuel loads. These relations are similar to those generated by the large and small burn barrels described in this paper (Fig. 3). However, the differences serve to emphasize the need to calibrate each burn barrel constructed. In some cases, single pressure-time relations are adequate while combinations are required in other situations. Once the calibration procedure is completed and tested, the plant burner is ready for treatment application.

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Protection of Instrument Wires in the Field

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Abstract

Electrical wires used with field instruments are frequently damaged by adverse environmental conditions and animal activities. Such damage can be minimized by enclosing the wires in a housing made of polyvinyl chloride water pipe as described in this paper.

Protecting instrument wires on a long-term basis is a problem common to field experiments. Damage to lead wires may result from solar radiation, temperature extremes, water, wind abrasion, and trampling by large animals. Rodents can also severely damage lead wires either by complete severing of the wires or by electrical shorting of the circuit (Brown and Johnston 1976).

A protective device designed to minimize such damage was constructed of rigid polyvinyl chloride (PVC) water pipe and field tested (Fig. 1). It was nicknamed the spider because of its long-legged similarity to certain arachnids. The spider can be used for instruments that are either buried below the soil surface (thermocouple psychrometers, soil thermistors, etc.) or mounted above the surface (anemometers, radiometers, etc.). Our units were designed for soil thermocouple psychrometers that are periodically read in the field with a portable meter. Slight modifications can be made to accommodate automatic data logging equipment. The total cost of materials needed to construct a spider unit is about $25.00.

Materials and Methods

The legs of the spider enclose the instrument lead wires and radiate out at any desired angle and length from a central housing in which the ends of the lead wires are stored. The legs are constructed of 0.75-inch (1.9 cm) inside diameter (ID) PVC pipe. As many as six legs can be

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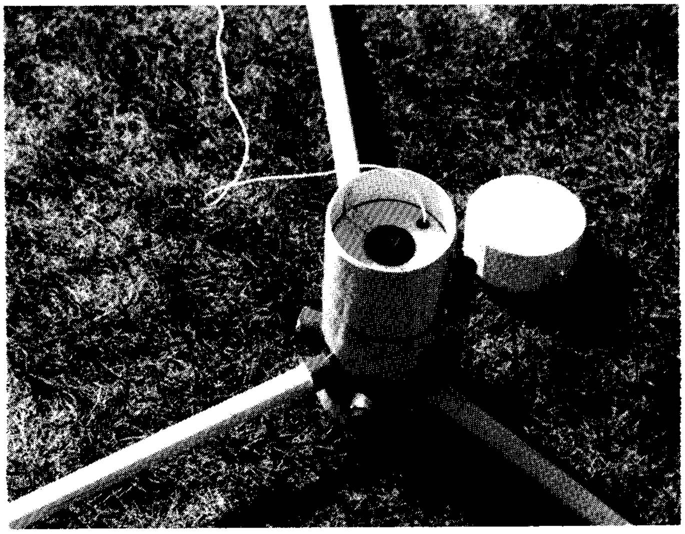

Fig. 1. *Photograph of the assembled spider showing three legs attached to the central vertical housing. Note couplings in housing for attachment of additional legs if needed.*

attached in a single whorl to the vertical PVC housing in the center of the spider. The housing is constructed of 4.5-inch (11.4 cm) outside diameter (OD) PVC pipe, and is 12 inches (30.5 cm) long. The large diameter of the housing allows easy retrieval of the lead wires. A rotary switch can be installed so that only one common lead has to be attached to the meter. A PVC cap on the top and bottom of the housing provides a sealed compartment for the lead wire storage. The use of white-colored PVC pipe is recommended because of its favorable reflective characteristics which maintain lower interior temperatures.

The legs of the spider are attached to the vertical housing through PVC couplings that are 1.0 inches (2.54 cm) ID (Fig. 2). The couplings are permanently cemented into holes drilled in the bottom of the housing above the lower cap. Up to six couplings can be installed per whorl at angles of 60° around the circumference of the housing, but it is possible that additional couplings can be installed above the first whorl. Any unused couplings can be plugged with rubber stoppers and sealed with RTV adhesive. These additional couplings allow for future expansion of instrumentation. The lower cap in the housing should also be permanently cemented and sealed in place.

Before the legs are attached to the housing a 90° PVC elbow (1.0 inch, 2.54 cm, ID) is cemented to the distal end of each leg (Fig. 2). The elbow is used primarily to protect lead wires that are buried below the soil surface. However, it may be positioned at any angle, as for instruments mounted above the soil surface.

It was found most convenient to transport the legs and central housings to the field site disassembled. The appropriate instrument leads can be pulled through each leg using a length of stiff wire. A No. 6 rubber stopper with a predrilled hole that has been slit halfway through with a razor blade provides a seal around the lead wires in the elbow (Fig. 2). RTV can be used to insure a waterproof seal. The lead wires extending out of the proximal end of the leg are then guided through one of the couplings in the housing. The end of the leg can now be sealed in the coupling with RTV, taking care to rotate the leg so that the elbow on the distal end is positioned as desired. It is recommended that RTV sealant be used so that the leg can be removed if later desired.

The legs of the spider are placed on the soil surface, and are anchored securely at several places with heavy gage "U"-shaped steel pins driven into the soil. The legs can be buried below the surface, but

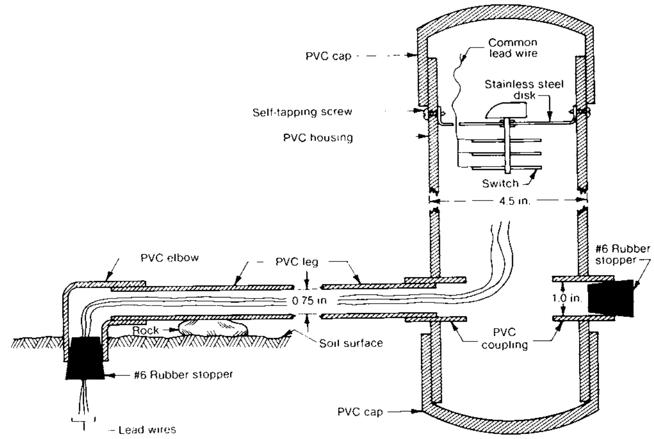

Fig. 2. *Schematic of the spider housing showing leg attachment to housing, sealed coupling for an additional leg, and the position of the caps. Also illustrated is the distal end of the spider leg showing the attached elbow fitting and the rubber stopper which provides a seal around the lead wires. Small rocks are used to elevate each leg slightly above the soil surface.*

this practice may cause undesirable site disturbance. A 3-ft (0.9 m) length of water pipe or steel rod can be driven into the soil next to the vertical housing to securely anchor the entire assembly with either wire or waterproof tape. This practice is recommended on steep slopes where sliding may tend to dislodge the sensors. A PVC cap with a friction fit can be placed over the top of the vertical housing to seal the lead wire ends stored within the compartment.

To facilitate more rapid field readings of the thermocouple psychrometers, a rotary switch can be installed in the housing of each spider unit. The switch is mounted in the center of a stainless steel disk (4-3/16 in, (10.6 cm) diameter) with two tabs for attachment inside the housing. After the lead wires in the housing are soldered to the switch contacts, the switch assembly is lowered into the housing about 3 inches (7.6 cm) and mounted to it with self-tapping screws (Fig. 2). This modification eliminates the time-consuming practice of attaching each instrument wire to the meter.

Field Application

Currently, 15 spider units are in year-round field use, and we have not yet noted any environmental or animal damage to the lead wires of the 135 thermocouple psychrometers housed in them. The flexible nature of PVC pipe allows the legs to conform to the general irregularities of the soil surface, but overland flow of water following heavy thunderstorms has resulted in some silt deposition on the uphill sides of some legs. Most surface water appears to flow readily under the PVC legs. However, to avoid ponding and channeling along the legs, and to prevent unnatural accumulations of water and soil where thermocouple psychrometers may be buried, we suggest that small rocks be placed under each leg in several places to elevate it above the soil surface (Fig. 2).

Condensation in the housings has been noted, particularly during periods of large diurnal temperature variation. Absorbent crystals in small cloth bags can be placed in each housing to absorb condensed water. However, the crystals have to be recharged periodically to maintain their absorbency.

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