FIRE SPREAD AND STRUCTURAL IGNITIONS FROM HORTICULTURAL PLANTINGS IN THE WILDLAND-URBAN INTERFACE

Alan Long and Brian Hinton
University of Florida
Gainesville, Florida

Wayne Zipperer and Annie Hermansen-Baez
U.S. Forest Service, Southern Research Station
Gainesville, Florida

Alex Maranghides and William Mell
National Institute of Standards and Technology
Gaithersburg, Maryland

INTRODUCTION

Although high-intensity fires are often the recognized ignition source for structures in the wildland-urban interface, many structures are also vulnerable to lower intensity surface fires carried through nearby landscaping materials such as grass, mulches, and shrubs. Significant numbers of homes were lost to such fires in the 2000 Cerro Grande fire (Cohen 2001) and in the multiple fires in Texas in late 2005. However, the placement of these landscaping materials around homes also helps serve other important landscaping objectives, such as water conservation, soil protection and wildlife habitat. If these materials are removed, this may counteract benefits of these other objectives. An improved understanding of fire behavior in landscaping materials used within "defensible space" should optimize the use of mulches and horticultural plantings for multiple landscaping objectives.

The research described in this paper was supported by the Building and Fire Research Laboratory (BFRL) at the National Institute of Standards and Technology, which is developing a Fire Dynamic Simulator (FDS) to predict fire behavior at the community scale (Rehm et al. 2002). One key set of information that is needed for the FDS is fire spread and behavior in typical landscaping combinations of mulch, small plants, and shrubs. This study was designed to provide flammability data for horticultural beds by evaluating the effect of mulch type, planting composition, and drought conditions on fire spread and heat release in both field and controlled environment conditions.

MATERIALS AND METHODS

Four common mulches were selected to represent a range of fuel sizes and packing ratios: pine straw (pine needles), small pine bark pieces, large pine bark pieces, and shredded cypress wood. Although other mulches are also used across the South, these four account for a high percentage of all ground coverings utilized.

Field plots were installed on an old field site at the Ordway-Swisher Biological Station, 20 miles east of Gainesville, FL. A nearby lake served as an irrigation source for implementing 0, 15, and 30-day drought regimes in each of the mulch types. Test plots were 4 m (13 ft) diameter circles, bounded by 12 cm (5 in) aluminum edging to maintain a uniform mulch depth across the plots as well as reduce potential ignition of the surrounding native vegetation. Circular plots were used to allow adjustment of the point of ignition in each plot to always be on the downwind side of the plot. Approximately 2 m^3 (2.6 yards) of mulch were needed to fill each plot to a depth of 10 cm. Plots were laid out in a split plot design, with three replications of each of the 12 mulch by drought regime combinations. Within replications, drought regimes were randomly assigned to blocks of four plots; within blocks, mulch types were randomly assigned to each plot. Mulches were allowed to settle under ambient conditions for two months (February-March) before the initiation of drought regimes. During the first week in April, all plots were irrigated with 2.5 cm of water, after which the 30-day drought regime was maintained by covering those plots with plastic sheeting during any subsequent precipitation event. Two weeks later, the 15-day drought regime was similarly watered and then covered during all subsequent rainfall events. The non-drought regime was irrigated every week with 2.5 cm of water if natural rainfall did not supply at least that amount up to the week that the burning tests were conducted.

Plots were burned during the week of May 8-12, 2006. All plots within a replication and particular drought regime were ignited (randomly) at 15-minute intervals in order to complete that set of burn tests under similar weather conditions. The weather conditions were variable from day to day with relative humidity ranging from 31-65%, temperature ranging from 77-93°F, and average wind speed ranging from 2-5 mph. Detailed weather information was recorded at a Florida Agricultural Weather Network (FAWN) station 200 meters from the burn plots.

Drip-torch ignition of each plot occurred as a straight line perpendicular to the prevailing wind at 1.75 m upwind from the center line of the plot. Rate of spread (ROS) data were collected by recording the time from ignition for flames to reach pins located at the center of the plot and at 0.5 and 1.0 m distances from the center in a line parallel to the expected direction of fire spread and a line perpendicular to the direction of spread. Seven independent rates were calculated for each plot. Flame temperatures were estimated by placing four aluminum tags (2.5 cm x 9 cm) on a metal stake 10 cm above the surface of the mulch at four points which were 0.5 m from the plot center. Tags were painted with Tempilaq° temperature-indicating paints in 100°F increments from 200°F to 800°F. Flame height was estimated using two digital camcorders positioned on the left and right flank at a height of 40 cm and 60 cm, respectively, and five steel rods painted with alternating black and white high temperature paint in 20 cm increments. One hour after ignition, fires were extinguished if they had not already burned across the plots and burn depths were measured on five wood stakes that had been placed at the plot center and at the four 1-m distances from the center, level with the top of the mulch, before each burn.

An additional 12 plots were installed with pine straw and five or ten gallberry (*Ilex glabra*) shrubs planted in a circle in the middle of the plot to serve as a pilot test of mulch/shrub configuration effects on fire behavior. Ignition of those plots in May showed no difference between combinations because of the amount of energy released from the burning pine straw. The intense fire behavior in the pine straw overwhelmed any potential shrub effects. When this part of the project is repeated in 2007, one of the other three mulches will be used to evaluate mulch-to-shrub ignition and flammability.

The same four mulches were also placed in 1.2 m x .9 m rectangular metal frames for flammability tests at the BFRL in October, 2006. Heat release and ROS data from those tests will be reported in the presentation but are not yet available for this extended abstract.

RESULTS AND DISCUSSION

Rate of spread (ROS) and flame lengths in pine straw were substantially faster and higher, respectively, than for the other three mulches (Table 1). Pine straw also resulted in the highest temperatures above the fuel surface and the most complete consumption of the fuel bed. Large pine bark pieces were similar to pine straw in terms of temperature and consumption, although in most of the large pine bark plots fire spread across the plot and consumption (burn depth) took place throughout the hour of burning while consumption of the pine straw was essentially completed within the first five minutes after ignition. Flames moved across the cypress mulch more rapidly than either of the pine bark mulches, but the flames were small and the consumption after one hour was generally only in the top layers of this densely packed fuel.

	ROS (m/min)			**Temperature (°F)**			**Flame Height (cm)**			**Burn Depth (cm)**		
Mulch	**N**	**Mean**	**SE**	**N**	**Mean**	**SE**	**N**	**Mean**	**SE**	**N**	**Mean**	**SE**
Cypress	63	0.29	0.02	36	359	16	36	7.5	0.4	34	5.0	0.6
Large Pine Bark	55	0.12	0.01	31	690	5	32	18.1	0.7	35	10.7	0.5
Pine straw	63	2.28	0.17	36	706	10	36	55.5	3.2	31	11.1	0.4
Small Pine Bark	53	0.16	0.05	30	463	23	28	7.0	0.8	31	6.8	0.4

Table 1. Burn characteristics in four mulches, averaged across drought regimes. (N = sample size; SE = standard error of the mean)

CONCLUSIONS

Initial field tests of the four mulch types indicate that pine straw has the greatest potential of the four mulches to rapidly create an ignition source for adjacent plants or structures. Of the other three mulches, the pine bark pieces burn the slowest but generate substantial heat and fuel consumption when given time to burn.

LITERATURE CITED

Cohen, J.D. 2001. Examination of the home destruction in Los Alamos associated with the Cerro Grande Fire, July 10, 2000. Unpublished report. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT.

Rehm, R.G., A. Hamins, H.R. Baum, K.B. McGrattan, D.D. Evans.2002. Community-scale fire spread. Pgs 126-139 in Proceedings of the California's 2001 Wildfire Conference: Ten years after the 1991 East Bay Hills Fire. Technical Rep 35.01.462. University of California Forest Products Laboratory, Richmond.