FOREST RESEARCH NOTES

Issued by the

PACIFIC NORTHWEST FOREST EXPERIMENT STATION

No. 30 Portland, Oregon. June 21, 1940

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Effect of Shape, Density, and Methods of Exposure of Fuel Moisture Indicator Sticks

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Purpose

The test was made to determine the effect of three possible variations in the indicator sticks:

1. Variations in shape. Will square, round, or flat sticks of the same cross section, length, and exposure have the same moisture content?

2. Variation in exposure. Determine the effect of exposing the sticks in the open versus exposing them under a screen.

3. Variation in density or the effect of preparing the sticks to have the same weight or preparing them to have the same length.

Procedure

The sticks were prepared from 1" x 6" x 24" boards of ponderosa pine sapwood. Each board was ripped to make two pieces of each shape. (Three pieces of equal density were used to make each stick.) One set of four square, four round, and four flat sticks having the same cross-sectional area (0.25 sq. in.) and prepared to have the same oven-dry weight (100 grams) was exposed in the open and a similar set was exposed under a wire screen. Another complete set of four square, four round, and four flat sticks having the same cross-sectional area was prepared to have the same length (22 inches) regardless of oven-dry weight and was exposed in the open and a similar set was exposed under a wire screen. Altogether 48 sticks were used and they were weighed to determine their moisture content at 8:30 a.m. and at 3:30 p.m. on 13 days during August, September, and October 1939. The test was run at the Wind River Experimental Forest on the Columbia National Forest, Washington. The sticks were oven-dried before and after the field test and the latter weights were used in computing their moisture content. Field weights were taken to nearest one-tenth gram.

The screen was made of two layers of 14-mesh wire screen 35 inches wide and 10 feet long, held in a horizontal north-and-south position 13 inches above the ground. (R-1 specifications.) All the sticks, screened and unscreened, rested on racks 10 inches above the ground. The sticks were not exposed closer than 12 inches to the end of the screen. The sticks were exposed for several weeks before the first weights were taken on August 17.

The effect of shape and exposure is indicated in the following table:

Time	Exposure	Shape of stick	Average moisture content (percent)	
			Cut to weight	Cut to length
8:30 a.m.	Open	Square	24.7	24.6
"	"	Round	24.6	24.0
"	"	Flat	28.4	29.7
8:30 a.m.	Screened	Square	22.8	23.8
"	"	Round	22.7	23.2
"	"	Flat	25.9	26.7
3:30 p.m.	Open	Square	12.2	12.0
"	"	Round	12.3	12.4
"	"	Flat	9.9	10.2
3:30 p.m.	Screened	Square	12.8	12.9
"	"	Round	12.9	13.0
"	"	Flat	10.1	10.2

The range in moisture content and variation between days of the four cut-to-weight sticks of each shape, open and screened, at 3:30 p.m. is shown in the following table: (Moisture contents are rounded off to nearest whole number. A single entry indicates that all measurements are rounded off to one whole number.)

Range in Moisture Content (in Percent) of Cut-to-Weight Sticks

Shape	Exposure	Days												
		August							September				October	
		17	18	19	22	23	29	30	5	6	7	8	2	5
Square	Open	9	8	7-8	9-10	12-13	14-17	12-13	15-16	11-13	9-11	9-11	14-15	20-22
Round		9-10	8-9	7-8	9-10	12-13	16-17	12-13	16	12-13	10-11	9-10	14-15	20-22
Flat		8-9	7	6-7	9	13	10	9-10	15	9-10	7-8	8	12-13	14
Square	Screened	9-10	8	7-8	9-10	12	16-18	13	16	13	10-11	10	15-16	24-26
Round		9	8-9	7-8	9-10	12	17-20	13-14	15-16	12-13	10-12	10-11	15-16	24-27
Flat		8-9	6-7	6	9	12	9-11	9-10	14-15	9-11	6-8	7-9	13-14	16-19

The data also throw some light on the question of the effect of wood density. The cut-to-weight sticks show marked variation in length; hence, they also vary in density because they all have the same cross section. The average moisture content of the longest and shortest stick for 13 days in each set of four cut-to-weight sticks, and each treatment, is summarized in the following table:

Effect of Length (density) of Stick on Moisture Content

Stick No.	Length (inches)	Shape	Time			
			3:30 p.m.		8:30 a.m.	
			Longest	Shortest	Longest	Shortest
			Open			
2 3	19-1/2 24	Square	11.8	12.7	25.4	23.5
9 10	20-3/4 23	Round	12.2	12.4	25.1	24.3
17 20	21-1/4 24	Flat	9.8	10.2	29.0	28.0
Total			33.8	35.3	79.5	75.8
Average			11.3	11.8	26.5	25.3
			Screened			
27 26	20 21-3/4	Square	12.7	12.6	23.5	22.0
34 33	19 24	Round	12.8	13.4	23.3	21.2
41 44	19-3/4 24	Flat	9.5	10.8	26.5	25.1
Total			35.0	36.8	73.3	68.3
Average			11.7	12.3	24.4	22.8

Conclusions

The following conclusions are based on inspection of the data and the use to which the sticks are put in practical application:

1. There does not appear to be any important difference between round and square sticks of the same cross section.

2. There does appear to be a small but important difference between sticks made from high density wood and sticks made from low density wood. Therefore, the practice of discarding sticks of high or low density wood is sound and should be continued.

3. Flat sticks of the same cross section as the round and square sticks show an important difference in behavior and could not be used interchangeably with round or square sticks.

4. There is not any important difference between sticks cut to weight and sticks cut to length, provided that the densest and lightest wood is eliminated under both methods of preparation.

5. In general screening does not appear to make a very great difference in the daily minimum moisture content of the sticks. The effect does not amount to as much as one percent in the afternoon averages.

Effect of Ground Surface and Height of Exposure upon Fuel Moisture Indicator Stick Values

William G. Morris

The ground surface at the fire weather stations where fuel moisture indicator sticks are used differs so greatly that it is impossible to find the same kind of surface over which to place the sticks at all stations. As a result some are placed above a leafy surface, some are above a duff surface, others are above a base soil surface, and some are above a rocky or gravel surface. Some investigators recommend preparing an artificial ground surface or bed of forest duff several feet wide over which to place the sticks at all stations.

It is the local practice to place the sticks on a wire rack six inches above the ground but there is a chance for error in regulating the height of the sticks and also the question of whether or not some other height would do as well or better.

To test the effect of differences in ground surface and height of stick supports, artificial ground surfaces of Douglas fir forest duff, gravel, and mineral soil each $3\frac{1}{2}$ feet by 7 feet were prepared beside a natural ground surface of wild grass at the Wind River Experimental Forest. Over each of the prepared surfaces 3 half-inch sticks were placed at each of the following heights above the surface: 3", 6", 9", and 12". Only the 6" height was used over the grass. The standard fuel moisture indicator stick for Oregon and Washington was used. This stick consists of three pieces of $\frac{1}{2}$" square ponderosa pine sapwood about two feet long held parallel and $\frac{1}{4}$" apart by two small wooden dowels. The sticks are cut to an oven-dry weight of 100 grams during preparation. The 39 sticks used in the experiment had been carefully calibrated to insure comparability. In the test they were weighed on seven days of moderately dry weather, the kind of weather in which precise fire danger measurement is important. All weights were carefully made on laboratory scales weighing to the nearest 0.1 percent moisture content.

The results showed no difference whatever between the sticks exposed over the different kinds of ground surfaces.

The sticks supported at different heights above all the prepared surfaces gave the following average values for nine sticks observed on seven days:

Height of stick in inches	Average moisture content in percent	Variance of the mean (σ^2_M)
3	7.9	.008
6	8.1	.027
9	8.6	.010
12	8.5	.030

The values for the 9-inch and 12-inch heights are significantly greater than for the 3-inch height. The value for the 9-inch height is significantly greater than for the 6-inch height, but with a lower probability (95 percent) than for the former comparisons. None of the other height comparisons differ by a statistically significant amount.

The conclusions from these tests are that the type of ground surface over which fuel moisture indicator sticks are exposed does not affect the stick moisture content when that ground surface is of the order of $3\frac{1}{2}$ feet by 7 feet in size. The height at which the stick is supported above the ground should be adjusted accurately at six inches when that height is used as a standard, but if 12 inches is used as a standard a variation of three inches in height will probably make no significant difference.