INITIAL DEFOLIATION AS PREDICTOR OF TOPKILL IN BRUSH-CONTROL SPRAYING

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ABSTRACT. Data from 15 foliar spraying studies comprising numerous herbicidal formulations and a variety of woody species yielded no relationship that would permit topkill to be accurately predicted from defoliation measurements. Defoliation does, however, define the upper limit of expectable topkill. Thus if defoliation is unsatisfactory, topkills will be no better and retreatment can be planned. When defoliation was satisfactory acceptable topkills were obtained in about 60 percent of the comparisons, but there was no way to predict which treatments would recover.

Foliar sprays to remove brush from southern pine stands are usually evaluated by the amount of topkill in the second growing season after spraying. Land managers are not able to tell earlier whether sprayed plants have been topkilled or whether they will recover when living buds begin to grow again. In addition, there is a widespread belief that some plants that appear undamaged may eventually die. Since sprays are most effective when applied in late spring or early summer, the delay in evaluation means that retreatment can be made no sooner than 2 calendar years after the first application. It would be a decided advantage if final success could be predicted from defoliation in the first year, since prompt retreatment might gain an extra year's growth for the pines.

Foliar spraying studies conducted in central Louisiana over the past 10 years by scientists of the Southern Forest Experiment Station afforded an excellent opportunity to determine if initial defoliation and second-year topkills are correlated. In these studies it was customary to measure defoliation the first season and topkills at the end of the second season after spraying. Some early studies were measured 3 or more years after spraying, but very little difference was found between second-year and later evaluations.

Methods and Procedures

Fifteen studies provided comparisons over a wide range of climatic conditions. More than 50 herbicidal formulations were included. Since Peevy and Brady (4) have shown that herbicidal effectiveness did not differ significantly with method of application, data from high-volume, mist-blower, and aerial applications were averaged together.

Fifteen species of hardwoods were included. They were hickory (Carya spp.), red maple (Acer rubrum L.), flowering dogwood (Cornus florida L.), southern red oak (Quercus falcata Michx.), huckleberry (Vaccinium virgatum Ait.), post oak (Q. stellata Wangenh.), water oak (Q. nigra L.), southern bayberry (Myrica cerifera L.), American beautyberry (Callicarpa americana L.), green ash (Fraxinus pennsylvanica Marsh.), blackjack oak (Q. marilandica Muenchh.), blackgum (Nyssa

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sylvatica Marsh.), sweetgum (Liquidambar styraciflua L.), persimmon (Diospyros virginiana L.), and shining sumac (Rhus copallina L.). In all, 831 comparisons were made, varying from eight on hickory to 152 on blackjack oak. Each treatment had been replicated on 10 to 40 trees in each comparison.

A satisfactory spray operation is often considered to be one producing 75 percent or greater topkill of all brush. Defoliation measurements on eight species appearing in four or more studies and comprising 556 treatments were divided into two groups: one with defoliation of 75 percent or more and the other with less than 75 percent. This division was made to learn if correlations were better at two levels of initial defoliation.

Results

Average initial defoliations for the 15 species ranged from a low of 49 percent for hickory to a high of 96 for sumac (table 1). None of the second-year topkills exceeded initial defoliations, although they were the same for sumac.

Table 1.--Comparisons of initial defoliation with second-season topkills of 15 hardwood species

Species	Comparisons	Initial defoliation	Second-year topkill	Correlation coefficient
	Number	Percent	Percent	r value
Hickory	8	49	40	0.9916
Dogwood	45	56	41	.6082
Red maple	54	58	48	.9502
Red oak	42	59	49	.9919
Huckleberry	45	60	44	.6757
Post oak	42	64	35	.5008
Water oak	15	68	55	.7764
Southern bayberry	13	72	69	.9454
American beautyberry	23	78	76	.6738
Green ash	30	79	74	.8024
Blackjack oak	152	82	60	.9010
Blackgum	40	86	85	.9014
Sweetgum	136	87	79	.8559
Persimmon	15	88	84	1/.3219
Sumac	45	96	96	.6061

1/All correlations except this one are significant at the 0.05 level.

Average recovery for all species was 10.3 percentage points. It was greatest with post oak, which averaged 29 points. Seven species had crown recovery of 10 percentage points or more, while eight had less than ten points. All of the oaks, red maple, huckleberry, and dogwood were in the high recovery class. Southern bayberry, beautyberry, green ash, blackgum, sweetgum, persimmon, and sumac were in the low class.

Correlation coefficients between initial defoliations and second-year topkills were significant for 14 of the 15 species. Several were very high, approaching 1.00 for hickory and red oak, and exceeding 0.90 for red maple, bayberry, blackjack oak, and blackgum. For persimmon, sumac, beautyberry, huckleberry, and dogwood, however, the regression accounted for less than 50 percent of the variation.

For seven of the eight species listed (table 2), low initial defoliation was significantly correlated with low percentage of topkill. While the correlation coefficients were lower than for the more numerous comparisons in table 1, there thus is little probability that undefoliated plants will die later. Additional support for this conclusion is provided by the last column in the table, which shows the number of comparisons in which low initial defoliation was followed by good topkill. In 98 comparisons with red maple, post oak, and blackjack oak, low initial defoliation was invariably followed by topkills of less than 75 percent. In red oak and sweetgum there were 3 exceptions in a total of 58 comparisons.

Table 2.--Comparison of initial defoliations with second-season topkills when defoliation was less than 75 percent

Species	Initial defoliation	Second-year topkills	Correlation coefficient[1/]	Comparisons	Comparisons with 75% topkill
	Percent	Percent	r value	Number	Number
Red maple	37	32	0.7762	34	0
Dogwood	48	38	.7184	35	2
Huckleberry	49	38	.5177	31	3
Red oak	44	32	.8524	29	1
Post oak	44	26	.3510	23	0
Blackjack oak	47	35	.6876	41	0
Sweetgum	53	49	.7905	29	2
Blackgum	42	57	.7221	8	3

[1/] All correlation values except that for post oak are significant at the 0.05 level.

Among 326 comparisons in which defoliation exceeded 75 percent, 134 failed to achieve satisfactory topkills (table 3). Hence even high defoliation is no guarantee of control. Correlations between topkill and defoliation were significant in four of eight comparisons, but none of the regressions accounted for 50 percent of the total variation.

Table 3.--Comparison of initial defoliations with second-season topkills when defoliation exceeded 75 percent

Species	Initial defoliation	Second-year topkills	Correlation coefficient[1/]	Comparisons	Comparisons with less than 75% topkills
	Percent	Percent	r value	Number	Number
Red maple	93	75	0.5728	20	9
Dogwood	85	52	.3532	10	10
Huckleberry	80	62	.6689	14	10
Red oak	94	91	.0283	13	2
Post oak	90	48	.2163	19	17
Blackjack oak	94	68	.5075	111	64
Sweetgum	94	87	.5698	107	20
Blackgum	97	92	.5491	32	2

[1/] Correlation values for red maple, huckleberry, blackjack oak, sweetgum, and blackgum are significant at the 0.05 level. In none of these comparisons, however, does the r^2 value equal 50 percent of the total variation in the data.

Post oak, dogwood, and blackjack oak, species common to droughty sites, were very difficult to kill even when defoliation was complete. Miller and Starr (3) found that sprays applied when soil moisture was low were usually ineffective. Recovery of these species may therefore have been due to unfavorable soil moisture at time of spraying. On the other hand, the physiologic adaptation that enables the species to survive and compete on unfavorable sites may also help them to recover from the herbicides.

Discussion and Conclusions

It is impossible to accurately predict the amount of topkill from the initial defoliation. Twenty-six of thirty-one correlations of average values were significant at the 0.05 level, indicating that there is a strong relationship between the two. However, in 18 of the significant relationships the regressions failed to explain 50 percent of the variation.

Low r^2 values were not surprising; many variables affect topkill that do not enter into defoliation with herbicides. Eaton et al. (2) have shown that when a herbicidal spray is applied to susceptible foliage in a manner that achieves adequate cover, defoliation follows. Brady (1) found that the herbicide must not

only be absorbed by susceptible foliage, but must also be translocated to the roots and to any parts of the top that were missed by the spray. Translocation is a far more complex process than absorption and is influenced by an almost infinite number of variables.

Defoliation measurements do define the upper limit of expectable topkill, and this limit may sometimes be useful in deciding whether retreatment will be required. Topkills did not average higher than defoliation on any of the 15 species studies. A few individual treatments produced higher topkills than defoliation, but no herbicide formulation or method of application consistently accomplished this. For the 15 species, average recovery following defoliation was slightly more than 10 percentage points, with some species--post oak and blackjack--averaging about 25 percent.

In about one-half of the comparisons defoliation exceeded 75 percent, but in these there was a 40-percent chance that topkills would not. Although it was impossible to pinpoint specific treatments that would recover, those species common to droughty sites, e.g., post oak, blackjack oak, and dogwood, recovered considerably more often than those growing on more favorable sites.

On about half the treatments initial defoliation was less than 75 percent. Where this occurred there was greater than 95-percent chance that topkills would also be unsatisfactory. Low defoliation, therefore, indicated that planning for retreatment could begin a year earlier than if it had been necessary to wait for topkill data. Other studies (2) have shown that it makes little difference in herbicidal effectiveness whether retreatments are applied one or more years following prior treatments.

Literature Cited

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