Guideline for analyzing the efficiency of fire retardants

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INTRODUCTION

- ✓ use of long term chemical retardants in the control of forest fires in Brazil
- ✓regulations or legal provisions which establish criteria to evaluate fire retardants
- ✓need for standardization

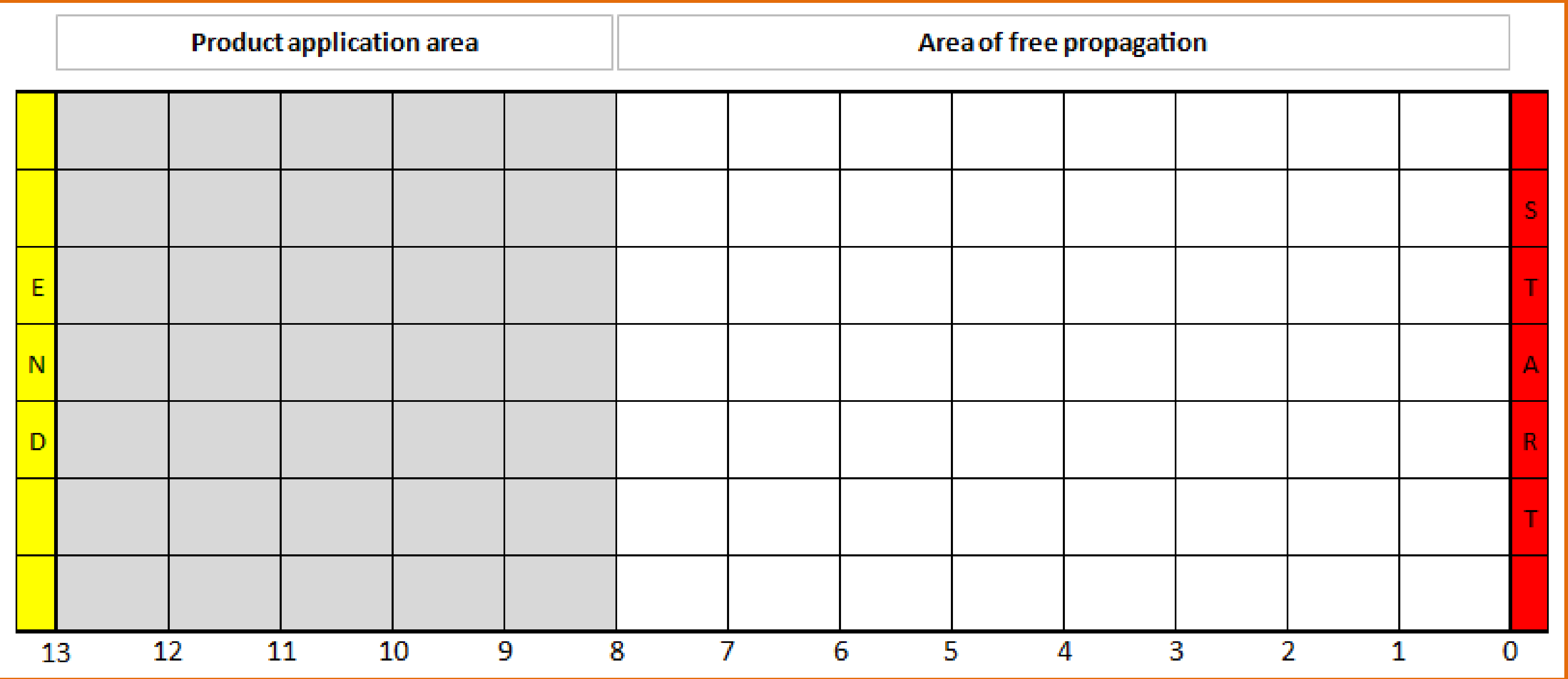
OBJECTIVE

The objective of this research was to improve a standard methodology to evaluate the efficiency of fire retardants in laboratory and field conditions, as a tool to help forest managers to take decisions when dealing with fire control activities.

THE IEE METHODOLOGY

Characteristics of the “Standard-Burn (QP)”

1. Fuel bed dimensions: 1.5m long, 0.75m wide, divided in 10cm intervals;



THE IEE METHODOLOGY

Characteristics of the “Standard-Burn (QP)”

2. Successive burns: it is a succession of 5 replications of each treatment that should be burned sequentially in the same day;

3. Time of burning: the burns should start after 10:00AM and, preferentially, not progress after 4:00PM (in the proposed fuel beds dimensions the total time to carry out the 5 burns may not take more than 3 hours);

4. Ideal environment: the tests should be carried out in laboratory environment, with exhaustion system, without the interference of external climatic conditions. The local must be closed, in order to maintain a minimum thermal and relative humidity variation and avoid wind interference. Laboratory doors and windows must be closed during the tests. Usually, the first burning tends to be slower, due to the lower temperature and higher relative humidity. Those conditions may change during the burnings. For this reason it is advisable to carry out calibration burns that would balance the laboratory environment;

THE IEE METHODOLOGY

Characteristics of the “Standard-Burn (QP)”

5. Fuel: “tifton” hay, dried at 80°C for at least 12 hours before utilization;
   i. The fuel load should be 1.0 kg/m^2, evenly distributed over the fuel bed;
   ii. The recommended thickness of the litter (hay) is 8.0 cm.

6. The recommended volume of the product to be tested is 0.5 l/m^2, regardless the concentrations to be evaluated;

7. Application equipment: a pressurized manual atomizer, of low operational cost, is recommended;

THE IEE METHODOLOGY

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The proposed methodology includes three steps, as follows:

1 - Utilizes an adaptation of the Global Efficiency Index (Ie) proposed by Ribeiro et. al. (2006) – evaluation of the **“retardant” effect**, which describes the outcome of flames high and fire speed reduction, without extinguishing the fire front;

2 - Utilizes a variable named “hammer effect” (EfM), which evaluates the retardant efficiency to **suppress** the fire front as soon as it reaches the area where the retardant was applied. This variable takes in account two factors: extinction time (TE) and the average penetration distance (P) of the fire in the retardant application area, both in percentage. The calculation of these two factors was based in the measured time and the dimension of the application area;

3 - For the calculation of the "Effective Efficiency Index (IEE)", which establishes a relationship between (Ie) and (EfM), a multiplication factor called "result valorization" and a "scale adjustment" were used, in such way that "**retardant" results never exceeds 70% in the (IEE) scale, and the results "Fire suppressor" can use the full scale range (from 0 to 100).**

THE IEE METHODOLOGY

The "hammer effect" (EfM)

$$EfM(\%) = \left(\frac{TE(\%) + P(\%)}{2} \right)$$

Table TE

Conditioned variable :

$$TE(\%) \Rightarrow n_{[n_i;n_{i+9}]} = 1{,}0$$

From	To	%
1	10	100
11	20	99
..	..	..

$$TE_{[100;0]}(\%) \Rightarrow \sum n_{[n_i;n_{i+9}]} = 16'50''$$

Penetration distance

Calculated variable :

$$P(\%) = \frac{(cAA - P) \times 100}{cAA}$$

Where cAA refers to the length of the application area in cm.

THE IEE METHODOLOGY

1. Evaluation of the "retardant effect" (based on the adapted "Ie");

$$Ie(\%) = \left(\frac{r_i + hc_i}{2} \right)$$

2. Evaluation of the "suppressing effect" (based on the "EfM");

$$EfM(\%) = \left(\frac{TE(\%) + P(\%)}{2} \right)$$

THE IEE METHODOLOGY

Adapted to different application areas;

Adjusted to the Protocol for Evaluation and Development of Chemical Retardants ;

$$IEE = \frac{(Ie \times \alpha) + (EfM \times \beta)}{2}$$

Particularities:

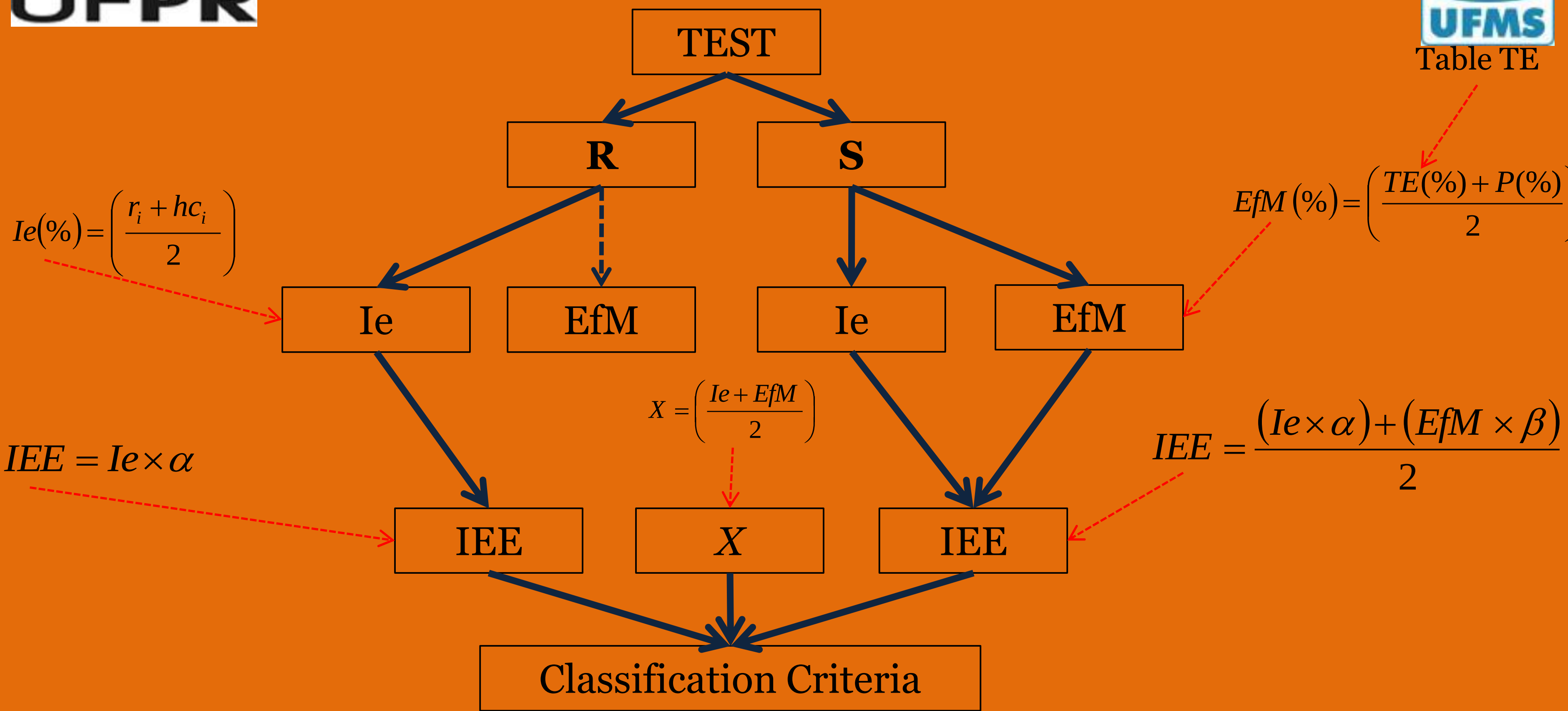
1. Results expressed in limited scale (0 - 100);
2. Utilization of results appreciation factors and adjustment of scale (α e β);

$\alpha = 0{,}714285714285714...$ $\beta = 1{,}285714285714285...$

0 | 50 | 70 | 100

DISAPPROVED | APPROVED with restriction | APPROVED

Evaluation flowchart

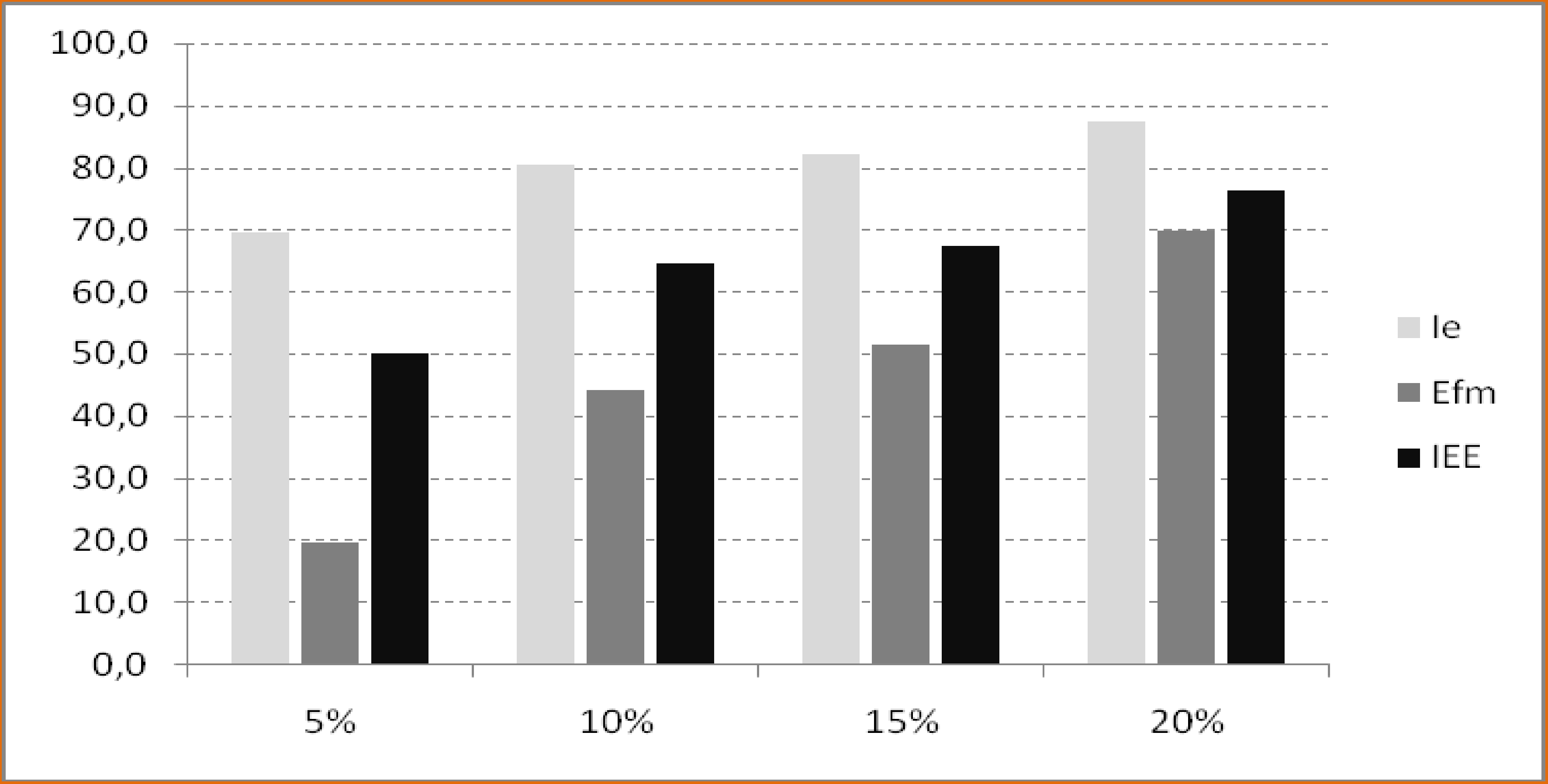


APPROVED (meeting all requirements)	**S** IEE > 70 IEE > X
APPROVED partially	**S** IEE > 70 IEE < X
APPROVED with restrictions	**S** or **R** 70 > IEE > 50
DISAPPROVED	**S** or **R** IEE < 50

APPLICATION OF THE IEE METHODOLOGY
a study case

In order to exemplify the IEE application, the efficiency of a fire retardant in concentrations of 5, 10, 15 and 20% was carried out.

APPLICATION OF THE IEE METHODOLOGY
a study case



Effective Efficiency Index (IEE) for the different concentrations of the fire retardant

CONCLUSIONS

Regarding the IEE

The (IEE) is quite sensible to the efficiency variation of the retardants, and because it presents a finite scale (0 to 100%), it makes possible the comparison of different products, as well as the efficiency rating due to different concentrations.

The index allows the analysis of retardants efficiency along the time, i.e., several days after the application, what helps in the determination of how long the product maintains its efficiency.

The IEE can be useful on the developing of different retardant formulations, tests of raw materials, and quality control.

CONCLUSIONS

Regarding the case study

For direct attack to the fire, the 5% concentration of the tested retardant is recommended;

For indirect attack or fire prevention, the 20% concentration is recommended.

Sugar cane test

Total area: 750 m² (75x10m)
Area without product: 550 m² (55x10m)
Area with product: 200 m² (20x10m)

5% concentration of the tested retardant
3.0 l/m²

OBRIGADO

THANK YOU

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