Evaluation Of The Efficacy Of Herbicides In Tea 
(*Cammelia Sinensis*) Production In Rwanda

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ABSTRACT

Tea, *Cammelia sinensis*, is an important industrial crop in Rwanda. Weeds pose a major threat and only the manual weeding is practiced. This study aims at evaluating the efficacy of chemical weeding in tea production through the comparative trial of three herbicides. It was conducted in Pfunda tea plantations, in Rubavu District. The experimental design used comprised five treatments and five replications. The treatments were: Control with no treatment (T0), Manual weeding (T1), Kalach 480 SL (3.5 l/ha) (T2), Ametrex 50 SC (4 l/ha) (T3), Diurex 80 SC (2.5 l/ha) (T4). The measured parameters were the success of the applied weeding method by counting the number of weeds emerging after treatment and the weight of green leaves (yield of tea) harvested in every plot. The statistical analysis of the results showed that Kalach and Diurex are the best performing treatments. Ametrex was not as efficient as the other herbicides: it was unable to eliminate a great number of weeds and low yield was recorded in plots under its treatment. Chemical weeding in tea plantation is feasible and efficient in Rwanda. Kalach 480 SL and Diurex 80 SC, which are effective and less hazardous, can be recommended for use as herbicides.

**Keywords:** Cammelia sinensis, herbicides, efficacy, weeding, Rwanda, comparative trial.

INTRODUCTION

Agriculture is an important sector of the economy of Rwanda: its contribution to the GDP was of 44% in 2004 and it employs 87.1% of the total active population [1]. Crop production is one of the major components of the agricultural production of
Rwanda. In addition to food crops, there are also cash crops, and these are dominated, in terms of cash earning and occupied land, by coffee and tea. Tea, *Cammelia sinensis*, that originated in India, was introduced in Rwanda in 1947 from the then Belgian Congo (now The Democratic Republic of Congo) in Bigutu, Rusizi District, Western Province, Rwanda. Studies have shown that tea could be grown successfully in Rwanda. The first governmental nursery was created in 1959 in Mulindi Valley.

Tea is an important crop in Rwanda: in 2006, it was grown on 12541 hectares and Rwanda exported 16457.6 tons of tea in 2005. The quality of Rwandan tea is considered as high on international markets.

Tea production in Rwanda faces some constraints among which there is a problem of pests, mainly weeds. The weeds compete with tea plants for sunlight, water and nutrients, some have allelopathic effects on plants, etc. Weeds cause yield losses estimated at 15%, and thus it becomes necessary to control them. Weed control in tea production is principally done by hand weeding and increases the production cost and limits the yield.

Chemical weeding seems like an alternative to hand weeding in tea production. It also can offer an advantage of taking less time, demanding less labour and causing less potential of injuring tea roots and the stem collar.

This study aims at evaluating the efficacy of chemical weeding by conducting a comparative study on 3 herbicides and manual weeding. It has been conducted in Pfunda tea plantation, Rubavu District, Western Province, Rwanda.

**MATERIALS AND METHODS**

**2.1. Study area**

This study is conducted in Pfunda tea plantations, Rubavu District, Western Province, Rwanda. The owner of the plantations is the cooperative of tea growers of Pfunda. The plantations are located at 1600-2000 m of altitude, and they receive on average 1800 mm of rainfall per year. The vegetation is dense and diversified and the major species found are *Commelia bengalensis*, *Cynodon dactylon*, *Bidens pilosa*, *Digitaria vestuta*, *Eragrostis aspera*, *Cyperus rotundus*, *Amaranthus viridis* and *Marsilea minuta*.

**2.2. Plant material, field status and variation criteria**

The plant used in this study is tea, *Cammelia sinensis* (Theaceae), clone 6/8 introduced in 1964 in Pfunda valley. The clone 6/8 is characterized by an average size and clear-green small leaves. The experiment was conducted on a field on which no weed control practice was done in the last 4 weeks, *id est* a field where there was a competition between tea plants and weeds. The experiment begun in May 2008 and data were taken in May, June, September and October 2008. The evaluated criteria for comparison are: (1) the number of weeds (stems) that develop after the control; (2) weight of fresh tea leaves harvested on plots under various treatments.

**2.3. Herbicides and application equipments**

Three herbicides are used in this study. Their trade names, active ingredients and
WHO pesticide class are presented in Table 1.

Table 1. Types of herbicides tested for chemical weeding efficacy in tea production

<table>
<thead>
<tr>
<th>Trade name</th>
<th>Active ingredients</th>
<th>WHO Pesticide class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalach 480 SL</td>
<td>Glyphosate isopropylammonium 480 g/l</td>
<td>III</td>
</tr>
<tr>
<td>Ametrex 50 SC</td>
<td>Ametryn 500 g/l</td>
<td>II</td>
</tr>
<tr>
<td>Diurex 80 SC</td>
<td>Diuron 800 g/l</td>
<td>III</td>
</tr>
</tbody>
</table>

About their mode of action, the aminophosphonic acids, from which glyphosate isopropylammonium salt is derived, are considered to be structural analogues of the corresponding amino acids which they very efficiently mimic, competing for their carboxylic counterparts for the active sites of enzymes and other cell receptors [2, 3]. Ametryn belongs to the group of triazines, which act as herbicides through blocking the photosynthetic electron transport chain in Photosystem II by binding the D1 protein and competing with plastoquinone $Q_B$ for the binding site [4]. Diuron also called DCMU (3-(3,4-dichlorophenyl)-1,1-dimethylurea), is a very specific and sensitive inhibitor of photosynthesis [5].

For herbicide application, the required dose of pesticide was taken with a syringe, then mixed with water in a back sprayer (marked CP 15) and sprayed. The different treatments were labeled. The balance has been used for measuring the weight of harvested leaves from different treatments.

### 2.4. Experimental design and data management

The treatments in this study, corresponding to the different weed control options are 5: (i) treatment 1: control (non-weeded plot); (2) treatment 2: hand weeding; (3) treatment 3: Weeding with Kalach 480 SL; (4) Weeding with Ametrex 50 SC; (5) Weeding with Diurex 80 SC. Each individual treatment was applied on an area of 1.44 m² and replicated randomly 5 times, thus making the experimental design of a latin square. Each treatment was bordered by a buffer area. Data were treated for the Analysis of variance (ANOVA), at the confidence interval of 0.05% and grouped in homogenous groups by DMRT (Duncan’s Multiple Range Test), using the software SPSS 19 (IBM Corporation, 2011).

### RESULTS AND DISCUSSION

#### 3.1. Weeds intensity after weed control application

The evolution of weed intensity after the application of different weed control treatments is presented in Figure 1.
Of the four weed control treatments, the control shows, in the first week after treatment, already around 48.6 developed weeds, Ametrex 50 SC presents 3 developed weeds, the manual weeding around 0.6 developed weed, and for Kalach 480 and Diurex 80, no weed is developed in the first week. For the weeks 2 and 3, the evolution of weeds intensity generally follows the same trends, except for the manual weeding, and at the fourth week after treatment, there are 56 developed weeds for control, 42.8 developed weeds for manual weeding, 17.2 developed weeds for Ametrex 50, 1.2 developed weeds for Diurex 80, and 0.4 developed weed for Kalach 480 weeds. Differences in weeds intensity per months and replications are negligible considering the error bars.

3.2. Fresh weight of tea after weed control application
The evolution of fresh weight after the application of different weed control treatments is presented in Figure 2.
The differences for fresh weight are less individualised two weeks after weed control application than after four weeks after application. It is in fact clear that the treatments are grouped in three homogenous groups after three weeks, while they are grouped in 5 weeks four weeks after treatment. The fresh weight is diminishing in yields for the cases of the control and the manual weeding. It is on the contrary increasing for the chemical controls especially Kalach 480 and Diurex 480. In the long run, the chemical control could give more yield in terms of number of t/ha than the other control options.

3.3. Discussion
The chemical control of weeds in tea production, which is easy to apply, is also efficient in limiting the development of weeds. This justifies why in major tea-
Growing countries, like India, herbicides are the largest used tea pesticides [6]. In the three chemicals on trial, Kalach 480 SL is the most efficient, followed by Diurex 80 SC, and then Ametrex 50 SC. Some previous studies have also shown that Ametryn does not always fully stop weed development [4].

Considering the yield in relation with the weed control method applied, the chemical control proves to be efficient, but also the manual weeding is efficient. The big difference in efficiency that was observed on limiting weeds development is not observed in yield. This may probably be explained by a possible interference of herbicide on the development of plants, through their potential carry-over effect by which residues in the soil may cause damage to certain other crops [7], although it is limited.

Taking into consideration the aspects of limiting the adverse effects of pesticides on the environment, Kalach and Diurex are grouped in pesticide class III of the WHO, i.e. they are slightly hazardous, while Ametrex is in pesticide class II, meaning that it is moderately hazardous, presenting more danger than the other two.

In planning the integrated pest management in tea production, it is important to consider using the herbicides for weed control. These should be carefully chosen by taking into consideration that the good pesticide is the one that is (i) effective, (ii) economically affordable, and (iii) safe for the user and the environment. Kalach 480 SL and Diurex 80 SC meet the requirements of good herbicides in tea production in Rwanda.

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REFERENCES
1. MINECOFIN. Rwanda Development Indicators. 7th Ed, 2005. Kigali.