Usage of Commonly Available Herbicides for the Weed Control on Rubber-Cinnamon Intercrop

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ABSTRACT

This study was carried out to investigate the influence of the herbicides on the weed growth and diversity and also on the growth performance of the cinnamon plants in rubber-cinnamon intercropping. Rubber - cinnamon intercrop was selected for the study in low country intermediate zone of Sri Lanka. All the floral species available at the field were identified and counted, and weed biomass was measured at third, sixth and twelfth weeks while the shoot number and height of cinnamon plants were measured at four week intervals. Summed dominance ratio of the flora was worked out for the determination of the ecological dominance of the species under different treatments. Three weeks after herbicide application, Rubiaceae was the most dominant family in diuron, mixture of diuron and glyphosate, diuron after glyphosate applied plots while Verbinaceae was in glyphosate applied and manually weeded plots. Twelve weeks after herbicide application, Leguminaceae was the most dominant family in diuron, glyphosate and mixture of diuron and glyphosate applied plots while Rubiaceae and Verbinaceae were the most dominant families respectively in diuron after glyphosate applied and manually weeded plots. The treatments did not have any significant effect on shoot number and height of cinnamon plants under the concentrations applied. When compared to the manual weeding, all other treatments were better for weed control in rubber-cinnamon intercrop: however, glyphosate appeared to be more convenient to apply.

KEY WORDS: Cinnamon, Herbicides, Intercrop, Rubber, Weed control

INTRODUCTION

Rubber (*Hevea brasiliensis*) being one of the major plantation crops, contributes 0.7 percent to Gross Domestic Production(GDP) of Sri Lanka (Anon, 2005). The long lag period between planting and beginning of tapping (six years) poses a significant problem to most growers.

The land tends to be underutilized in immature rubber plantations. Intercropping offers a practical mean of raising not only land use efficiency but also income during the immature phase of the rubber plantation (Rodrigo, 2001a).

Cinnamon (*Cinnamomum verum*) is one of economically important crops and has a good potential to be intercropped with rubber (Rodrigo, 2001b). Weeds are strong and aggressive competitors for sunlight and soil moisture containing dissolved mineral salts (especially when they are in short supply) and deprive the crop of these essential factors. Therefore, weeds must be controlled during crop growth in order to maximize production and economic return from the land. Weeds cause difficulties in harvesting of crops. The presence of tough, wiry vines or of tall woody plants in cinnamon can seriously interfere with the operation of harvesting. Weeds growing close to crop plants, are often alternative hosts to a wide range of pests and diseases (Swabrick, 1974). Estimates made in India illustrate that approximately 40 percent of the total annual loss of crops in the field is caused by weeds (Rao, 1983). Weed control is therefore considered important in the rubber -cinnamon intercropping fields.

Establishment of cover crop is very effective in suppressing weed growth in young rubber clearings and is essential for the preservation of fertility, soil conservation and weed control. As these cover crops climb over the cinnamon plants, they can not be effectively established in rubber-cinnamon intercropped lands. Chemical herbicides are relatively new to cinnamon for weed control. Therefore, it is important to understand both their effectiveness and limitations if they are to be used successfully, economically and safely.

This study was therefore, carried out to assess the effectiveness of different herbicides as a weed control measure in rubber-cinnamon intercropped lands. It was specifically aimed to identify suitable commonly available herbicides for the weed control and their effect on the crop.

MATERIALS AND METHODS

An immature rubber-cinnamon intercropped area, planted in 2005 at the substation of Rubber Research Institute (RRI), Polgahawela was selected and study was carried out from January to June 2006. A herbarium of weed species found in the study site was prepared and weed species were identified with the help of the specimens kept at the library of faculty of Agriculture and Plantation Management of Wayamba University of Sri Lanka. The experiment was set up using a Complete Randomized Design (CRD) having five treatments and three replicates. Rubber-cinnamon intercropped field was divided in to plots with 4m x 4m area. Plots consisted only of cinnamon plants.

The details of the treatments are given in the Table1.These treatments were applied only once during the study period.

Assessment on Floral Distribution

Weed samples were selected using a 1m x 1m wooden quadrat. The weed species found within the quadrat were counted in third and twelfth weeks after the application of treatment. Density (D) and Frequency (F) together with the Relative Density (RD) and Relative Frequency (RF) were worked out for each treatment to express the ecological significance of a floral species based on a single value (Thomas and Abraham, 1996). Summed Dominance Ratio (SDR) was worked out using RD and RF values (Table 2).

Assessment on Weed Biomass

Weeds in area of 0.25 m^2 covered by quadrat was uprooted at third, sixth, twelfth weeks and fresh weight was measured using an electronic top loading balance of BL - 2200 H type. The samples were dried at 105 ^{0}C for 48 hours in an oven (German Memmert type) to determine the dry weight.

Growth Assessment in Cinnamon

Height of cinnamon plants in each plot was measured and number of shoots of cinnamon plants in each plot was counted in four week intervals.

Table 1-Details of the treatments used in the experiment:

Treatment No.	Treatment
T_1	Diuron(20g/10l) after clean Weeding
T_2	Glyphosate(100ml/16l)
T_3	Mixture of Diuron(10g/5l) and Glyphosate (50ml/8l)
T_4	Glyphosate (100ml/16l) Followed by Diuron(20g/10l, One week after applying Glyphosate)
T_5	Manual weeding by slashing

Table 2 -Equations of the indices needed for floral assessment in the cinnamon field:

Index	Equation
Density	$\frac{\text{Total count of the from all sites species}}{\text{Number of sites where the species is present}}$
Frequency	$\frac{\text{Number of sites where the species occur}}{\text{Total number of Surveyed}}$
RD	$\frac{\text{Density of a Species} \times 100}{\text{Sum density of all species}}$
RF	$\frac{\text{Frequency of a Species} \times 100}{\text{Sum frequency of all species}}$
SDR	$\frac{RD + RF}{2}$

RESULTS AND DISCUSSION

Assessment on Floral Distribution

Hediyotis auricularia belongs to the family Rubiaceae was the most dominant species among the 12 floral species found at the third week whilst *Euphorbia heterophylla* of family Euphorbiaceae dominated at the 12th week among 15 floral species in plots treated with diuron.

Nevertheless at the family level, Rubiaceae was the most dominant followed by Leguminaceae at three weeks after the application. Total SDR value of both families was 61.08 representing over 60 percent of species.

By 12 weeks after application, Leguminaceae became most dominant family followed by Euphorbiaceae and Verbinaceae. Total SDR value of these three families was 58.34 showing their high dominance (Figure 1).

Euphorbia heterophylla of Euphorbiaceae family was dominant among 12 floral species at third week and *Lantana camara* of Verbinaceae family was dominant among 14 floral species at 12th week in glyphosate applied plots.

Verbinaceae was the most dominant family observed at three weeks after application of glyphosate followed by Rubiaceae and Euphorbiaceae. Total SDR value of these three families was 69.4 representing more than 65 percent of the species. Leguminaceae was the most dominant family observed at 12 weeks after application followed by Verbinaceae and Euphorbiaceae. Total SDR value of these three families was 62.5 representing more than 60 percent of the species (Figure 2).

When considering the plots treated with the mixture of diuron and glyphosate, 10 and 13 floral species were found. Among them *Lantana camara* of family Verbinaceae and *Calapoganium mucunoides* of family Leguminaceae were the most widely spread plant species at 3rd and 12th weeks after treatment respectively.

Rubiaceae became the most dominant family at three weeks after application followed by Verbinaceae. Total SDR value of both families was 54.34 representing more than 50 percent of the species. However, Leguminaceae was the most dominant family by 12 weeks after application followed by Euphorbiaceae. Total SDR value of both families was 55.22 representing more than 50 percent of the species (Figure 3).

Hediyotis auricularia of Rubiaceae family *was* the most dominant among 13 and 15 floral species that were found at 3rd week and 12th week respectively in plots treated with diuron followed by glyphosate.

Rubiaceae was the most dominant family at third week after application followed by Verbinaceae and Leguminaceae. Total SDR value of these three families was 66.78 representing more than 65 percent of the species. Similarly, Rubiaceae was the most

dominant family observed at 12 weeks after application followed by Leguminaceae and Verbinaceae. Total SDR value of these three families was 66.91 representing more than 65 percent of the species (Figure 4).

In manually weeded plots, *18* and 16 floral species were found three weeks and 12 weeks after application respectively with *Lantana camara* of Verbinaceae family as the most widely spread plant species.

Verbinaceae was the most dominant family observed at three weeks after the treatment followed by Leguminaceae. Total SDR value of both families was 50.8 representing over 50 percent of the species. Similarly, Verbinaceae was the most dominant family followed by Rubiaceae and Leguminaceae after 12 weeks. Total SDR value of these three families was 63.03 representing over 60 percent of the species (Figure 5).

Assessment on weed biomass

Weed biomass was highest in manually weeded plots. The lowest biomass was observed in diuron applied plots until the sixth weeks after weedicide application and then by 12 weeks, the lowest was recorded in glyphosate applied plots (figure 6). But, there was no significant difference in relative biomass among chemical treatments (Table 3). Although the lowest total biomass was observed in diuron applied plots, application of this chemical was difficult as it requires pre clean weeding which demands higher labour inputs and time. Diuron after glyphosate was also observed as a difficult method since two herbicides had to be applied at one week interval.

Glyphosate application (T_2) seemed to be the best method when considering the convenience in application. However, this conclusion can be affected by various factors such as labour availability, chemical cost, social and environmental factors. Therefore, this investigation has to be continued with analyses of other factors affecting weed control.

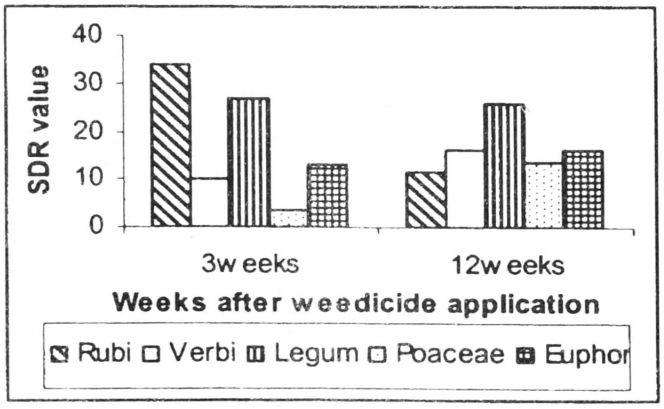

Figure 1- Summed dominance ratio of main weed families after application of diuron,
Codes for families: Rubi: Rubiaceae, Verbi: Verbinaceae, Legum: Leguminaceae, Poaceae: Poaceae, Euphor: Euphorbiaceae.

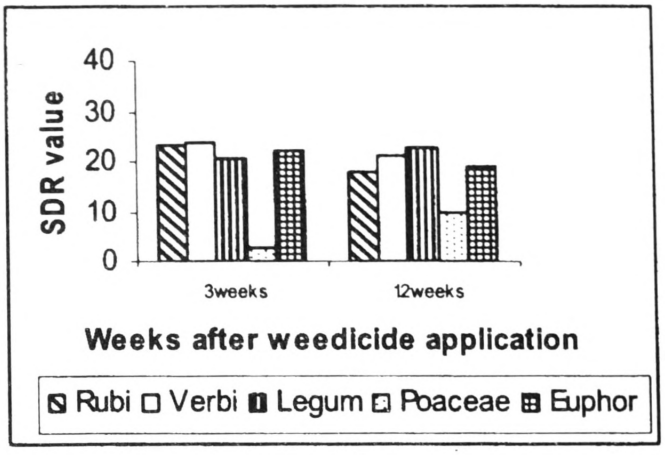

Figure 2 - Summed dominance ratio of main weed families after application of glyphosate,
Codes for the families are same as in the figure1.

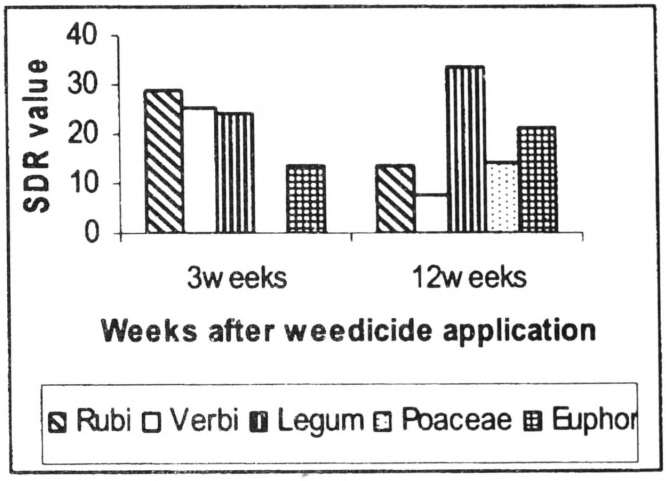

Figure 3 - Summed dominance ratio of main weed families after application of mixture of diuron and glyphosate,
Codes for the families are same as in the figure1.

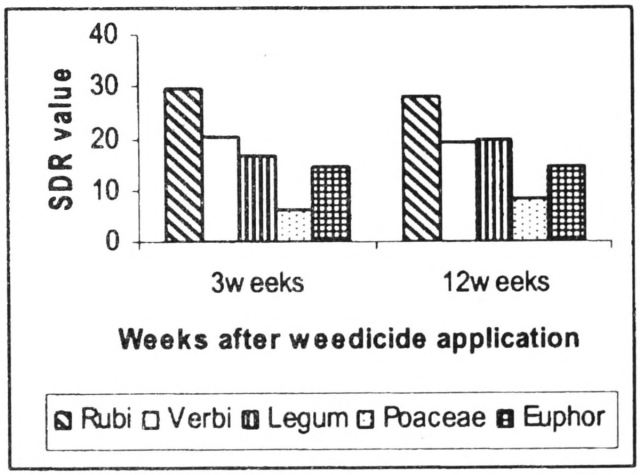

Figure 4 - Summed dominance ratio of main weed families after application of diuron followed by glyphosate,
Codes for the families are same as in the figure1.

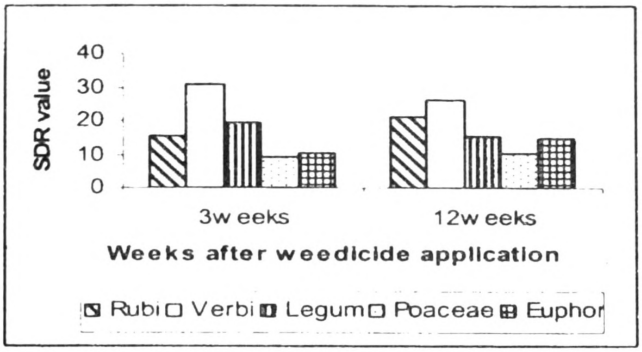

Figure 5- Summed dominance ratio of main weed families after manual weeding, Codes for the families are same as in the figure1.

Growth Assessment in Cinnamon

The height of the cinnamon plants was lowest in manually weeded plots (Figure 7). This could be due to the high level of weeds present in the manually weeded plots. However, growth difference of cinnamon among treatments was not significant (Table 4).

Shoot number of cinnamon plants in each plot was reduced at eight weeks. But, it reduced until the end of 12th week in diuron and diuron after glyphosate applied plots. However, number of shoots in those plots increased thereafter (Figure 8). Nevertheless, these differences were not significant (Table 5). In the application of chemicals, extra care should be taken, particularly with high concentration, as there have been some earlier records in the reduction of number of shoots in cinnamon where chemical weed control was practiced (Bavappa *etal.*, 2005).

Table 3 -Relative difference of weed biomass when compared to manual weeding :

Treatment	3w	6w	12w
T_1	-93.92[a]	-83.75[a]	19.23[a]
T_2	-63.92[a]	-39.57[a]	34.49[a]
T_3	-96.21[a]	-77.53[a]	141.39[a]
T_4	-68.55[a]	-68.80[a]	30.12[a]

Means in a column followed by the same letter are not significantly different at P>0.05 level, w= weeks

Table 4 - Mean height of cinnamon plants:

Treatment	4w	8w	12w	16w
T_1	50.64[a]	56.04[a]	63.55[a]	70.39[a]
T_2	47.51[a]	54.29[a]	60.02[a]	66.37[a]
T_3	50.43[a]	57.23[a]	63.19[a]	68.90[a]
T_4	47.98[a]	55.58[a]	61.13[a]	69.37[a]
T_5	45.94[a]	52.51[a]	56.19[a]	61.41[a]
CV	14.39	12.59	11.99	13.58
LSD	12.70	12.63	13.27	16.65

Means in a column followed by the same letter are not significantly different at P>0.05 level, w= weeks, CV= Coefficient of Variance , LSD=Least Significant Difference

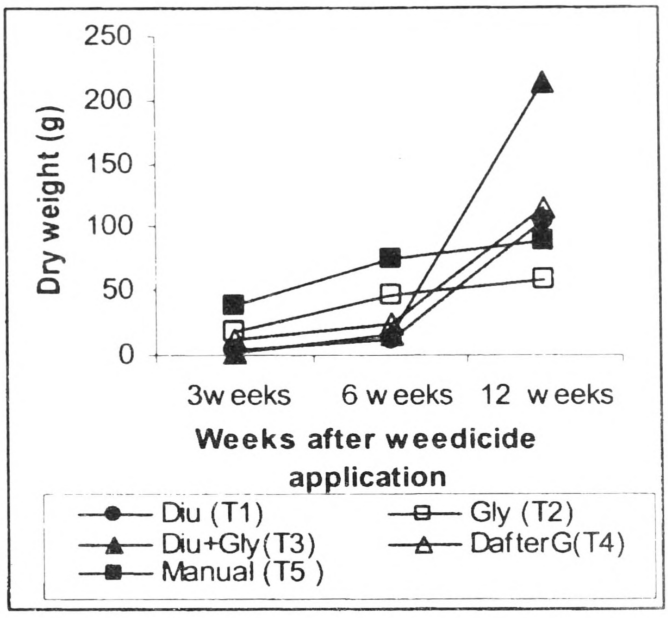

Figure 6 - Effect of weed control methods in weed dry weight, Details of the treatment codes are given in table 1.

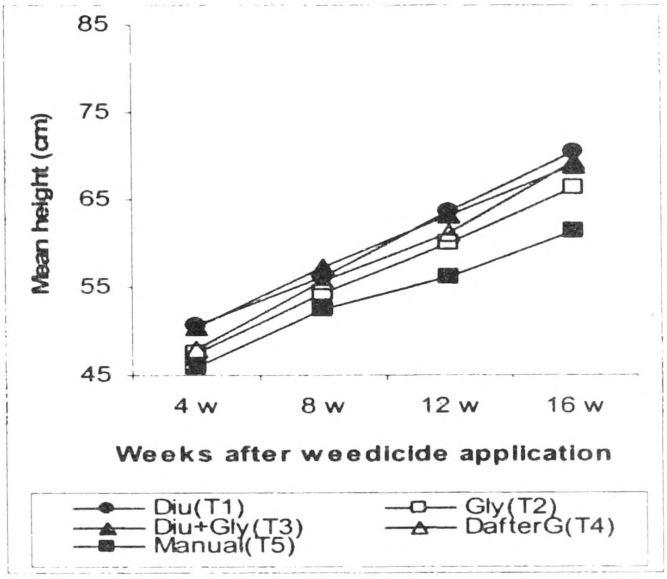

Figure 7- Mean height of cinnamon plants, Details of the treatment codes are given in table 1. w= weeks

Table 5 - Mean shoot number of cinnamon plants:

Treatment	4w	8w	12w	16w
T1	4.71[a]	4.45[a]	4.34[a]	4.88[a]
T2	4.23[a]	4.06[a]	4.09[a]	4.15[a]
T3	4.92[a]	4.65[a]	4.79[a]	5.03[a]
T4	5.09[a]	4.36[a]	4.18[a]	4.39[a]
T5	4.13[a]	4.05[a]	4.24[a]	4.58[a]
CV	16.47	17.27	16.36	14.83
LSD	1.38	1.36	1.29	1.24

Means in a column followed by the same letter are not significantly different at P>0.05 level, w= weeks, CV=Coefficient of Variance, LSD=Least Significant Difference

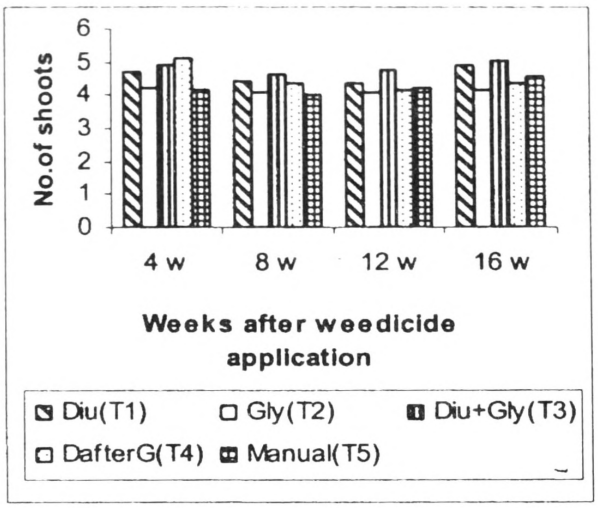

Figure 8- Mean shoot numbers of cinnamon plants, Details of the treatment codes are given in table 1. w= weeks

CONCLUSIONS

Rubiaceae , Verbinaceae, Leguminaceae and Euphorbiaceae were the most dominant families in study area whilst *Hediyotis acuricularia,Lantana camara*, *Euphorbia heterophylla*, were the most dominant floral species .

Shoot number and height of cinnamon plants were not affected by applying chemicals in the present study at concentrations used.

When compared to the manual weeding, all other treatments had higher level of weed control in rubber-cinnamon intercrop. Considering the convenience in application, glyphosate (T_2) would be more appropriate chemical to be used as weed control.

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