Contact herbicides combined with mineral oil to control dayflower weeds

Tomaz Marques Leite[1]

Gustavo Rabelo Botrel Miranda[2]

Willis dos Santos Medeiros[3]

Priscila Pereira Botrel[4]

Alberto Donizete Alves[5]

Abstract

Dayflower weeds are tolerant to some herbicides; an alternative for their control is the addition of adjuvants in the solution to be applied to improve the efficiency of these products. Thus, the objective of this work was to evaluate the effect of application of different herbicides with and without adjuvants on the control of dayflower weeds. The experiment was conducted under field conditions in April 2015 on the Santo Azarias Farm, Muzambinho, state of Minas Gerais, Brazil. The area had coffee crops (cultivar Catuaí/Vermelho 144) with plant spacing of 3.00 m × 1.00 m, which had been subjected to a hard pruning. A randomized block experimental design was used, with 9 treatments in 3 blocks, totaling 27 plots. The treatments consisted of four contact herbicides (Saflufenacil 700.0 g kg^{-1}, at 140.0 g c.p. ha^{-1}; Bentazon 600.0 g L^{-1}, at 1.2 L c.p. ha^{-1}; Paraquat 200.0 g L^{-1}, at 3.0 L c.p. ha^{-1}; and MSMA 720.0 g L^{-1}, at 4.0 L c.p. ha^{-1}) and an adjuvant (Nimbus®, mineral oil, 428.0 g L^{-1}) at the rate of 0.3% of the solution volume. The plants in the treatments were evaluated visually by three people every three days, using a scale of grades of control. The plants were weighed every seven days after application of the herbicides to evaluate the percentage of water loss. The treatments MSMA, and MSMA combined with mineral oil presented the best results for the control of dayflower weeds.

Keywords: *Commelina* spp. Weed control. Chemical control.

Introduction

Several factors, abiotic or biotic, can affect the development and production of coffee crops. Weeds are among the biotic factors that affect the plant grown due to competition for light, nutrients, and water, and due to their allelopathic effects. Moreover, they are hosts of pests and diseases and hinder cultural practices, such as harvest, soil fertilization, and application of pesticides (PITELLI; DURIGAN, 1984).

1 Instituto Federal de Educação, Ciência e Tecnologia do Sul de Minas Gerais (IFSULDEMINAS) – *Campus* Muzambinho. Graduado em Tecnólogo em Cafeicultura. tomazmarques.mb@gmail.com.

2 IFSULDEMINAS – Campus Muzambinho. Professor. grbmiranda@gmail.com. Estrada de Muzambinho, km 35, Bairro Morro Preto, Cx. Postal 02, CEP: 37890-000, Muzambinho, MG, Brasil.

3 IFSULDEMINAS – *Campus* Muzambinho IFSULDEMINAS – *Campus* Muzambinho. Graduado em Tecnólogo em Cafeicultura. willis.medeiros@hotmail.com.

4 IFSULDEMINAS – *Campus* Muzambinho. Professora. priscila.botrel@muz.ifsuldeminas.edu.br..

5 IFSULDEMINAS – *Campus* Muzambinho. Professor. alberto.alves@muz.ifsuldeminas.edu.br.

Dayflowers are among the weed species that most compromise coffee crops. These plants are from the genera *Commelina* and *Tripogandra* (Commelinaceae) and are the most important weeds in the world; *Commelina benghalensis* L. is the most spread species (HOLM et al., 1997).

The effect of these weed plants is aggravated when dealing with crops at implementation and initial development stages. In these cases, coffee plants present a slow growth and, therefore, suffer intense effects from competition with weeds for environmental resources (KOGAN, 1992).

Dayflowers reproduce by seeds and vegetative parts; they are perennial herbaceous plants that have erect or semi-prostrate growth habit and are easily disseminated. They have preference for clay-ey, moist, shaded soils, becoming a big problem for coffee crops, which provide these characteristics in their interrow environment; mechanical control of dayflowers is inefficient due to the easy vegeta-tive propagation of these species (BATISTA et al., 2010).

The type of herbicide to be used is usually a bigger concern than the application technic, dis-regarding the importance of a good distribution of the solution on the target area, which can be im-proved with use of adjuvants. In fact, application of herbicides can be more efficient when the solution is better spread on the leaf target (CUNHA, et al., 2003; MATIELLO; FREITAS; GOUVÊA, 2005).

Adjuvants are commonly used for herbicide applications to improve the efficiency of the for-mulations, regardless of the target. Adjuvants can improve the final performance of a product in two ways: some adjuvants alter the chemical composition of the solution (surfactants), favoring the retention of the product by the leaf surface, for example, decreasing the water surface tension and increasing the spreading of the drops on the leaf; and others change the plant leaf surface (additives), favoring the penetration and absorption of the product by the plants.

Adjuvants are used in solutions for application of pesticides to modify their physical-chemical characteristics, changing their interfacial forces, and improving the effect of these substances due to a uniform application of the solution and a decrease in the water surface tension (IOST, 2008).

According to Alves et al. (2010), the rotation of products with different active ingredients is among the techniques recommended for the use of herbicides in coffee crops; it is a chemical strategy to avoid the emergence and spread of plants that are resistant or tolerant to herbicides.

In this context, the objective of the present work was to evaluate the effect of application of different herbicides with and without adjuvant on the control of dayflower weeds.

Material and methods

The experiment was conducted in field conditions in April 2015 on the Santo Azarias Farm, in Muzambinho, state of Minas Gerais, Brazil (21°17'26.64"S, 46°29'58.44"W, and altitude of 974 meters). The area had coffee crops (cultivar Catuaí/Vermelho 144, planted in 1985) with plant spacing of 3.00 × 1.00 m, which had been subjected to a hard pruning.

The experiment was conducted in a randomized block design, with 9 treatments in 3 blocks, totaling 27 plots. The treatments consisted of four contact herbicides (Heat® Ludwigshafen, Germany, saflufenacil 700.0 g kg^{-1}, at 140.0 g c.p. ha^{-1}; Basagram®, bentazon 600.0 g L^{-1}, at 1.2 L c.p. ha^{-1}; Gramoxone®, paraquat 200.0 g L^{-1}, at 3.0 L c.p. ha^{-1}; and MSMA®, monosodium methanearsonate 720.0 g L^{-1}, at 4.0 L c.p. ha^{-1}) and an adjuvant (Nimbus®, mineral oil, 428.0 g L^{-1}) at the rate of 0.3% of the solution volume. The size of the plots was 2.5 m × 1 m.

The solutions were applied using a CO_2-pressurized sprayer equipped with twin flat broadcast spray tips (TwinJet TJ-60 110/02VS; Teejet®, Wheaton, USA), which were set to a solution flow rate of 383.0 L ha^{-1} (test in blank) and pressure of 241.3 kPa. The climate conditions at the time of application were: wind speed of 1.4 m s^{-1}, maximum air temperature of 26.8 ºC, minimum air temperature of 24.6 ºC, and relative air humidity of 73%.

The plants in the treatments were evaluated visually by three people every three days, using a scale of grades of control, according to Velini (1994), in which 5 represents excellent or total control of the species under study; 4 represents good, acceptable control in the infested area; 3 represents moderate, insufficient control in the infested area; 2 represents deficient or inexpressive control; and 1 represents absence of control.

The direct efficiency of herbicides was also evaluated using the drying method: the fresh and dry weights of the plants (dayflower weeds) were evaluated every 7 days after herbicide application. The samples were dried in an oven at 45 °C until constant weight, which reached 60 hours. The samples were collected in the field in areas of 0.16 m^2 that were measured using a metallic ring.

The data were tabulated in spreadsheets and subjected to evaluation by the F test; the means were subjected to the Scott-Knott test at 5% significance for the indirect evaluation (scale of grades) and at 10% significance for the direct method of evaluation (drying of the plants), using the Sisvar 4.3 program (FERREIRA, 2011).

Results and discussion

The results of the indirect evaluation by scale of grades at 3, 6, 9, 12, 15, 18, and 21 days after application (DAA) of the herbicides are presented in Table 1.

Table 1 – Grades attributed to the control of dayflower weeds by herbicides combined with adjuvant (mineral oil). Muzambinho, MG, Brazil, 2019.

Treatment	Days after application (DAA)						
	3DAA	6DAA	9DAA	12DAA	15DAA	18DAA	21DAA
Saflufenacil	1.000B	2.333B	2.666A	2.666A	2.333A	1.666B	2.000B
Saflufenacil + Mineral oil	1.000B	4.000A	3.666A	3.666A	2.666A	2.666A	2.333B
Bentazon	1.000B	2.333B	2.333A	1.666B	1.333B	1.000B	1.000C
Bentazon + Mineral oil	1.000B	1.333B	1.000B	1.000B	1.000B	1.000B	1.000C
Paraquat	1.666B	4.333A	3.333A	3.333A	3.333A	3.000A	2.333B
Paraquat + Mineral oil	3.333A	4.666A	4.666A	4.000A	3.333A	3.000A	2.333B
MSMA	1.666B	4.000A	4.333A	4.000A	4.000A	3.666A	4.000A
MSMA + Mineral oil	1.000B	3.333A	3.000A	3.333A	2.666A	3.000A	4.000A
Control	1.000B	1.000B	1.000B	1.000B	1.000B	1.000B	1.000C
CV (%)	9.350	15.16	15.92	14.82	15.54	16.97	9.2

MSMA = monosodium methanearsonate; *Significant at 5% probability. Means followed by the same letter in the columns are not different by the Scott Knott test at 5% probability.

Source: Elaborated by the authors (2019).

The treatment with application of paraquat combined with mineral oil presented weed control at 3 DAA, whereas the other treatments presented similar results to those of the control treatment (TABLE 1). Therefore, the adjuvant accelerated the action of paraquat at 3 DAA; this result is consistent with those found by Theisen and Ruedell (2004), who reported that the addition of adjuvants improves the solution applied and the conditions for the protection and absorption of herbicides.

The treatments with applications of saflufenacil combined with mineral oil; paraquat; paraquat combined with mineral oil; MSMA; and MSMA combined with mineral oil presented weed control at 6 DAA, whereas the other treatments were inefficient (TABLE 1).

Marchi et al. (2008) reported that the action of contact herbicides is fast in the contact point and does not allow them to move into the internal systems of plants, i.e. they are not translocated as systemic herbicides that move from leaves to the growth point of plants (translocated via phloem); this makes the contact herbicides preferred to the systemic ones by killing weeds very rapidly and enabling the planting of crops soon after the treatment because they are not persistent.

The results confirmed that contact herbicides are more efficient for weed control in terms of time.

The treatment with application of bentazon combined with mineral oil resulted in no weed control at 9 DAA, remaining equal to the control.

Despite the addition of mineral oil, improvement of the solution applied and the conditions for protection and absorption of the herbicide molecules, some active ingredients were not efficient, as in the case of bentazon.

The treatments with applications of bentazon and bentazon combined with mineral oil presented no weed control from 12 DAA to 15 DAA, presenting similar results to the control (TABLE 1).

According to Silva et al. (2001), before presenting phytotoxic action, the herbicide should be absorbed via apoplast or simplest systems and reach the site of action, which is usually in the interior of an organelle (HESS; FALK, 1990). However, part of the herbicide that reaches the leaf surface can slide and be washed, volatilize, dry as an amorphous sediment, crystalize after evaporation of the solvent, or even penetrate the cuticle and remain associated with lipidic compounds of this layer and not be translocated. An immediate consequence is the decrease in the herbicide action for the control of weeds.

Some contact herbicides act rapidly in the control of weeds, but their efficiency is not satisfactory in relation to their residual action in DAA.

The treatments with applications of saflufenacil; bentazon; and bentazon combined with mineral oil presented no weed control at 18 DAA, remaining similar to the control (TABLE 1).

Heap (2006) defined resistance of weeds to herbicides as the ability of plants to survive and reproduce after exposition to a normally lethal rate of herbicide for the wild biotype of the plant. This denotes that the characteristic of resistance to herbicides of a plant can be a natural occurrence by selection in weeds populations of natural occurrence in the field, or can be induced by techniques of genetic engineering or selection of variants produced by tissue cultures or mutagenesis.

The dayflowers presented regrowth at 18 DAA, i.e., capacity of surviving and reproduction, denoting that the herbicides used were not efficient.

The treatment MSMA and the treatment MSMA combined with mineral oil showed better weed control at 21 DAA than the other treatments, and they did not differ from each other (TABLE 1).

According to Pitelli (1990), the first goal of any weed management system is the maintenance of the most inhospitable possible environment to the weeds through the specific or combined use of biological, cultural, mechanical, and chemical methods.

Therefore, the choice of the method to be used for weed control should also be considered. Thus, technical information about the plant species is required to obtain the best efficiency of the chosen method and provide a lower financial cost to the producer.

The results of the evaluations from the drying method presented no differences in relation to those of the control from 7 to 14 DAA (TABLE 2).

Table 2 – Water loss efficiency (drying in an oven at 45 **ºC)** at 7, 14, and 21 days after application (DAA) of herbicides. Muzambinho, MG, Brazil, 2019.

Treatment	Water loss (%)		
	7 DAA	**14 DAA**	**21 DAA**
Saflufenacil	59.333A	37.333A	74.666B
Saflufenacil + Mineral oil	55.000A	39.333A	69.333A
Bentazon	65.000A	33.000A	73.666B
Bentazon + Mineral oil	62.000A	36.666A	77.333B
Paraquat	62.666A	36.000A	68.333A
Paraquat + Mineral oil	64.000A	40.666A	69.333A
MSMA	61.666A	38.666A	62.000A
MSMA + Mineral oil	63.000A	40.000A	64.333A
Control	69.333A	37.666A	72.333B
CV (%)	12.94	14.11	7.85

MSMA = monosodium methanearsonate. Means followed by the same letter in the columns are not different by the Scott Knott test at 10% probability.

Source: Elaborated by the authors (2019).

The treatments with applications of saflufenacil without mineral oil; and bentazon with and without mineral oil; and the control treatment showed higher water losses than the other treatments at 21 DAA (TABLE 2).

According to Wilson (1981), the difficulty in controlling species of the Commelinaceae family can be attributed to their double mechanism of reproduction—by seeds and by rooting of buds.

The water loss was relatively lower in the treatments with applications of saflufenacil combined with mineral oil; paraquat with and without mineral oil; and MSMA with and without mineral oil because of their lower amount of water caused by the drying promoted by the herbicides applied with and without the adjuvant.

Conclusions

The treatment MSMA and the treatment MSMA combined with mineral oil presented the best control and highest residual time.

The addition of mineral oil to the herbicides did not improve the control of dayflower weeds.

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Efeito de herbicidas de contato associados ao adjuvante no controle de trapoeraba

Resumo

A trapoeraba é uma planta daninha tolerante a alguns herbicidas, e uma das alternativas para seu controle é a adição de adjuvantes na calda para melhoria da eficácia desses produtos. Assim, o objetivo do trabalho foi avaliar o efeito de diferentes herbicidas com e sem adjuvantes no controle da trapoeraba. O experimento foi implantado em abril de 2015 e conduzido em condições de campo no Sítio Santo Azarias no município de Muzambinho, sul de Minas Gerais com o cultivar Catuaí/ Vermelho 144 em plantio convencional de espaçamento 3,00m x 1,00m (recepada). O delineamento experimental utilizado foi em blocos casualizados (DBC), contendo 9 tratamentos em 3 blocos, totalizando 27 parcelas, sendo utilizados quatro tipos de herbicidas de contato, mais um adjuvante: Heat® (saflufenacil, 700,0 g kg^{-1} i.a.), na dose de 140,0 g p.c. ha^{-1}, Basagram® (bentazona 600,0 g L^{-1} i.a.), na dose 1,2 L p.c. ha^{-1}, Gramoxone® (paraquat, 200,0 g L^{-1} i.a.), na dose de 3,0 L p.c. ha^{-1}, MSMA® (sodium hydrogen methylarsonate, 720,0 g L^{-1} i.a.), na dose de 4,0 L p.c. ha^{-1} e adjuvante Nimbus® (óleo mineral, 428,0 g L^{-1}), na dose 0,3% sobre o volume de calda. O experimento foi avaliado por três pessoas a cada três dias usando uma escala de notas de controle. As plantas foram pesadas a cada sete dias após aplicação do herbicida para avaliar a percentagem de perda de água. Os tratamentos MSMA® e MSMA® com adição de Nimbus® apresentaram os melhores resultados para o controle da trapoeraba.

Palavras-chave: *Commelina spp.* Planta daninha. Controle químico.

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