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Benghal dayflower control with different glyphosate formulations[1]

Controle de trapoeraba com diferentes formulações de glyphosate

Felipe Paolinelli de Carvalho[2]; Ricardo Henrique São José[3]; Lorena Caroline de Moraes Lopes[2]; Cláudio Pagotto Ronchi[4]

Abstract - Benghal dayflower (*Commelina benghalensis* L.) is a weed plant that easily infests agricultural areas due to its aggressive characteristics associated with reproductive aspects of the species. One important aspect of this plant is presenting its tolerance to the glyphosate. An experiment in greenhouse was conducted to verify the effects of different formulations and commercial products of glyphosate in controlling benghal dayflower. The experimental design was completely randomized, with four replications. The plants were grown in pots filled with eight liters of substrate each, consisting of soil, sand and tanned cattle manure until they have reached the stage of development of the second growth sector, when the following products and their commercial formulations were applied: Roundup Original® – isopropylamine salt; Trop® – isopropylamine salt; Roundup WG® – ammonium salt; Zapp QI® – potassium salt; Roundup Transorb R® = potassium salt and Crucial® – isopropylamine salt + potassium salt. The intoxication of benghal dayflower plants was visually assessed at 7, 14 and 21 days after application of the products, and leaf area, dry matter of leaves, dry matter of the stem, dry matter of root and total dry matter at 21 days after application. The treatments show significant differences in the toxicity of the plants after 14 days of application, and at 21 days it was found that the products Roundup WG® and Crucial® were more toxic to plants. The products Roundup WG® and Crucial® were highlighted with greater reductions in dry matter of the leaves, stem and total plant. In general, the benghal dayflower has not been effectively controlled by the products at the doses tested and/or by the application after the emission of the second branch of weed. Among the commercial formulations or products, the ammonium salt is highlighted – Roundup WG® and the mixture of isopropylamine salt with potassium salt – Crucial® presents higher efficiency in weed control.
Keywords: *Commelina benghalensis*; isopropylamine salt; potassium salt; ammonium salt

Resumo - A trapoeraba (*Commelina benghalensis* L.) é uma planta daninha que infesta facilmente áreas agrícolas devido à suas características de agressividade associadas aos aspectos reprodutivos da espécie. Um dos aspectos importantes desta planta apresentar é sua tolerância ao herbicida glyphosate. Um experimento em ambiente protegido foi realizado para verificar os efeitos de diferentes formulações e produtos comerciais do herbicida glyphosate no controle da trapoeraba. O delineamento experimental utilizado foi o inteiramente casualizado, com quatro

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[2] Universidade Federal de Viçosa - Campus Florestal; Rua Rodovia LMG 818, km 06 – CEP 35690-000 – Florestal (MG), Brasil, (felipepaolinelli@yahoo.com.br; lopeslorena98@yahoo.com.br).
[3] Universidade Federal de Viçosa - Campus Florestal; Graduando em Agronomia, Rua Rodovia LMG 818, km 06 – CEP 35690-000 – Florestal.
(MG), Brasil, (ricardogsaojose@gmail.com).
[4] Universidade Federal de Viçosa - Campus Florestal; Professor Adjunto do Instituto de Ciências Agrárias, Rua Rodovia LMG 818, km 06 – CEP 35690-000 – Florestal (MG), Brasil, (claudiopagotto@yahoo.com.br).

repetições. As plantas foram cultivadas em vasos preenchido com oito litros de substrato cada, composto por solo, areia e esterco de curral curtido até atingiram o estádio desenvolvimento de crescimento do segundo ramo, quando aplicaram-se os seguintes produtos e suas respectivas formulações comerciais: Roundup Original® – sal de isopropilamina; Trop® – sal de isopropilamina; Roundup WG® – sal de amônio; Zapp QI® – sal de potássio; Roundup Transorb R® = sal de potássio e Crucial® – sal de isopropilamina + sal de potássio. A intoxicação das plantas de trapoeraba foi avaliada visualmente aos 7, 14 e 21 dias após a aplicação do produtos, e a área foliar, matéria seca das folhas, matéria seca do caule, matéria seca da raiz e matéria seca total aos 21 dias após a aplicação. Os tratamentos mostraram diferenças significativa na intoxicação das plantas após 14 dias da aplicação e aos 21 dias contatou-se que os produtos Roundup WG® e Crucial® foram os mais tóxicos às plantas. Os produtos Roundup WG® e Crucial® foram destacados com maiores reduções na matéria seca das folhas, do caule e a total das plantas. No geral, a trapoeraba não foi eficientemente controlada pelos produtos nas doses testadas e/ou com aplicação logo após a emissão do segundo ramo da planta daninha. Entre as formulações comerciais ou produtos, destaca-se o sal de amônio – Roundup WG® e a mistura sal de isopropilamina com sal de potássio – Crucial® com eficiência superior no controle da planta daninha.
Palavras-chaves: *Commelina benghalensis*; sal de isopropilamina; sal de potássio; sal de amônio

Introduction

The benghal dayflower (*Commelina benghalensis* L.) has excelled among the main weeds of Brazilian agricultural areas. This has occurred because of the aggressive characteristics such as production of overhead and underground seed, seeds numbness, reproduction in water stress condition and planting (Webster and Grey, 2008). Furthermore, this species is widely used tolerance to herbicides such as glyphosate (Tuffi Santos et al., 2004; Monqueiro et al., 2005, Rocha et al., 2007).

Glyphosate is a total action herbicide, which efficiently controls a large number of weeds (Petter et al., 2007). It has been used in various forms and application times. The main application indications are in desiccation before planting, in the post-emergency transgenic crops tolerant to the herbicide, and jet directed on weeds in crops with spacing as to enable such mode. Such herbicides inhibit the enzyme EPSPs (5-enolpyruvylshikimate-3-phosphate synthase), which is the precursor of aromatic amino acids essential to growth and development of plants, and plants when sprayed with glyphosate stop growing and die seven to 30 days after application. The extensive use of glyphosate contributes to the establishment of benghal dayflower, without interference from other species susceptible to the product.

In Brazil, there are several commercial products registered with glyphosate as the active ingredient, with isopropyl amine salt, potassium salt and ammonium salt formulations (Rodrigues e Almeida, 2005; AGROFIT, 2015). Each formulation has its own characteristics that influence efficiency in control, to change the speed of absorption, translocation and action (Molin and Hirase, 2005), which are also dependent on the weed species present (Li et al., 2005). Thus, the characteristics of each commercial formulation may result in different levels in controlling benghal dayflower.

This study aim was to investigate the effects of using different formulations and commercial products of glyphosate in controlling benghal dayflower.

Material and Methods

The experiment was conducted in greenhouse with roof made up of transparent polyethylene 100 μm thick and 50 mesh polyethylene screen side. In the trial period the average temperature was 28°C and relative humidity 62%. Seedlings of benghal dayflower

(*Commelina benghalensis* L.) were collected in the field at the first true leaf development stage. Each seedling was transplanted in pots filled with eight liters of substrate consisting of soil, sand and manure hardened sieved in 2 mm sieve at the proportion of 2:1:1 (soil:sand:manure).

The completely randomized design was used in the experiment with four replications. The treatments were applied at 25 days after transplanting of benghal dayflower, when the plants were at the second branch development stage. Each plot was represented by a pot containing a plant; the treatments were established with applications of different commercial products and glyphosate formulations in the same dosage 1080 g ha^{-1} of the equivalent glyphosate acid. Thus the treatments were the application of Roundup Original® (isopropylamine salt), Trop® (isopropylamine salt), Roundup WG® (ammonium salt), Zapp QI® (potassium salt), Roundup Transorb R® (potassium salt) e Crucial® (isopropylamine salt and potassium salt) (Table 1).

Table 1. Compounds treatments of different products and formulations applied on benghal dayflower weed species (*Commelina benghalensis* L.).

Treatment	Commercial Product	Formulation	Glyphosate dose (g ha^{-1} a.e.)
TEST	Control	-	0,0
RORSI	Roundup Original®	Isopropylamine salt	1080,0
TROSI	Trop®	Isopropylamine salt	1080,0
RWGSA	Roundup WG®	Amonium salt	1080,0
ZAPSP	Zapp QI®	Potassium salt	1080,0
RTRSP	Roundup Transorb R®	Potassium salt	1080,0
CRUCIP	Crucial®	Isopropylamine salt and potassium salt	1080,0

[1/] solid product unit kg ha^{-1}.

Treatments were applied with the aid of scientific accuracy spray, pressurized with CO_2, equipped with a bar with two nozzles TT110.02 spaced at 50 cm and providing spray volume of 180 L ha^{-1}. The application was carried out between eight and nine o'clock in the morning. Weather conditions at the time of application were as follows: relative humidity 68%, temperature 23.0 °C and wind speed 3.6 km h^{-1}.

Visual assessments of poisoning caused by glyphosate in benghal dayflower plants were performed at 7, 14 and 21 days after application of the products. Grades were attributed to phytotoxicity from 0 to 100%, where 0 represents the absence of toxicity in the plant and 100 represents the death of the plant.

After 22 days of treatment application, the evaluation of the plant growth was performed. For this purpose, each plant was cut at soil level and the aerial part separated into leaf and stem, and subsequently stored in identified paper bags. Immediately after, the leaf area was determined by the determiner unit areas LICOR model LI-3100C. The roots were separately washed and stored in paper bags. All materials were placed in a air circulation greenhouse, at 70 °C until the achievement of the samples constant weight. Then the samples were weighed separately by portion and part of the plant, using a 0.001 g precision balance.

Data were subjected to analysis of variance ($p \geq 0.05$) and when significant, they were subjected to the Tukey test ($p \geq 0.05$) to compare the treatment means.

Results and Discussion

The evaluation of benghal dayflower (*Commelina benghalensis* L.) intoxication after the application of different commercial products and glyphosate formulations showed that seven days after applying the product the plants did not present visual symptoms (Table 2). Glyphosate needs to be absorbed and transported to the site of action so it can

demonstrate the phytotoxic effect. This herbicide inhibits the biosynthesis of amino acids essential to plants, paralyzing the fast growth of treated plants, though the possible effects that can be observed visually appear next 15 days after application in benghal dayflower (Tuffi Santos et al., 2004), and may vary up to 30 days from the application, depending on the dose of the herbicide and on the plant growth stage.

Table 2. Visual intoxication of benghal dayflower weed (*Commelina benghalensis* L.) after application of different glyphosate commercial products.

Tratamentos	Época de avaliação após a aplicação		
	7 dias	14 dias	21 dias
	----------%----------		
TEST	0 a	0 c	0 c
RORSI	0 a	40 b	53 b
TROSI	0 a	33 b	45 b
RWGSA	0 a	55 a	73 a
ZAPSP	3 a	43 b	55 b
RTRSP	0 a	40 b	53 b
CRUCIP	0 a	50 ab	75 a
DMS	3	11	17
CV (%)	31	31	32

TEST – Control without glyphosate application, RORSI – Roundup Original® application, TROSI – Trop® application, RWGSP – Roundup WG® application, ZAPSA – Zapp QI® application, RTRSA – Roundup Transorb® application, CRUCIP – Crucial® application, MSD – mean signed difference, CV – Coefficient of variation.

At 14 days after application it was observed that all treatments caused poisoning in weed (Table 2). RW GSA treatment, which constitutes the commercial product Roundup WG®, which formulation is in ammonium salt, was what caused most poisoning plants, not significantly differing from the CRUCIP treatment which is Crucial® and its formulation is based on potassium salt and isopropylamine salt (Table 2). In this case, greater control of benghal dayflower species was made with application of glyphosate formulation in ammonium salt, other authors also obtained similar results in similar conditions compared to other formulations in benghal dayflower weed (Oliveira et al., 2009), beggartick (*Bidens pilosa*) (Werlang et al., 2005) and southern cutgrass (*Leersia hexandra* e *Luziola peruviana*) (Scherner et al., 2014).

The RW GSA and CRUCIP treatments caused poisoning damage higher when plants were visually assessed at 21 days after application (Table 2). These products are composed by the formulations of ammonium salt glyphosate from the RW GSA treatment and of the mixture of potassium salt formulations and isopropylamine salt from the CRUCIP treatment. Among the treatments all formulations of glyphosate can be found, and it is emphasized that the CRUCIP mixture equaled RW GSA potassium formulation, known as the best weed control (Oliveira et al., 2009).

The applied products reduced benghal dayflower plants leaf area when compared to the control without application; however differences between the products were not found (Table 3). All the products used reduced the dry matter of the benghal dayflower plants, yet treatments for applying products containing the potassium salt formulation were lower than the other (Table 3). On the other hand, Santos et al. (2007) analyzed the behavior of glyphosate on resistant soybean plants and found that the distribution on the plant depends on the formulation when a particular formulation can affect an organ in greater proportion.

The benghal dayflower stem dry matter was affected regardless of the formulation or commercial product. The RW GSA and CRUCIP treatments caused the greatest reduction of dry matter stem, but do not differ from the RORSI and ZAPSP TROSI treatments (Table 3). The products reduced benghal dayflower roots dry matter, showing that the effects on the roots do not differ between products or formulations (Table 3). Glyphosate provides better growth reduction of organs that have meristematic regions due to movement in the phloem following the route of photoassimilates until the growing points (roots) or storage (stem) of treated plant (Monqueiro et al., 2004), thus differences of the effects of each

formulation are diluted, for they are enhanced in those organs regardless of the formulation.

With the values of benghal dayflower total dry matter submitted to the application of the products of each treatment, the effects of phytotoxicity of glyphosate could be seen; in addition the Roundup WG products of ammonium salt formulation and Crucial mixture of potassium salt formulations and isopropylamine salt demonstrated major negative effects on weed (Table 3).

Table 3. Benghal dayflower plant growth (*Commelina benghalensis* L.) after the application of different commercial glyphosate products.

Tratamento	AF	MSF	MSC	MSR	MST
	--cm^2--		----------mg----------		
TEST	306 a	960 a	1238 a	460 a	3207 a
RORSI	55 b	248 b	263 bc	95 b	733 b
TROSI	68 b	300 b	265 bc	108 b	814 b
RWGSA	19 b	88 c	118 c	65 b	322 c
ZAPSP	32 b	245 b	205 bc	90 b	643 b
RTRSP	59 b	275 b	283 b	135 b	832 b
CRUCIP	33 b	123 c	140 c	75 b	419 c
DMS	158	116	131	82	218
CV (%)	44	34	47	24	52

TEST – Control without glyphosate application, RORSI – Roundup Original® application, TROSI – Trop® application, RWGSP – Roundup WG® application, ZAPSA – Zapp QI® application, RTRSA – Roundup Transorb® application, CRUCIP – Crucial® application, MSD – mean signed difference, CV – Coefficient of variation, LA – leaf area, LDM – leaf dry matter, SDM – stem dry matter, RDM – root dry matter, TDM – total dry matter.

Thus, the ammonium salt formulation or product Roundup WG® can be emphasized and the formulation potassium salt and isopropylamine salt mixture as the most efficiency in controlling *Commelina benghalensis*. However, the values of total dry matter and percentage of poisoning 21 days after the application does not demonstrate effective species control. Thus, the products must be tested at higher doses, the done application in less developed weed stage, according to the indication of efficient use or, as highlighted by Ronchi et al. (2002a, 2002b), the mixture with other products which enhance the benghal dayflower control.

Conclusions

Glyphosate herbicide, at dose 1080 g e.a. ha^{-1}, regardless the applied product, did not efficiently control benghal dayflower (*Commelina benghalensis* L.) in the second branch development stage. Even with values lower than satisfactory for optimal control, Roundup WG® and Crucial® products were the most toxic to weeds.

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