Revista Brasileira de Herbicidas, v.14, n.4, p.271-279, out./dez. 2015 (ISSN 2236-1065)
DOI: http://dx.doi.org/10.7824/rbh.v14i4.435 www.rbherbicidas.com.br

Application rates and herbicide in weed control in pasture[1]

Taxas de aplicação e herbicidas no controle de plantas daninhas em pastagem

Fábio Henrique Krenchinski[2]; Alfredo Junior Paiola Albrecht[2]; Leandro Paiola Albrecht[2]; Victor José Salomão Cesco[2]; Danilo Morilha Rodrigues[2]; Ricardo Victória Filho[3]

Abstract - Pastures formed with *Cynodonn lemfuensis* Vanderyst are excellent alternatives for feeding livestock. The competition from weeds can cause damage to pasture, and *Vernonia polyanthes* and *Desmodium incanum* are among the main competing species. The objective of this study was to evaluate the efficacy of different herbicides to control *Vernonia polyanthes* and *Desmodium incanum*, applied in high and low spray mix volumes. The experiment was established in an area formed for over 10 years by African stargrass (*Cynodonn lemfuensis*). The experimental design was a randomized block in a 2x7 factorial arrangement with two spray mix volumes of 50 and 200 L ha^{-1} and seven herbicides. Variables phytotoxicity on grass *Cynodonn lemfuensis* at 3, 7, 14, 21 and 28 days after application (DAA) and control of weed plants *Vernonia polyanthes* and *Desmodium incanum* at 7, 14, 21 and 28 DAA were evaluated. There were no high levels of phytotoxicity in the pasture. The treatments that provided the best controls of *Vernonia polyanthes* and *Desmodium incanum* were fluroxypyr-meptyl + triclopyr, 2,4 D + aminopyralid and 2,4 D + picloram. Spray mix volumes provided no significant differences in the evaluation of control after 28 DAA for herbicides, but were higher for some treatments at 7, 14 and 21 DAA. Thus, the lowest volume of spray mix (50 L ha^{-1}) becomes a viable alternative in the control of these species in the pasture.
Keywords: spraying technology; creeping beggarweed or Spanish clover/tick-trefoil; *assa-peixe*; African stargrass; selectivity

Resumo - Pastagens formadas com *Cynodonn lemfuensis* Vanderyst são excelentes alternativas para alimentação dos rebanhos. A competição de plantas daninhas pode ocasionar prejuízos à pastagem, sendo que *Vernonia polyanthes* e *Desmodium incanum* estão entre as principais espécies competidoras. O objetivo do presente trabalho foi avaliar a eficácia de diferentes herbicidas no controle de *Vernonia polyanthes* e *Desmodium incanum*, aplicados em alto e baixo volume de calda. O experimento foi instalado em uma área formada há mais de 10 anos por grama-estrela-africana (*Cynodonn lemfuensis*). O delineamento experimental empregado foi o de blocos ao acaso, no esquema fatorial 2x7, sendo dois volumes de calda 50 e 200 L ha^{-1} e sete herbicidas. Foram avaliadas as variáveis fitotoxicidade na grama *Cynodonn lemfuensis*aos 3, 7, 14, 21 e 28 dias após a aplicação (DAA) e controle das plantas daninha *Vernonia polyanthes* e *Desmodium incanum* aos 7, 14, 21 e 28 DAA. Não foram encontrados níveis altos de fitotoxicidade na pastagem. Os tratamentos que proporcionaram os melhores controles de *Vernonia polyanthes* e *Desmodium*

[1] Received for publication on 09/12/2015 and approved on 13/02/2016.
[2] Universidade Federal do Paraná – Setor Palotina, R. Pioneiro, 2153, Jardim Dallas, CEP 85950-000. Palotina, PR. E-mail: fhkrenchinski@gmail.com; ajpalbrecht@yahoo.com.br; lpalbrecht@yahoo.com.br; vsalomaoc@gmail.com; danilomorilharodrigues@gmail.com;
[3] Escola Superior de Agricultura 'Luiz de Queiroz'/Universidade de São Paulo - ESALQ/USP, Departamento de Produção Vegetal, Av. Pádua Dias, 11, CEP: 13418-260, Jardim Universitário, Piracicaba, SP. E-mail: rvctori@usp.br

incanum foram fluroxypyr meptílico + triclopyr, 2,4 D + aminopiralide e 2,4 D + picloram. Os volumes de calda não proporcionaram diferenças significativas na avaliação de controle aos 28 DAA para herbicidas, porém foram superiores para alguns tratamentos aos 7, 14 e 21 DAA. Com isso o menor volume de calda (50 L ha^{-1}) torna-se uma alternativa viável no controle dessas espécies na pastagem.
Palavras-chaves: tecnologia de pulverização; carrapicho-beiço-de-boi; assa-peixe; grama-estrela-africana; seletividade

Introduction

Brazil currently ranks second on the world stage in relation to cattle (USDA, 2015a) and second in beef production, and its per capita production is around 35 kg/inhabitant/year (USDA, 2015b). For milk production, Brazil is fourth in the worldwide scenario (USDA, 2015c). All this production is mostly supported by an extensive production (grazing) that prevails in the country.

Pastures formed with *Cynodon* genus grasses, such as African stargrass (*Cynodonn lemfuensis* Vanderyst), are alternatives for feeding livestock and forming new pastures in Brazil (Pedreira, 2005). This species is characterized by being perennial, with long stolons and lying on the ground. Its leaves have broad edges and thick stems, without rhizome (Athayde et al. 2005).

In this production system, as in many others, the presence of weeds is extremely undesirable with respect to the pastures yield efficiency. The competition provided by the weed covers basic production factors such as space, light, water and nutrients essential to the development of pasture, as well as factors related to undesirable plants such as external parasites (Pitelli, 1989), injuries in animals and their poisoning when swallowing some weeds (Lorenzi, 2006).

Among the species commonly found in pastures, *assa-peixe (Vernonia polyanthes* Less) and creeping beggarweed or Spanish clover/tick-trefoil (*Desmodium incanum* DC) are worth mentioning. According to Lorenzi (2008), *assa-peixe* is a plant that most infests and undermines Brazilian pastures. This is due to greater resilience when mowed or burned, due to being 1.0 to 3.0 meters tall and the seeds high reproductive and dispersive capacity. Creeping beggarweed or Spanish clover/tick-trefoil is also characterized as an important weed present in pastures throughout Brazil. Its outstanding feature is the ability to adhere to animals and people, which facilitates its spread to other areas (Lorenzi, 2008).

The use of herbicides in pastures is an excellent alternative for weed control. According to Victória Filho (1985), the success of the practice is directly related to the herbicide hitting the target and providing its uniform coverage.

Currently there is a tendency in reducing the application rates used at the time of spraying in order to reduce costs and increase the spraying operational capacity. The lowest application rate enables losses reduction by draining (Rodrigues et al. 2011) but can lead to less coverage of the target, compromising the efficacy of the products used (Bueno et al. 2013a). Thus, the choice of application technology can ensure better results in control, greater operational capacity, and ensure the sustainability of the agro-ecosystems (Bracamonte et al. 1999). According to Bueno et al. (2013b), weed control with glyphosate herbicide was not affected when spray mix volumes varied in 30, 60 and 150 L ha^{-1}. Galon et al. (2007), evaluating treatments with systemic and contact herbicides, have found no significant difference when evaluating the spray mix volume of 100 and 200 L ha^{-1}.

According to Alves et al. (2002), information about possible damage from phytotoxicity of herbicides under forage grasses and for use in pastures is not satisfactorily studied. According to Martins et al. (2007), herbicides selectivity to pastures is based mainly on the formation of non-phytotoxic compounds by the product rapidly metabolized by the plant.

Due to the importance of the pasture area for the world food production and considering that weeds interfere with the quality and quantity of pasture, its efficient control is crucial. Therefore, the objective of this study was to evaluate the efficiency of the use of different herbicides to control *V. polyanthes* Less and *D. incanum* DC. applied in high and low application rates, and the effect of these on pasture consisting of *Cynodonn lemfuensis* Vanderyst.

Material and Methods

The experiment was conducted in an established pasture area located in the Brazilian municipality of Marechal Cândido Rondon, PR, S 24°45'25.3" W 54°05'19.0" GR with an altitude of 347 meters in relation to sea level. The soil was classified as typical clayey-textured red Oxisol Eutrudox (Embrapa, 2013). The weather in the region is Cfa with well defined seasons and well distributed rainfall throughout the year, according to the Köppen classification (1923). The pasture consisted of African stargrass (*C. lemfuensis*), having been set in place for several years without reformation, and basic managements being conducted only regarding the maintenance of forage, such as weed control and maintenance of soil fertility.

A randomized complete block design with four replications and treatments arranged in a 2x7 factorial scheme was adopted, with the first factor being represented by two spray mix volume levels (50 and 200 L ha^{-1}) and the second factor by seven chemical control levels (Table 1). Each experimental unit measured 4.0 m x 6.0 m, totaling an area of 24 m² and with a floor area of 15 m^2.

Table 1. Herbicides and their respective doses applied in two volumes of spray mix. Marechal Cândido Rondon, PR, 2014.

Treatment	Herbicides	Dose (g i.a. ha^{-1})
T1	Untreated	-
T2	2,4 D (DMA 806 BR, CS, 670 g i.a. L^{-1}, Dow AgroSciences)	1340
T3	2,4 D + Aminopiralide (Jaguar, CS, 320 + 40 g i.a. L^{-1}, Dow AgroSciences)	640 + 80
T4	2,4 D+ Picloram (Tordon, CS 240 + 64 g i.a. L^{-1}, Dow AgroSciences)	840 + 224
T5	Fluroxypyr+ Picloram (Plenum, ME 80 + 80 g i.a. L^{-1}, Dow AgroSciences)	200 + 200
T6	Aminopiralide + Fluroxypyr (Dominum, EA 40 + 80 80 g i.a. L^{-1}, Dow AgroSciences)	80 + 160
T7	Fluroxypyr Meptílico + Triclopyr (Truper, EC 80 + 240 g e.a L^{-1}, Dow AgroSciences)	240 + 720

For the application, a knapsack sprayer propelled at CO_2 was used, with a constant pressure of 2 BAR (or 29 PSI), 0.65-L min^{-1} flow, equipped with a spray boom containing six flat-jet-type spraying nozzles of the XR-110.02-type Teejet series, working at a height of 50 cm from the target and a speed of 1.0 m second^{-1}, with a 50-cm distance between nozzles, providing a spray mix volume equivalent to 200 L ha^{-1}. For the reduced spray mix volume applications, a constant pressure of 2 BAR (or 29 PSI) was used, a 0.65-L min^{-1} flow, with six flat jet nozzles of large angle of the TT-110.04-type Teejet series which, at a 1.0-m second^{-1} speed, provided a spray mix volume equivalent to 50 L ha^{-1}.

About 10 days before the treatments application, cattle arrays aged approximately 3 years, an average weight of 280 kg, at a density of 4 animal units ha^{-1} in the area were released in order to allow grazing of the forage grass and thereby provide better conditions for the treatments application. The application of the treatments occurred on wet soil, with no rainfall for more than 24 hours after their end. The average environmental conditions of temperature, relative humidity and wind speed were respectively: 27 ºC; 65%; 1.0 km h^{-1} and the plants did not have dew.

A phytosociological survey was performed in the experimental area prior to the application of the treatments, in which average values of 2.6 and 6.0 plants m^{-2} of *V. polyanthes* and *D. incanum* and an average height of 60 cm and 20 cm respectively were found and both weeds were in the vegetative stage of development.

Variables phytotoxicity of the *C. lemfuensis* grass at 3, 7, 14, 21 and 28 days after application (DAA) and control of weeds *V. polyanthes* and *D. incanum* at 7, 14, 21 and 28 DAA via visual evaluations were assessed, to which percentage scores were assigned at each experimental unit (0 for no injury to 100% for plant death), considering in this case the plants visual symptoms, according to their development (SBCPD, 1995).

The data were analyzed according to Pimentel-Gomes and Garcia (2002). Analysis of variance and all developments required were performed at 5% probability. To evaluate the behavior of treatments (herbicides) the means were compared by Tukey's test ($p < 0.05$), while for the spray mix volumes the F-test was conclusive.

Results and Discussion

It is observed that high levels of herbicide damage were not found in the pasture of *C. lemfuensis*, noting that the herbicides used show great selectivity for this species.

In the phytointoxication of the *C. lemfuensis* pasture (Table 2) it was possible to find a significant difference among the herbicides applied and the spray mix volumes at 7 and 14 DAA. At 21 and 28 DAA, the presence of phytotoxicity was not observed since symptoms of injuries caused by the herbicide were not observed either, given the growth shown by the species under study.

Table 2. Phytotoxicity observed in *C. lemfuensis* at 7 and 14 days after the application of the herbicides in two spray mix volumes. Marechal Cândido Rondon, PR, 2014.

Treatment	7 DAA		14 DAA	
	Spray Mix Volumes (L ha^{-1})			
	50	200	50	200
T1	0.00Ba	0.00Da	0.00Ca	0,00Ca
T2	1.25Ba	2.25BCa	1.25Ca	3.25BCa
T3	2.50Ba	1.50 Da	3.75BCa	3.25BCa
T4	0.00 Ba	0.00 Da	0.00Ca	0.00Ca
T5	4.50Ba	6.75ABa	6.00Ba	6.75ABa
T6	4.25Bb	9.25Aa	6.50Bb	10.25Aa
T7	9.75Aa	8.75Aa	11.00Aa	10.75Aa
Média	3.18	4.18	4.07	5.00
CV%	3.68		4.53	
DMS T*V	5.20		4.01	
DMS V*T	3.38		2.61	

Equal uppercase letters in the column among the treatments and equal lowercase letters in the row between the spray mix volumes (50 and 200 L ha^{-1}) do not significantly differ by the Tukey's test ($P \geq 0.05$) and F-test ($P \geq 0.05$), respectively.

Herbicides that provided greater phytotoxicity in the pasture at 7 and 14 DAA (Table 2) were fluroxypyr-meptyl + triclopyr in the spray mix volume of 50 L ha^{-1} and aminopyralid + fluroxypyr and fluroxypyr-meptyl + triclopyr in the spray mix volume of 200 L ha^{-1}. In both volumes, herbicide 2,4 D + picloram (Table 2) provided no phytotoxicity to the pasture of *C. lemfuensis*. The same result was observed by Maciel et al. (2008) when assessing phytotoxicity of 2,4 D + picloram in pasture of *Brachiaria brizantha* cv. MG-5.

Herbicide fluroxypyr-meptyl + triclopyr provided greater phytotoxicity symptoms, but in contrast it provided, at 7, 14 and 21 (Table 3), the highest controls of *V. polyanthes*, significantly differing from the other herbicides used. At 28 DAA, herbicides fluroxypyr-meptyl + triclopyr, 2,4 D + aminopyralid and 2,4 D + picloram showed 100% of control for this species.

Table 3. Percentage of control of *V. polyanthes* at 7, 14, 21 and 28 days after the application of the herbicides in two spray mix volumes of 50 and 200 L ha^{-1}. Marechal Cândido Rondon, PR, 2014.

Treatment	7 DAA		14 DAA		21 DAA		28 DAA	
	Spray Mix Volumes (L ha^{-1})							
	50	200	50	200	50	200	50	200
T1	0.00Ca	0.00Ca	0.00Ea	0.00Ea	0.00Ea	0.00Ea	0.00Ea	0.00Da
T2	2.75Ca	1.75Ca	13.50Da	11.50Da	31.50Da	25.00Db	54.75Da	51.25Ca
T3	11.00Ba	8.75Ba	57.50Ba	46.00Bb	79.00Ba	71.75Bb	100.00Aa	100.00Aa
T4	13.00Ba	12.50Ba	51.50Ba	46.25Ba	74.75Ba	71.50Ba	100.00Aa	100.00Aa
T5	4.25Ca	3.50Ca	21.25Da	14.50Db	41.00Da	32.50Db	65.00Ca	53.00Cb
T6	14.50Ba	11.00Bb	33.75Ca	26.75Cb	63.00Ca	52.50Cb	82.50Ba	75.25Bb
T7	34.25Aa	29.50Ab	100.00Aa	100.00Aa	100.00Aa	100.00Aa	100.00Aa	100.00Aa
Média	11.39	9.57	39.64	35.00	55.60	50.46	71.75	68.50
CV%	19.10		10.43		8.19		3.89	
DMS T*V	4.40		8.55		9.55		6.00	
DMS V*T	2.86		5.57		6.21		3.90	

Equal uppercase letters in the column among the treatments and equal lowercase letters in the row between the spray mix volumes (50 and 200 L ha^{-1}) do not significantly differ by the Tukey's test ($P \geq 0.05$) and F-test ($P \geq 0.05$), respectively.

Herbicides of 2,4 D + aminopyralid and 2,4 D + picloram showed higher control in relation to 2,4 D alone in all evaluations. Similarly to the control of *Mimosa pudica* in pasture, Silva (2013) has also observed that treatments containing herbicides 2,4 D + picloram and 2,4 D + aminopyralid showed higher control in relation to 2,4 D alone. As the three herbicides mimic auxin, some individual characteristics of the chemical group are key to explaining this difference in control. Picloram presents long persistence in the environment and half-life of 20 to 300 days (Silva, 2007). As for 2,4 D applied at doses recommended, it has short persistence, not exceeding four weeks in the environment (Silva, 2007). Thus, the greater persistence in soil provides control for a longer period and more efficiently. Rassini and Coelho (1994) have observed higher efficacy in the control of *V. polyanthes* with the use of 2,4-D + picloram when comparing to underdoses of glyphosate.

For spray mix volumes in all significant results, the volume of 50 L ha^{-1} proved to be more favorable to the control of *V. polyanthes* (Table 3) in relation to the volume of 200 L ha^{-1}. Herbicides that showed greater control with the 50-L ha^{-1} volume were aminopyralid + fluroxypyr and fluroxypyr-meptyl + triclopyr at 7 DAA, fluroxypyr + picloram, aminopyralid + fluroxypyr and 2,4 D + aminopyralid at 14 DAA, 2,4 D, fluroxypyr + picloram, aminopyralid + fluroxypyr and 2,4 D + aminopyralid at 21 DAA and at 28 DAA fluroxypyr + picloram and aminopyralid + fluroxypyr. In these cases, the lower volume of spray mix did not result in worse control efficiency. The use of a lower volume of spray mix enables greater operational autonomy, hence lower cost of application (Souza et al., 2011), reducing the risks of product flow to the ground (Rodrigues et al. 2011).

For herbicide fluroxypyr-meptyl + triclopyr, which presented the control of 100% at 14 DAA, the spray mix volume significantly differed only at 7 DAA. After this period, the two spray mix volumes for this herbicide were equally effective. For 2,4 D + aminopyralid, the spray mix volume of 50 L ha^{-1} promoted higher control at 14 and 21 DAA. For 2,4 D + picloram, the spray mix volume of 50 L ha^{-1} promoted higher control only at 21 DAA. But for both situations at 28 DAA, when the control was 100%, the spray mix volume had no significant influence. According to Barbosa et al. (2011), the lower spray mix volume with similar levels of control reduces environmental impacts and provides lower operational costs as there is greater efficiency in the application and less replenishments of the spray tank.

The control of *D. incanum* (Table 4) was higher when herbicide fluroxypyr-meptyl + triclopyr was applied at 7 and 14 DAA, significantly differing from the other herbicides. At 21 and 28 DAA, only herbicide 2,4 D and the control without application did not cause a 100% control of *D. incanum*. According to Freitas et al. (2003), herbicides 2,4 D + picloram and triclopyr promoted good control of *D. incanum* in grasses at 15 and 30 DAA. This was observed in the mix of fluroxypyr-meptyl + triclopyr and 2,4 D + picloram at 21 DAA in this study.

Table 4. Percentage of control of *D. incanum* at 7, 14, 21 and 28 days after the application of the herbicides in two spray mix volumes of 50 and 200 L ha^{-1}. Marechal Cândido Rondon, PR, 2014.

Treatment	7 DAA		14 DAA		21 DAA		28 DAA	
	Spray Mix Volumes (L ha^{-1})							
	50	200	50	200	50	200	50	200
T1	0.00Ca	0.00Da	0.00Fa	0.00Fa	0.00Ca	0.00Ca	0.00Ca	0.00Ca
T2	7.25Ba	6.5Ca	15.00Ea	14.75Ea	28.50Ba	29.50Ba	53.50Bb	55.00Ba
T3	8.25Ba	6.5Ca	71.75Ba	68.75Ba	100.00Aa	100.00Aa	100.00Aa	100.00Aa
T4	9.75Ba	9.00BCa	76.50Ba	74.75Ba	100.00Aa	100.00Aa	100.00Aa	100.00Aa
T5	8.25Ba	11.00Ba	54.25Da	51.25Da	100.00Aa	100.00Aa	100.00Aa	100.00Aa
T6	9.00Ba	11.5Ba	62.50Ca	62.00Ca	100.00Aa	100.00Aa	100.00Aa	100.00Aa
T7	59.00Aa	61.00Aa	95.50Aa	96.50Aa	100.00Aa	100.00Aa	100.00Aa	100.00Aa
Média	14.50	13.78	53.64	52.57	75.50	75.64	79.07	79.28
CV%	14.12		5.61		0.93		1.22	
DMS T*V	4.38		6.55		1.53		2.12	
DMS V*T	2.86		4.26		1.00		1.38	

Equal uppercase letters in the column among the treatments and equal lowercase letters in the row between the spray mix volumes (50 and 200 L ha^{-1}) do not significantly differ by the Tukey's test ($P \geq 0.05$) and F-test ($P \geq 0.05$), respectively.

Likewise, Barbosa et al. (2011), when testing the control efficacy of *Ipomoea nil* using herbicide diuron + hexazinone with and without an adjuvant, applied with a spray centrifugal nozzle at different spray mix volumes, have also found that, regardless of the spray mix volume used, there was no difference in the studied weed control efficacy, thus in agreement with the results of this study. According to these authors, the lowest volume with similar control levels reduces environmental impacts and provides lower operational costs.

The control of *D. incanum* has not significantly changed with spray mix volumes of herbicides, i.e., regardless of the herbicide deposition in the plant, control is effective. This enables the use of lower spray mix volumes for the control of this species in grazing areas. For Bueno et al. (2013b), glyphosate applied in the spray mix volumes of 30, 60 and 150L ha^{-1} provided no significant difference for the control of weeds in fallow areas. According to Galon et al. (2007), contact or systemic herbicides can increase or decrease weed control, depending on the spray mix volume used because factors of the species itself and environmental factors influence the control.

For the control of both species *V. polyanthes* and *D. incanum* reducing spray mix volume in the herbicides application provided in some cases greater or equal control when compared to the higher volume of spray mix.

Therefore, it is possible to use low spray mix volumes in weeds control in pastures due to their operational advantages. For desiccation of *Panicum maxicum* v. Mombaça with glyphosate (2,160 g ha^{-1}) with different nozzles and volumes (100 and 200 L ha^{-1}) Da Costa et al. (2012) have observed that all treatments were efficient and found no difference among the spray mix volumes used.

According to Bueno et al. (2013a), the use of smaller volumes of spray mix increases the autonomy and operational capacity of sprays, reducing costs, enabling applications to be carried out in good weather conditions, reducing the risk of loss by draining the product and consequently may cause less environmental contamination. However, some authors claim that the lower spray mix volume decreases the Median Volumetric Diameter (MVD), therefore increasing the susceptibility of the occurrence of drift (Murphy et al., 2000). Thus, to avoid losses due to drift in the application of lower spray mix volumes, weather conditions at the time of the application should be noted or adjuvants which enhance MVD and enable lower drift should be used (Thebaldi et al. (2009), Bueno et al. (2013 b) and Queiroz et al., 2008).

Conclusions

As for phytotoxicity, high values that compromise the pasture development were not found. The best herbicides for the control of both species were fluroxypyr-meptyl + triclopyr, 2,4 D + aminopyralid and 2,4 D + picloram. For these herbicides, the final control was not influenced by the volume of spray mix used. Thus the adoption of a lower volume of spray mix becomes more advantageous in grazing areas.

References

Alves, E.; Martins, D.; Souza, F.H.D. Seletividade de herbicidas pré-emergentes para gramíneas forrageiras tropicais. **Planta Daninha,** v.20, n.3, p.457-464, 2002.

Athayde, A.A.R.; Carvalho, R.C.R; Medeiros, L.T.; Valeriano, A.R.; Rocha, G.P. Gramíneas do gênero *Cynodon* – cultivares recentes no Brasil. **Boletim técnico Universidade Federal de Lavras**, n.73, p.1-14. 2005.

Barbosa, B.F.F.; Costa, M.F.; Silva, J.L.; Cavichioli, F.A.; Bertonha, R.S.; Custódio, A.A.P. Controle de *Ipomoea nil* utilizando ponta centrífuga de pulverização em diferentes volumes de aplicação com e sem adjuvante. **Revista Brasileira de Herbicidas**, v.10, n.3, p.277-290, 2011.

Bracamonte, E.R.; Loeck, A.E.; Pinto, J.J.O. Eficiência do herbicida sethoxydim em função do volume de calda no controle de papuã (*Brachiaria plantaginea* (Link.) Hitch.) na cultura da soja. **Revista Brasileira de Agrociência**, v.5, n.1, p.60-63, 1999.

Bueno, M.R. Cunha, J.P.A., Alves, G.S. Deposição de calda na aplicação aérea e terrestre de fitossanitário na cultura da batata. **Engenharia Agrícola,** v.33, n.6, p.1210-1222, 2013a.

Bueno, M.R.; Alves, G.; Paula, A.; Cunha, J. Volumes de calda e adjuvante no controle de plantas daninhas com glyphosate**. Planta Daninha**, v.31, n.3, p.705-713, 2013b.

Costa, N.V.; Martins, D.; Costa, A.C.P.R.; Cardoso, L.A. Deposição de glyphosate com diferentes pontas de pulverização na dessecação de plantas de *Panicum maximum*. **Revista Brasileira de Herbicidas**, v.11, n.1, p.96-107, 2012.

Embrapa. Empresa brasileira de pesquisa agropecuária. **Sistema de classificação dos solos**. Rio de Janeiro: Embrapa solos. 3. ed. 2013. (Boletim técnico).

Freitas, F.C.L.; Ferreira, L.R.; Silva, A.A.; Barbosa, J.G.; Miranda, G.V.; Machado, A.F.L. Eficiência do triclopyr no controle de plantas daninhas em gramado. **Planta Daninha**, v.21, n.1, p.159-164, 2003.

Galon, L.; Agostinetto, D.; Dal Magro, T. Controle de plantas daninhas e seletividade de herbicidas à cultura da soja, aplicados em dois volumes de calda. **Revista Brasileira de Agrociência**, v.13, n.3, p.325-330, 2007.

Lorenzi, H. **Manual de identificação de plantas daninhas do Brasil:** terrestres, aquáticas, parasitas e tóxicas. 4ª ed. Nova Odessa: Instituto Plantarum, 2008. 640 p.

Lorenzi, H. **Manual de identificação de plantas daninhas:** plantio direto e convencional. 6ª ed. Nova Odessa: Plantarum, 2006. 362 p.

Maciel, C.D.G.; Nogueira, I.F.; Alves, E.; Alves, L.S. Misturas em tanque de 2,4-D + picloram e reguladores vegetais em pastagens de *Brachiaria brizantha* cv. MG-5. **Revista Brasileira de Herbicidas**, v.7, n.2, p.43-52, 2008.

Martins, D.; Triguero, L.R.C.; Domingos, V.D.; Martins, C.C.; Marchi, S.D.; Costa, N.D. Seletividade de herbicidas aplicados em pós-emergência sobre capim-braquiária. **Revista Brasileira de Zootecnia**, v.36, n.6, p.1969-1974, 2007.

Murphy, S.D.; Miller, P.C.H.; Parkin, C.S. The effect of boom section and nozzle configuration on the risk of spray drift. **Journal of Agricultural Engineering Research**, v.75, n.2, p.127-137, 2000.

Pedreira, C.G.S. Capins do gênero *Cynodon*: histórico e potencial para a produção brasileira. In: Vilela, D.; Resende, J.C.; Lima, J. ***Cynodon*****: forrageiras que estão revolucionando a pecuária brasileira**, p.33-58, 2005.

Pimentel-Gomes, F.; Garcia, C.H. **Estatística aplicada a experimentos agronômicos e florestais**: exposição com exemplos e orientações para uso de aplicativos. Piracicaba: FEALQ, 309p. 2002.

Pitelli, R.A. Ecologia de plantas invasoras em pastagens. In: Favoreto, V.; Rodrigues, L.R.A. (Ed.). **Anais do Simpósio sobre Ecossistemas de Pastagens.** p.69-86, 1989.

Queiroz, A.A.; Martins, J.A.S.; Cunha, J.P.A.R. Adjuvantes e qualidade da água na aplicação de agrotóxicos. **Bioscience Journal**, v.24, n.4, p.8-19, 2008.

Rassini, J.B.; Coelho, R.R. Controle químico de assa-peixe (*Vernonia polyanthes*) em pastagens. **Revista Sociedade Brasileira de Zootecnia**, v.23, n.6, p.871-876, 1994.

Rodrigues, E.B.; Abi Saab, O.J.G.; Gandolfo, M.A. Cana-de-açúcar: avaliação da taxa de aplicação e deposição do herbicida glyphosate. **Revista Brasileira de Engenharia Agrícola e Ambiental**, v.15, n.1, p.90-95, 2011.

SBCPD - Sociedade brasileira da ciência das plantas daninhas. **Procedimentos para instalação, avaliação e análise de experimentos com herbicidas**. Londrina: 1995. 42 p.

Silva, A.A. Herbicidas: classificação e mecanismo de ação. In: Silva, A.A.; Silva, J.F. (Eds.). **Tópicos em manejo de plantas daninhas**. 2007. p.83-148.

Silva, P.C. Controle químico de Mimosa pudica em pastagem de *Brachiaria decumbens* com doses reduzidas de herbicidas. 2013. 37f. **Dissertação (Mestrado)** – Curso de Pós-graduação em Sistema de Produção, Universidade Estadual Paulista.

Souza, L.; Cunha, J.; Pavanin, L. Eficácia e perda do herbicida 2,4-D amina aplicado com diferentes volumes de calda e pontas de pulverização. **Planta Daninha**, v.29, n.2, p.1149-1156, 2011.

Thebaldi, M.S.; Reis, E.; Gratão, P.T.; Santana, M.S. Efeito da adição de adjuvante na redução de deriva em pontas de pulverização tipo cone vazio. **Revista Ciências Técnicas Agropecuárias**, v.18, n.2, p.1-6, 2009.

USDA. **Dairy: Reports.** Disponível em: <http://www.fas.usda.gov/psdonline>. Acesso em: 05 dez. 2015a.

USDA. **Livestock and poultry: world markets and trade.** Disponível em: <http://www.fas.usda.gov/psdonline>. Acesso em: 05 dez. 2015b.

USDA. **Livestock: Reports.** Disponível em: <http://www.fas.usda.gov/psdonline>. Acesso em: 05 dez. 2015c.

Victória Filho, R. Fatores que influenciam a absorção foliar de herbicidas. **Informe Agropecuário**, v.1, n.129, p.31-38, 1985.