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Potencialization of mesotrione efficiency in tank mixture with inhibiting of Photosystem II by distinct absorption pathways of crabgrass[1]

Potencialização da eficiência do mesotrione em mistura com inibidores de Fotossistema II em diferentes vias de absorção de capim-colchão

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Abstract - With the objective of evaluating the potencialization efficiency of mesotrione in tank mixture with inhibitors Photosystem II in *Digitaria horizontalis* control, four experiments were conducted in plastic greenhouses belonging to Superior School of Agronomy of Paraguaçu Paulista County, São Paulo State, being used a Latosoil with sandy texture. The experimental design of four experiments was entirely randomized, with 10 treatments and 5 replications, in factorial scheme 3x3+1, being considered the contrast between mesotrione (96 g ha^{-1}) and inhibitors of the Photosystem II herbicide (ametryn, 1500 g ha^{-1}; metribuzin, 1440 g ha^{-1}; diuron + hexazinone, 936+264 g ha^{-1} and atrazine, 2000 g ha^{-1}) products, isolated and in tank mixture for three absorption conditions and a check. The absorption conditions were constituted by the isolation and/or partial exhibition of target seedling of *D. horizontalis* (3 to 6 leaves) in relation to deposition of pulverizations for the modalities: a) seedlings protected with plastic tubes in discovered soil (root absorption *pathway*); (b) unprotected seedlings in soil covered with aluminum sheet (leaf absorption *pathway*); (c) seedlings and soil submitted to deposition of the herbicides (absorption roots + leaves *pathways*) and (d) check. The largest synergism levels obtained for *D. horizontalis* control were registered to root absorption and leaf + root of the tank mixture with mesotrione + atrazine, as well as for leaf absorption and leaf + root of mesotrione + diuron + hexazinone from the 3 to the 7 DAA (days after application) and of mesotrione + ametryn starting from 7 DAA, both characterized by reduction of control initial time in reaching great levels (≥ 90%). Antagonistic effects were not verified for the tank mixtures.
Keywords: herbicide, control, synergism, *Digitaria horizontalis*

Resumo - Com objetivo de avaliar a potencialização da eficiência do mesotrione em mistura em tanque com herbicidas inibidores do Fotossistema II no controle de capim-colchão (*Digitaria horizontalis*), quatro experimentos foram conduzidos em estufas plásticas pertencentes à Escola Superior de Agronomia de Paraguaçu Paulista, município de Paraguaçu Paulista, Estado de São

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Paulo, utilizando-se um Latossolo de textura arenosa. Os delineamentos experimentais dos quatro experimentos foram o inteiramente casualizado, com 10 tratamentos e 5 repetições, em fatorial 3x3+1, considerando-se o contraste entre mesotrione (96 g ha^{-1}) e herbicidas inibidores do Fotossistema II (ametryn, 1500 g ha^{-1}; metribuzin, 1440 g ha^{-1}; diuron + hexazinone, 936+264 g ha^{-1} e atrazine, 2000 g ha^{-1}), isolados e em mistura para três condições de absorção e uma testemunha sem aplicação. As condições de absorção constituíram-se pelo isolamento e/ou exposição parcial das plântulas alvo de *D. horizontalis* (3 a 6 folhas) em relação a deposição das pulverizações pelas modalidades: (a) plântulas protegidas com canudos plásticos em solo descoberto (absorção radicular); (b) plântulas desprotegidas em solo coberto com papel alumínio (absorção foliar); (c) plântulas e solo submetido à deposição dos herbicidas (absorção raízes + folhas) e (d) testemunha. Os maiores níveis de sinergismo obtidos no controle de *D. horizontalis* foram registrados para a absorção radicular e foliar+radicular da mistura mesotrione + atrazine, assim como da absorção foliar e foliar+radicular de mesotrione + diuron + hexazinone dos 3 aos 7 DAA (dias após aplicação) e de mesotrione + ametryn a partir dos 7 DAA, ambos caracterizados pela redução do tempo inicial do controle em atingir níveis ótimos (≥ 90%). Não foram constatados efeitos antagônicos para as misturas.
Palavras-chaves: herbicida, controle, sinergismo, *Digitaria horizontalis*

Introduction

Herbicides application in post-emergence with residual effect is a fairly common practice for annual and perennial crops. Typical examples are several formulations of atrazine, metribuzin, ametryn, diuron or hexazinone, that are used isolated and/or in tank mixture in annual dicotyledonous weeds post-emergence and some annual monocotyledonous species (Vidal, 1997; Rao & Almeida, 2011).

Mesotrione herbicide, commercialized in Brazil for corn and sugar cane crops named Callisto®, presents as action mechanism to inhibit carotenoids synthesis by interference in enzyme HPPD activity (4-hydroxyphenylpyruvate - dioxygenase) in chloroplasts, belonging to chemical group of tricetones. Its phytotoxic symptoms involve since the bleaching of sensitive weeds with subsequent necrosis and tissues death between 1 to 2 weeks (Lee, 1997; Karam & Cruz, 2004). Despite the different action mechanism of herbicides belonging to photosystem II inhibitors, presents the same versatility as for absorption by leaves as for weeds roots, and consequent, metabolizing capability by corn and sugar cane plants (Rodrigues & Almeida, 2011). This way, post-emergence applications of mesotrione in addition to foliar absorption, also make it possible to provide part of spraying on residual effect in the soil, minimizing the weeds emergence during critical period of weed interference. Silva et al. (2011) reported that mesotrione applied in pre-emergence conditions showed efficient control of *Ipomoea triloba* in sugar cane straw absence or presence, in raw sugar cane system.

The interaction between herbicides may promote: synergistic effects, when the effect of herbicides applied together is greater than the sum of their individual effects; additive effects, when the effect of herbicides in tank mixture is equal to the sum of their effects when applied separately; and antagonistic effects, when the effect of herbicides in tank mixture is less than the sum of their effects when applied separately (Procópio et al., 2003; Silva & Silva, 2007). In the search for a larger control spectrum, some studies suggest that mesotrione association with herbicides inhibitors of Photosystem II (PSII) can provide superior weeds control than the isolated application of both products.

Bachiega & Soares (2002), Schumm et al. (2004), Vidal & Portes (2004) observed synergistic effects in weeds control of annual species by tank mixture of mesotrione with atrazine, as well as Christoffoleti et al. (2006), reported additives effects of mesotrione in tank mixture with ametryn, diuron + hexazinone or metribuzin, for controlling *Digitaria ciliaris* and *Digitaria nuda.*

Weeds importance in production systems, justifies the necessity of efficient methodologies, simple and economically viable for more rigorous evaluations of herbicides effectiveness with wide absorption possibility (Maciel et al., 2002; 2007). In this context, there are several possibilities of studying foliar and root absorption of herbicides, and the choice of the most appropriate method depends on the experimental objectives, procedure facility and specialized instrumentation availability (Devine et al., 1993). However, all existing techniques require the intense use of equipment, installations and highly specialized procedures that usually involves high cost in developing products evaluation protocols.

The work aimed to evaluate the potentiality of mesotrione efficiency in tank mixture with photosystem II inhibitors herbicides in controlling *Digitaria horizontalis* through different pathways of absorption.

Material and Methods

The work was conducted during October to December, 2005 agricultural year, in plastic greenhouse located at urban campus of Superior School of Agronomy, Paraguaçu Paulista County, Sao Paulo State (ESAPP). Four experiments were performed separately using as experimental units plastic vessels with capacity for 2.0 kg of substrate, consisting of Latosoil Red dystrophic typical, sandy texture (Embrapa, 2006).

Experimental design used in each one of the four experiments was randomized entirely design, with 10 treatments and 4 replications, arranged in factorial scheme 3 x 3 + 1, considering the contrasts between three application conditions in post-emergence, constituted by isolated herbicides use and in tank mixture, both in three absorption conditions and a check without application. Herbicides used were: mesotrione (96 g ha^{-1}), ametryn (1500 g ha^{-1}), metribuzin (1440 g ha^{-1}), [hexazinone+diuron] (936+264 g ha^{-1}) and atrazine (4000 g ha^{-1}), both with 0.5% of v/v Assist® mineral oil.

Crabgrass seeds (*D. horizontalis*) were uniformly sown in experimental units at 0.5 cm deep, and on the occasion of herbicides application, repetitions were represented by six weeds in stages of three to five leaves, in order to simulate a population of approximately 120 plants m^{-2} that in field conditions is considered a common infestation in several annual and perennial crops.

Possibilities for herbicides absorption were studied in the absence or presence of plants or soil protection, and absence of both protections, thus providing isolation and/or exposure to deposition of herbicides spraying and their tank mixtures to achieve these targets. This way, the conditions of herbicides absorption by plants were constituted by the modalities: (a) protected plants with plastic straws in uncovered soil (root pathway absorption); (b) unprotected plants in covered soil with aluminum foil (leaf pathway absorption); (c) plants and soil submitted to herbicides deposition (roots + leaves pathway absorption) and (d) check without application. For the isolation of plants aerial part it was used plastic straws with approximately 1.5 cm in diameter, where crabgrass leaves were carefully jointed and covered by the straws with closed superior extremity. This procedure made it impossible the contact and herbicide absorption by plants aerial part, and consequently, causing limitation to absorption only by root.

For treatments with soil isolation, it was used aluminum foil secured with duct tape to protect the entire soil surface of experimental units, exposing only plants aerial part to spray nozzles, according to methodology described by Maciel et al. (2002; 2007).

Thirty minutes after herbicides applications in post-emergence, plastic straws and aluminum foil were carefully removed, avoiding plants contamination. Approximately 24 hours after herbicides application, all experimental plots were irrigated by subsurface, by placing the pots in trays with depths water of volume previously established through weighing. This way, daily there was uniform soils damping by capillary action through holes in the bottom of pots, thus keeping the humidity around 80% of field capacity.

Isolated herbicides and in tank mixture were applied by using a CO_2 pressured costal sprayer whit nozzle design XR 110.02-VS maintained at work pressure of 2.15 kgf cm^{-2} and consumption of 200 L ha^{-1}. At the time of herbicides applications, soil was moist, with temperature, air relative humidity and wind speed around 26.6ºC, 72.0% and 3.4 km h^{-1}, respectively.

Phytotoxic evaluations in crabgrass seedlings were conducted at 3, 7, and 14 days after application (DAA), using visual scales of damage percentage (E.W.R.C., 1964), where herbicides effects were compared to the check without application, with "0%" corresponding to "damage absence" and "100%" corresponding to weeds death (SBCPD, 1995), being considered efficient the treatment that have showed phytotoxic percentage or control, superior to 80.0%. In order to facilitate the terminology regarding control of their efficiency in tank mixtures studied, it was considered in description of effects the possibility of occurring additive effects (when occurs inefficient control of molecules involved in tank mixture, is not damaged), antagonistic (when there is inefficiency of molecules involved in tank mixture, damaging the control) and synergistic (when there is increased efficiency of molecules involved in tank mixture favoring control), similarly to the works developed by Colby (1967), Green (1989) and Kruse et al. (2001).

At 14 DAA, aerial part were collected and duly identified by treatment in paper bags and packed in a forced circulation oven, at a temperature of 60ºC, for a period of three days, for isolated quantification of structures dry matter.

D. horizontalis control data were submitted to variance analysis by F test and means compared by t test, at 10% probability level. For dry matter, the results of different pathways of herbicides absorption it was established the confidence intervals for t test at 5% probability level. In order to determine confidence interval, it was used the following equation: CI = (t x stdev)/nr root, where: CI = confidence interval; t = t value tabled, at 5% probability level; where stdev = standard deviation; root nr = square root of repetitions number.

Results and Discussion

D. horizontalis control at 3 and 7 DAA with the association of mesotrione + ametryn (96 + 1500 g ha^{-1}) herbicides by foliar and root + foliar pathway absorption was significantly superior to root absorption (Table 1). From 7 DAA was possible to verify evident synergy in superior efficiency of foliar and root + foliar pathways absorption for tank mixture of mesotrione + ametryn. At 14 DAA, tank mixture mesotrione + ametryn reached the maximum level control (100%) of *D. horizontalis* for all absorption forms studied, but when compared to effects of isolated herbicides, it is evident that synergism of tank mixture was more expressive for foliar absorption. Ametryn herbicide absorbed exclusively by root and/or foliar + root pathways also provided excellent control of *D. horizontalis* (100%) from 14 DAA, on the contrary of mesotrione in isolated application that only reached efficient control of the referred specie at 14 DAA, when absorbed by foliar + root pathways.

Monquero et al. (2009) also observed synergistic effects in controlling by using mesotrione in tank mixture with ametryn and applied in post emergence conditions for *Brachiaria decumbens*, *Bidens pilosa* and *Euphorbia heterophylla* species. For Carvalho et al. (2006), the synergism in the control of its mixture occurred for *B. decumbens*, *Brachiaria plantaginea*, *D. horizontalis*, *Panicum maximum*, *Amaranthus deflexus*, *B. pilosa*, *Ipomoea nil* and *Sida glaziovii* species.

Table 1. *Digitaria horizontalis* control (%) at 3, 7 and 14 days after application (DAA), by using mesotrione (MESO) and ametryn (AMET) herbicides isolated and in tank mixture, through different absorption pathways.

Absorption Pathways	Control (%)								
	3 DAA			7 DAA			14 DAA		
	MESO	AMET	MESO + AMET	MESO	AMET	MESO + AMET	MESO	AMET	MESO + AMET
Leaves	4.2 $^{C a}$	38.0 $^{A a}$	33.4 $^{B a}$	18.6 $^{C b}$	42.4 $^{B c}$	91.0 $^{A a}$	83.0 $^{B b}$	48.0 $^{C b}$	100.0 $^{A a}$
Roots	4.0 $^{A a}$	4.4 $^{A b}$	6.4 $^{A c}$	16.2 $^{B b}$	57.2 $^{A b}$	56.6 $^{A b}$	74.0 $^{B c}$	100.0 $^{A a}$	100.0 $^{A a}$
Leaves + Roots	3.8 $^{C a}$	36.4 $^{A a}$	30.0 $^{B b}$	23.2 $^{C a}$	78.2 $^{B a}$	88.8 $^{A a}$	94.6 $^{A a}$	100.0 $^{A a}$	100.0 $^{A a}$
Check	0.0 $^{A b}$	0.0 $^{A c}$	0.0 $^{A d}$	0.0 $^{A d}$	0.0 $^{A d}$	0.0 $^{A c}$	0.0 $^{A d}$	0.0 $^{A c}$	0.0 $^{A b}$
Absorption (A)		207.396*			561.898*			23.272*	
Herbicides (H)		309.660*			617.232*			679.342*	
H x A		64.723*			98.477*			26.760*	
CV%		21.03			10.90			10.10	
DMS A (10%)		3.6749			5.6007			4.1295	
DMS H (10%)		2.9618			4.5139			3.3282	

*Means followed by the same minuscule letter in line and capital letter in column, do not differ statistically from each other by t test at 10% probability level. * = significant value by F test $P<0.1$; ^{NS} = no significant.

Similarly to mesotrione + ametryn tank mixture, *D. horizontalis* control efficiency at 3 DAA with the association of mesotrione + metribuzin (96 + 1440 g ha^{-1}) by foliar and foliar + root absorption ways, although has not yet reached satisfactory levels, was characterized as significantly superior to root absorption (Table 2). However, from 7 DAA it was observed showed excellent levels control of *D. horizontalis* both for metribuzin (≥92.6%) as for mesotrione + metribuzin (≥98.0%) in all absorption forms studied, and thus characterizing only small additive effect in terms of herbicides tank mixture effectiveness. At 14 DAA, only mesotrione root absorption did not reach maximum *D. horizontalis* efficiency control, what evidences once again the superiority of foliar absorption in relation to the root one of this herbicide for the studied specie.

For tank mixture of mesotrione + [diuron + hexazinone] (96 + [936 + 264] g ha^{-1}), it was observed excellent early efficiency of *D. horizontalis* control to 3 DAA only for foliar absorption (96.2%) and foliar + root (98.8%), characterizing significant synergistic effect of herbicides mixture, mainly for absorption foliar way (Table 3). In the same period, [diuron + hexazinone] (936 + 264 g ha^{-1}) herbicide also controlled *D. horizontalis* efficiently only when the absorption was root + foliar pathway (95.4%). At 7 DAA, it was observed only satisfactory control of *D. horizontalis* using mesotrione + [diuron + hexazinone] by root absorption, where there was not synergistic effect for herbicides association either. However, from 14 DAA, tank mixture of mesotrione + [diuron + hexazinone] reached excellent control level for *D. horizontalis* (≥ 95.6%) for all absorption pathways, but with synergistic action of tank mixture only for foliar absorption.

Table 2. *Digitaria horizontalis* control (%) at 3, 7 and 14 days after application (DAA), by using mesotrione (MESO) and metribuzin (METRI) herbicides isolated and in tank mixture, through different absorption pathways.

Absorption Pathways	Control (%)								
	3 DAA			7 DAA			14 DAA		
	MESO	METRI	MESO + METRI	MESO	METRI	MESO + METRI	MESO	METRI	MESO + METRI
Leaves	17.6 B a	20.2 B a	33.8 A a	37.0 B b	97.8 A a	100.0 A a	100.0 A a	100.0 A a	100.0 A a
Roots	9.2 B b	6.6 B b	16.8 A b	33.0 C c	92.6 B b	98.0 A a	78.0 B b	100.0 A a	100.0 A a
Leaves + Roots	17.0 C a	22.8 B a	35.0 A a	65.0 C a	96.4 B a	99.6 A a	100.0 A a	100.0 A a	100.0 A a
Check	0.0 A c	0.0 A c	0.0 A c	0.0 A d	0.0 A c	0.0 A b	0.0 A c	0.0 A b	0.0 A b
Absorption (A)		91.209*			1875.120*			20.167*	
Herbicides (H)		298.338*			4422.271*			3586.833*	
H x A		14.228*			265.675*			20.167*	
CV%		17.77			3.92			4.32	
DMS A (10%)		3.6749			3.0654			8.7885	
DMS H (10%)		2.9618			2.4706			7.0832	

*Means followed by the same minuscule letter in line and capital letter in column, do not differ statistically from each other by t test at 10% probability level. * = significant value by F test P<0.1; NS = no significant.

Table 3. *Digitaria horizontalis* control (%) at 3, 7 and 14 days after application (DAA), by using mesotrione (MESO) and diuron + hexazinone (DI+HE) herbicides isolated and in tank mixture through different absorption pathways.

Absorption Pathways	Control (%)								
	3 DAA			7 DAA			14 DAA		
	MESO	DI+HE	MESO + DI+HE	MESO	DI+HE	MESO + DI+HE	MESO	DI+HE	MESO + DI+HE
Leaves	39.4 B b	27.4 C b	96.2 A b	66.0 B c	24.0 C c	97.0 A a	74.6 B a	22.6 C c	96.4 A ab
Roots	22.2 B c	14.2 C c	28.0 A c	32.0 C b	66.6 B b	81.2 A b	51.2 B b	95.0 A b	95.6 A b
Leaves + Roots	45.8 C a	95.4 B a	98.8 A a	70.0 B a	99.2 A a	100.0 A a	77.6 B a	100.0 A a	100.0 A a
Check	0.0 A d	0.0 A d	0.0 A d	0.0 A d	0.0 A d	0.0 A c	0.0 A c	0.0 A d	0.0 A c
Absorption (A)		923.877*			306.915*			177.048*	
Herbicides (H)		3837.550*			1547.721*			1595.574*	
H x A		470.495*			170.822*			175.873*	
CV%		5.67			7.03			6.73	
DMS A (10%)		2.8843			4.8634			5.2214	
DMS H (10%)		2.3246			3.9197			4.2083	

*Means followed by the same minuscule letter in line and capital letter in column, do not differ statistically from each other by t test at 10% probability level. * = significant value by F test P<0.1; NS = no significant.

Losasso et al. (2006) also observed that associations of mesotrione with ready tank mixtures hexazinone + diuron and ametryn + trifloxysulfuron were efficient in *D. horizontalis* and *B. decumbens* control in post emergence in sugar cane crop.

For mesotrione + atrazine (96 + 4000 g ha^{-1}) tank mixture it was also observed excellent control of *D. horizontalis* at 3 DAA for root absorption pathway (94.4%) and root + foliar pathway (96.8%), but evidencing synergistic action of the mixture only up to 7 DAA, where control levels reached maximum effectiveness (100%). At 14 DAA, mesotrione herbicide absorbed by root pathway and foliar + root pathway also constituted excellent levels of *D. horizontalis* control, without significantly difference from mesotrione + atrazine tank mixture (Table 4). For foliar absorption pathway, it was observed that only mesotrione + atrazine association presented satisfactory control at 14 DAA, being this effect significantly lower to root absorption pathway and foliar + root absorption pathway, but characterized as synergistic action. Maciel et al. (2007) also observed that isolated atrazine application did not promote satisfactory control of *D. horizontalis* in any of pathways absorption studied.

Table 4. *Digitaria horizontalis* control (%) at 3, 7 and 14 days after application (DAA), by using mesotrione (MESO) and atrazine (ATRA) herbicides isolated and in tank mixture through different absorption pathways.

Absorption Pathways	Control (%)								
	3 DAA			7 DAA			14 DAA		
	MESO	ATRA	MESO + ATRA	MESO	ATRA	MESO + ATRA	MESO	ATRA	MESO + ATRA
Leaves	20.0 $^{A\,b}$	0.0 $^{C\,b}$	13.0 $^{B\,b}$	31.6 $^{A\,c}$	0.0 $^{C\,b}$	23.0 $^{B\,b}$	66.0 $^{B\,b}$	0.0 $^{C\,b}$	83.0 $^{A\,b}$
Roots	25.6 $^{B\,a}$	7.2 $^{C\,a}$	94.4 $^{A\,a}$	48.0 $^{B\,b}$	13.8 $^{C\,a}$	100.0 $^{A\,a}$	96.6 $^{A\,a}$	5.0 $^{B\,b}$	100.0 $^{A\,a}$
Leaves + Roots	30.0 $^{B\,a}$	9.2 $^{C\,a}$	96.8 $^{A\,a}$	57.4 $^{B\,a}$	15.0 $^{C\,a}$	100.0 $^{A\,a}$	97.0 $^{A\,a}$	23.8 $^{B\,a}$	100.0 $^{A\,a}$
Check	0.0 $^{A\,c}$	0.0 $^{A\,c}$	0.0 $^{A\,c}$	0.0 $^{A\,d}$	0.0 $^{A\,b}$	0.0 $^{A\,c}$	0.0 $^{A\,c}$	0.0 $^{A\,b}$	0.0 $^{A\,c}$
Absorption (A)	575.790*			502.511*			866.044*		
Herbicides (H)	383.954*			453.731*			584.446*		
H x A	167.040*			126.701*			102.631*		
CV%	18.12			15.61			11.21		
DMS A (10%)	5.8418			6.3272			6.9701		
DMS H (10%)	4.7083			5.0994			5.6177		

*Means followed by the same minuscule letter in line and capital letter in column, do not differ statistically from each other by t test at 10% probability level. * = significant value by F test P<0.1; ^{NS} = no significant.

In relation to dry matter production of plants aerial part at 14 DAA (Figure 1), it was observed that in general information reflect the results obtained in control visual evaluation and consolidate more expressively the understanding of the best answers established by treatments. In this context, the higher rates of dry matter of *D. horizontalis* obtained through foliar absorption of ametryn and diuron + hexazinone at 14 DAA, as well as atrazine, confirm with greater certainty the inefficient control levels of these herbicides, in its condition. At 14 DAA, dry matter information also did not demonstrate the occurrence of antagonistic effects for any of mesotrione tank mixture with studied herbicides.

Tank mixtures of mesotrione + ametryn (96 +1500 g ha^{-1}), mesotrione + diuron + hexazinone (96 + 936 + 264 g ha^{-1}) and mesotrione + atrazine (96 + 2000 g ha^{-1}) provided synergetic effect in controlling *D. horizontalis* at 3 and 7 DAA (Tables 1, 3 and 4), favoring the acceleration of visual damage intensity, primarily for foliar absorption pathway exclusively, where control levels were expressive (≥ 91,0%) and similar to foliar + root absorption for these referred periods. These results corroborate with those obtained by Braz & Schumm (2004) for *D. horizontalis* and Christoffoleti et al. (2006) for *D. ciliaris* and *D. nuda*, where mesotrione tank mixture with ametryn or (tryfloxysulfuron + ametryn), diuron + hexazinone and metribuzin promoted control additive effects.

In these four experiments, it was observed that at 14 DAA mesotrione herbicide, absorbed in isolation pathway by leaves, was characterized by showing control levels close to the satisfactory (80%) up to the excellent one (100%), and these were, in medium, approximately 24% higher than those obtained by absorption only in root pathway.

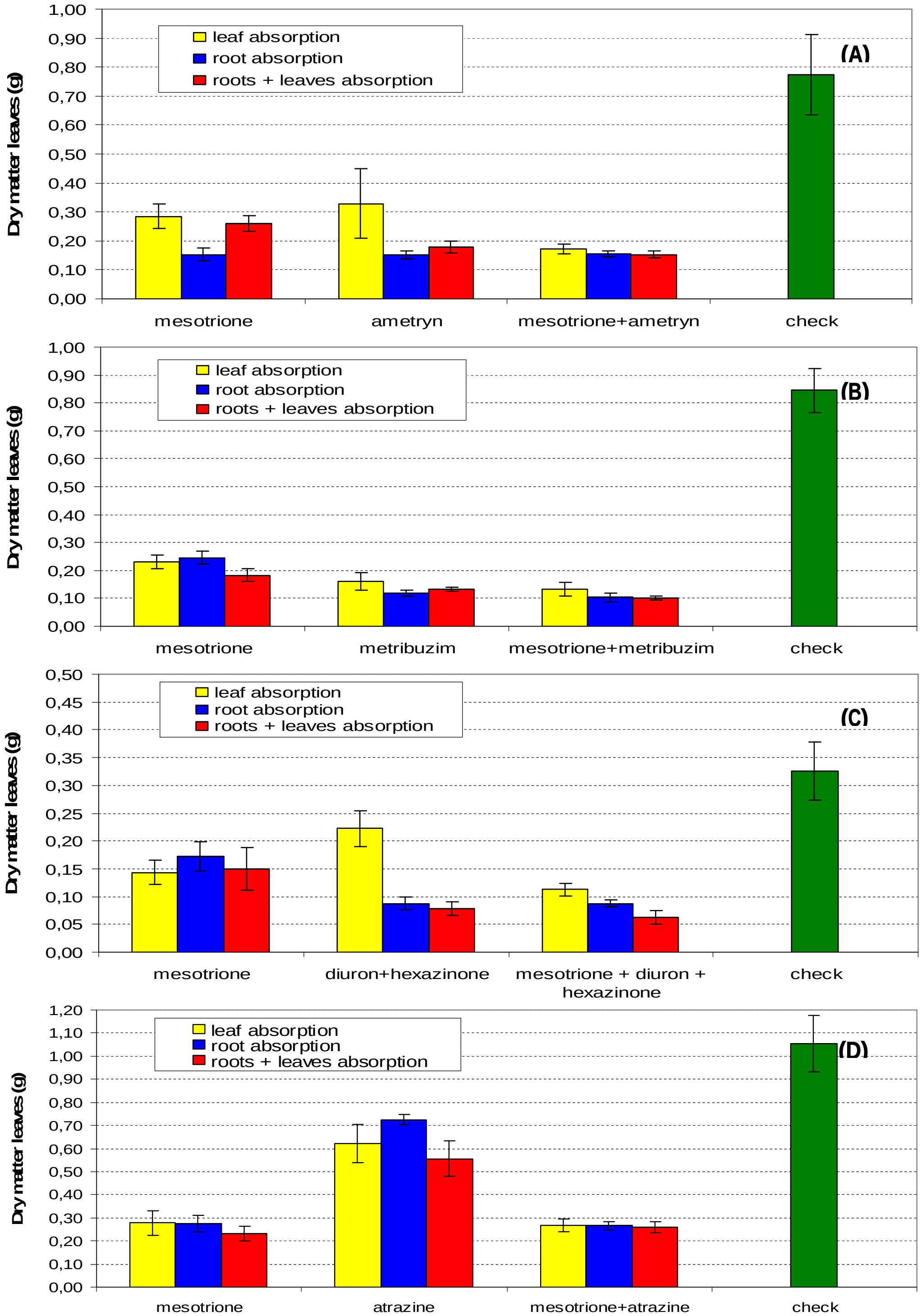

Figure 1. Dry matter of *D. horizontalis* aerial part submitted to different absorption pathways of mesotrione herbicide isolated or in tank mixture with ametryn (A), metribuzim (B), diuron+hexaxinone (C) and atrazine (D), through confidence interval (CI 5%).

For absorption exclusively by root pathway were not recorded significant increments of control depending on the mesotrione mixture with ametryn, metribuzin and diuron + hexazinone herbicides (Tables 1, 2 and 3), and in all cases mesotrione always showed inferior control level. However, the exception to this behavior was characterized by tank mixture of mesotrione + atrazine (Table 4), where it was observed synergistic effect for root absorption at 14 DAA, with control level considered satisfactory (83%).

It is important to note that synergistic effects observed by tank mixture of mesotrione and PS II inhibitors herbicides, as well as the conditions where there was only additives effects from 7 to 14 DAA, could be much more intensified for situations where the species would be in development stage of more than 5 leaves. In this way, this condition of different development stage of weeds is really common in field conditions, where development irregularities are frequent due to the distinct seedling emergence. Besides it, it would be also possible to consider the use of inferior doses of PS II herbicides inhibitors in order to obtain efficient control of *D. horizontalis* when used in tank mixture with mesotrione.

Conclusions

Tank mixture with ametryn (96 +1500 g ha), [diuron + hexazinone] (96 + [936 + 264] g ha^{-1}) and atrazine (96 + 2000 g ha^{-1}) promoted synergistic effects in *D. horizontalis* control at 3 and 7 DAA, accelerating this weed death when absorption pathway was exclusively foliar. Tank mixture mesotrione + metribuzin (96 + 1440 g ha^{-1}) did not promote synergic effects and/or additives in *D. horizontalis* control. For mesotrione + atrazine (96 + 2000 g ha^{-1}) it was observed synergic effect in *D. horizontalis* control through absorption pathway exclusively root at 14 DAA.

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