

Susceptibility of non-dicamba-resistant soybean cultivars to low rates of dicamba

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ABSTRACT

Nowadays, dicamba-resistant soybean cultivars are an agricultural reality in Brazil, thus applications of this herbicide have grown in recent years. However, adjacent areas may be grown with dicamba non-resistant soybeans and genetic background of these plants must be considered if dicamba accidentally reaches non-target areas. This study was carried out to evaluate the susceptibility of eleven non-dicamba-resistant commercial soybean cultivars to sublethal rates of dicamba herbicide applied at the V3 stage over two consecutive growing seasons. Two field experiments were carried out: in the 2020/2021 and 2021/2022 crop seasons. The treatments consisted of three rates of herbicide dicamba (checkplots, 0.48 g ha⁻¹, and 2.40 g ha⁻¹) and 11 commercial soybean cultivars. The following parameters were evaluated: pods per plant, grains per pod, grain yield (kg ha⁻¹), and thousand-grain weight (TGW; g). Phytotoxicity caused by the treatments was evaluated at 14 and 28 days after application (DAA), and plant height was measured at 42 DAA. Plant stand in the plots was evaluated before harvest. Dicamba rate related to the toxicity process was a more relevant factor for changes in grain yield than the cultivar genetic. The dicamba rates had no effect on plant stand and number of pods per plant. There was a negative effect of dicamba on plant height, grains per pod, TGW, and consequently grain yield. Low difference in cultivar sensitivity to dicamba was found, however with no practical relevance in the field.

Keywords: Chemical handling; Transgenics; Drift; Phytotoxicity; Injury.

Suscetibilidade de onze diferentes cultivares comerciais de soja não-resistente à subdoses do herbicida dicamba

RESUMO

Atualmente, cultivares de soja resistentes ao dicamba são uma realidade agrícola no Brasil, de modo que as aplicações deste herbicida têm aumentado nos últimos anos. Contudo, as áreas adjacentes podem conter cultivares de soja não resistentes de modo que a base genética destas plantas deve ser considerada caso o dicamba atinja áreas não alvo. Este trabalho foi realizado com o objetivo de avaliar a suscetibilidade de onze cultivares comerciais de soja não-resistente à pulverização de subdoses do herbicida dicamba em estágio V3, em duas safras consecutivas. Para tanto, dois experimentos foram realizados em campo, respectivamente nas safras 2020/21 e 2021/22. Os tratamentos foram consequência da combinação entre três doses do herbicida dicamba (testemunha, 0,48 e 2,40 g ha⁻¹) e 11 cultivares comerciais de soja. As seguintes variáveis foram avaliadas: vagens por planta, grãos por vagem, rendimento (kg ha⁻¹) e massa de mil grãos; fitotoxicidade aos 14 e 28 dias após aplicação (DAA) e altura de plantas aos 42 DAA. Em pré-colheita, avaliou-se o estande das parcelas. Em síntese, a dose de dicamba relacionada ao processo de intoxicação foi um fator mais relevante para as alterações de produtividade que o efeito de cultivar. Não houve efeito de dicamba sobre o estande de plantas e número de vagens por planta. Houve efeito negativo de

dicamba sobre a altura de plantas, relação de grãos por vagem, massa de mil grãos e, conseqüentemente, produtividade. Houve mínima diferença na sensibilidade das cultivares ao dicamba, porém com baixa relevância prática em campo.

Palavras-chave: Manejo químico; Transgenia; Deriva; Fitotoxicidade; Injúria.

1. Introduction

Weeds are an important biotic component in soybean (*Glycine max* [L.] Merrill) production systems that might interfere with crop yield (Fialho et al., 2020; Carvalho et al., 2023). This interference is characterized by competition for available growth resources in the environment (water, light, and nutrients), hosting of pests and diseases, and by causing difficulty in harvesting procedures and reduction in the quality of the harvested product (Datta et al., 2017; Piccinini et al., 2018; Fialho et al., 2020).

Weed infestations in soybean crops are even more significant when considering the several confirmed cases of biotypes of important weed species resistant to herbicides, mainly glyphosate, such as species of horseweed (*Conyza* spp.), sourgrass (*Digitaria insularis*), and recently, pigweed (*Amaranthus* spp.) (Carvalho et al., 2015; Braz et al., 2017; Beres et al., 2018; Dalazen et al., 2019; Melo et al., 2019; Heap, 2026).

In this context, a viable strategy for managing dicotyledonous weeds is the introduction of soybean cultivars tolerant to broadleaf herbicides, such as the dicamba-tolerant soybean cultivar (Spaunhorst et al., 2014) approved by CTNBio (CTNBio, 2016) and commercially released in the 2021/2022 crop season. Considering the many cases of glyphosate-resistant horseweed in Brazil (Heap, 2026), it is expected that dicamba will be widely used in agricultural areas as an alternative for managing these weeds (Osipe et al., 2017; Novello et al., 2025; Agostinetto et al., 2025; Salmazo et al., 2026).

Dicamba is a product that has becoming important as an alternative for controlling some glyphosate-resistant weeds and other infesting plants in agroecosystems and due to few reported cases of resistance to its mode of action (Spaunhorst et al., 2014). However, if recommended conditions of applications are not observed, it is an herbicide with a high volatility potential and, consequently, a high potential for drift during applications, affecting non-target crops, such as neighboring fields and non-resistant soybean plants (Silva et al., 2018; Oliveira et al., 2019; Meyeres et al., 2021; Antuniassi et al., 2024).

The high sensitivity of non-dicamba-tolerant soybean plants is well-documented in scientific literature (Costa et al., 2020a,b; Carvalho et al., 2022; Carvalho et al., 2023). Studies have evaluated toxicity in crops during pre-emergence and early stages of

vegetative development, as well as during reproductive stages when soybean plants are more susceptible to herbicide toxicity (Egan et al., 2014; Silva et al., 2018; Costa et al., 2020a; Marques et al., 2021; Carvalho et al., 2022). According to Griffin et al. (2013), soybeans are 2.5 times more sensitive to toxicity during flowering compared to the vegetative stage. Therefore, the developmental stage of the crop at the time of contamination is an important factor for the emergence of injuries and changes in crop yield (Costa et al., 2020a). However, no studies were found evaluating the susceptibility of the different soybean genetic materials adopted in Brazil.

The genetic diversity of cultivars is relevant regarding the observed phytotoxicity and, consequently, the interference with crop yield (Meyeres et al., 2025). Therefore, this study was carried out to evaluate the susceptibility of eleven non-dicamba-resistant commercial soybean cultivars to sublethal rates of dicamba herbicide applied at the V3 vegetative stage over two consecutive growing seasons.

2. Material and Methods

Two field experiments were carried out in agricultural areas grown with soybean plants in the municipality of Paraguaçu, South of Minas Gerais, Brazil. The first experiment was carried out between October 2020 and March 2021, in an area of the Oriente Farm (21°34'42"S, 45°47'09"W). The second experiment was conducted between October 2021 and March 2022, in another parcel of the same farm (21°37'04"S, 45°46'26"W). In both areas, soybean was grown in a clayey soil, maintained under no-till system with rainfed cereal crops. The soil chemical attributes are shown in Table 1.

Both areas had grown with sorghum before the soybean crops. The experiments were carried out in a randomized block design with four replications. Two experimental blocks with three plots were implemented within each 60-meter strip. A 6-meter border was determined at the beginning of the strip, followed by three 7-meter plots, a 6-meter central corridor for machinery transit, three additional 7-meter plots, and a 6-meter border at the end. Each plot had six soybean rows spaced 0.50 meters apart, with a total length of 7 meters, resulting in a total area of 21 m² and an evaluation area of 10 m².

Table 1. Chemical attributes of the soils collected in the experimental areas. Paraguaçu, MG, Brazil, 2023

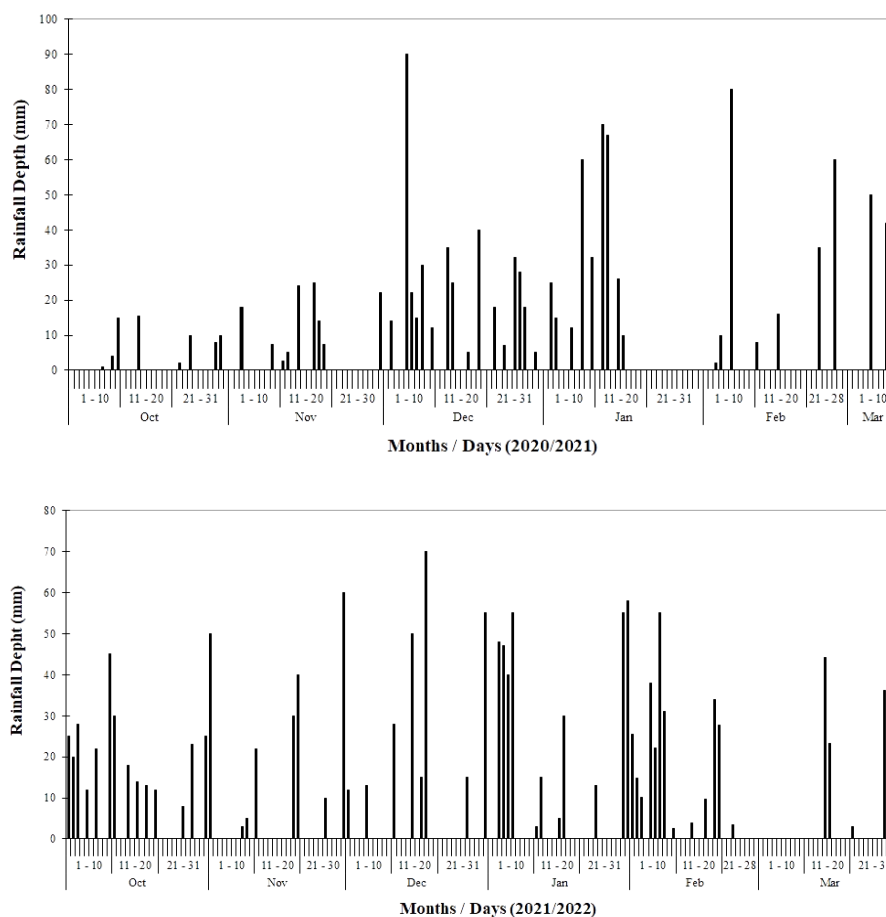
Crop season	pH H ₂ O	OM dag kg ⁻¹	P mg dm ⁻³	K mg dm ⁻³	Ca	Mg	H+Al cmol _c dm ⁻³	SB	CEC	BS %	m %
2020/2021	5.82	2.36	26.03	36.0	3.79	1.22	3.08	6.74	8.19	82.3	0.0
2021/2022	5.24	2.23	5.82	47.0	2.54	0.83	4.90	3.45	8.30	41.6	5.17

OM – organic matter; SB – sum of bases; CEC – cation exchange capacity; BS – base saturation; m – aluminium saturation.

The 11 soybean cultivars were sown on October (2020/2021 crop season) and October (2021/2022 crop season), using 6 rows x 60 m strips, rows spaced 0.50 meters apart (3 m). Each cultivar was sown in two distinct random strips within the area. In the first crop season, all cultivars were sown for obtaining an initial population of 300,000 plants per hectare. In the following crop season, the sowing was carried for obtaining 260,000 plants per hectare. The density was standardized due to mechanical procedures, and once

potential yield was not the aim of the experiment and thus comparing treated and untreated plots.

The phytosanitary management was carried following the commercial routine of the Oriente Farm, ensuring that soybeans achieved full development without occurrence of pests, diseases, or weeds. All maintenance sprayings were performed using a high-tech self-propelled device. Rainfall data recorded for the location during the experimental period are shown in Figure 1.

**Figure 1.** Rainfall depths recorded for the region during the experimental periods. Paraguaçu, MG, Brazil, 2023.

The experimental treatments were based on a factorial arrangement consisted of three rates of the herbicide dicamba (check plots, 0.48, and 2.40 g ha⁻¹) and eleven commercial soybean cultivars. Rates of 0.48 and 2.40 g ha⁻¹ are proportional to 0.1 and 0.5% of the commercial rate (480 g ha⁻¹ – Dicamax[®]). The dicamba rates were applied when the soybean plants were at the V3/V4 stage (two to three fully developed trifoliate

leaves), in both experiments. The soybean cultivars selected were: Monsoy 5917 IPRO, Pioneer 97R59 IPRO, Brasmax Zeus IPRO, Monsoy 5838 IPRO, Monsoy 6410 IPRO, LG 60162 IPRO, Brasmax Desafio RR, Pioneer 96R29 IPRO, Nidera 7709 IPRO, Syngenta NK 7201 IPRO, and Brasmax Ativa RR.

The experimental treatments were applied to the plots on November 2020 and November 2021, when the

soybeans were at the V3/V4 stage, once it is the most probable occurrence in field condition. It was used a precision CO₂-pressurized backpack sprayer coupled to a spray boom with four TTI 110.02 nozzles, calibrated for 200 L ha⁻¹. Only the four central rows of each plot were subjected to dicamba application, ensuring a lateral border between strips. In the first crop season, the treatments were applied between 8:00 and 9:00 a.m., under conditions of mean relative humidity of 75.3%, mean temperature of 27.3 °C, mean wind speed of 2.98 km h⁻¹, and partly cloudy sky. In the second crop season, the treatments were applied between 8:20 and 10:00 am, under conditions of mean relative humidity of 75.6%, mean temperature of 23.8 °C, mean wind speed of 3.3 km h⁻¹, and partly cloudy sky.

Phytotoxicity in soybean plants caused by the treatments was evaluated at 14 and 28 days after application (DAA), using a percentage injury scale ranging from zero to 100%, where zero represented the absence of symptoms (healthy plants) and 100% represented dead plants (SBCPD, 1995). Plant height in the plots was measured at 42 DAA. Plant standing in the plots were determined before harvest by counting the number of plants in the central 3 meters of each plot, within its two central rows.

Harvest was carried out considering the maturation cycle of the cultivars, over four consecutive weeks (Table 2). Twenty consecutive plants, non-adjacent to gaps, in each of the two central rows of each plot, were sampled at each harvest date, totaling 40 plants per plot. Subsequently, the harvested pods were transported to the laboratory of the Federal Institute of the South of Minas Gerais (IFSULDEMINAS), Machado campus, counted (pods per plant), dried, and threshed to obtain the number of grains per pod, grain yield per plant (g plant⁻¹), total grain yield (kg ha⁻¹), and thousand-grain weight (TGW; g). The relative grain yield was also calculated, considering the control treatment for each cultivar as 100% yield. All production data were standardized to 13% moisture content.

The experimental data were subjected to F-test for analysis of variance. Variables with significant effects of the treatments were grouped using the Scott-Knott test, with 5% of significance (Scott & Knott, 1974). Considering experimental homogeneity, the yield data were also grouped for analysis by group of experiments. All tests were performed with a significance level of 5%.

Table 2. Harvest date and crop cycle (in days) for each soybean cultivar in two consecutive crop seasons. Paraguaçu, MG, Brazil 2022

Soybean cultivar	Harvest date	Cycle (days)	Harvest date	Cycle (days)
Monsoy 5917 IPRO	02/11/2021	118	03/03/2022	128
Pionner 97R50 IPRO	05/03/2021	139	03/16/2022	141
Brasmax Zeus IPRO	02/11/2021	118	03/10/2022	135
Monsoy 5838 IPRO	02/26/2021	132	03/03/2022	128
Monsoy 6410 IPRO	02/26/2021	132	03/16/2022	141
LG 60162 IPRO	02/11/2021	118	03/03/2022	128
Brasmax Desafio RR	05/03/2021	139	03/16/2022	141
Pioneer 96R29 IPRO	02/19/2021	125	03/10/2022	135
Nidera 7709 IPRO	02/26/2021	132	03/16/2022	141
Syngenta NK 7201 IPRO	02/19/2021	125	03/10/2022	135
Brasmax Ativa RR	02/11/2021	118	02/23/2022	120

3. Results and Discussion

Significant effects of the factors cultivar and herbicide rate were observed, as well as the interaction between these factors were found only 14 days after application (DAA) in the 2021/2022 crop season. The application of the highest rate of dicamba (2.4 g ha⁻¹) caused more injuries to the plants than the rate of 0.48 g ha⁻¹ in all evaluations (Table 3), as expected due to the sensitivity of the species to dicamba. Differences in sensitivity to dicamba among cultivars were found in all evaluations, enabling their classification into susceptibility groups. However, the range of differentiation among the groups was small and not significantly applicable in practice, as the largest ranges did not exceed 15% of phytotoxicity. In other words,

concerning phytotoxicity, it is considered that the herbicide drift concentration was more important than the soybean genetic material, as changing the rate from 0.48 to 2.4 g ha⁻¹, on average, doubled the observed phytotoxic effects (Table 3).

Considering the application of low dicamba rates, the most common symptoms of phytotoxicity found were: wrinkling at edges and tips of leaflets, widespread curling leaflets, presence of cupping, excessive petiole growth, slight alteration in meristematic regions, and epinasty. Dicamba is an herbicide from the benzoic acid chemical group, belonging to the class of growth regulators, synthetic auxins, or also known as an auxin mimic herbicide. The first symptom observed in susceptible plants after its application is epinasty of

leaves and petioles. Other metabolic functions are affected over time, leading to the emergence of additional symptoms, such as deformations in veins and leaf blade, growth cessation with thickening of roots,

and death of susceptible plants, which typically occurs gradually, usually between 3 to 5 weeks after application (Zhou et al., 2016; Cunha et al., 2022; Carvalho et al., 2023).

Table 3. Phytotoxicity in 11 different soybean cultivars subjected to application of two low rates of dicamba (0.48 and 2.40 g ha⁻¹) at the V3 stage (two fully developed trifoliate leaves), evaluated at 14 and 28 days after application (DAA), in two consecutive crop seasons. Paraguaçu, MG, Brazil, 2023.

Soybean cultivar	Phytotoxicity at 14 DAA			Phytotoxicity at 28 DAA		
	0.48 g ha ⁻¹	2.40 g ha ⁻¹	Mean	0.48 g ha ⁻¹	2.40 g ha ⁻¹	Mean
2020/2021 crop season						
Monsoy 5917 IPRO	12.3	26.5	19.4 A	8.8	39.3	24.0 A
Pionner 97R50 IPRO	10.8	29.3	20.0 A	8.0	37.0	22.5 A
Brasmax Zeus IPRO	9.0	26.8	17.9 A	8.0	37.8	22.9 A
Monsoy 5838 IPRO	13.0	32.8	22.9 B	8.3	41.3	24.8 A
Monsoy 6410 IPRO	13.3	31.3	22.3 B	11.8	43.3	27.5 B
LG 60162 IPRO	15.3	31.8	23.5 B	14.3	39.8	27.0 B
Brasmax Desafio RR	12.0	30.0	21.0 B	9.0	37.5	23.3 A
Pioneer 96R29 IPRO	9.3	28.3	18.8 A	11.3	37.3	24.3 A
Nidera 7709 IPRO	11.8	27.5	19.6 A	9.5	33.5	21.5 A
Syngenta NK 7201 IPRO	8.0	26.8	17.4 A	7.5	36.8	22.1 A
Brasmax Ativa RR	14.0	33.3	23.6 B	11.5	43.0	27.3 B
Mean	11.7 a	29.5 b	---	9.8 a	38.8 b	---
F _{int}	0.338 ^{NS}			1.970 ^{NS}		
2021/2022 crop season						
Monsoy 5917 IPRO	18.8 A a	38.3 B b	28.5	14.3	25.8	20.0 B
Pionner 97R50 IPRO	16.5 A a	31.8 A b	24.1	16.0	27.8	21.9 C
Brasmax Zeus IPRO	20.0 A a	37.5 B b	28.8	20.0	28.3	24.1 C
Monsoy 5838 IPRO	18.0 A a	43.0 B b	30.5	13.0	20.8	16.9 A
Monsoy 6410 IPRO	21.8 A a	40.0 B b	30.9	16.5	23.5	20.0 B
LG 60162 IPRO	19.3 A a	34.5 A b	26.9	14.3	21.8	18.0 A
Brasmax Desafio RR	20.5 A a	27.5 A b	24.0	15.0	25.8	20.4 B
Pioneer 96R29 IPRO	18.8 A a	33.0 A b	25.9	14.3	25.0	19.6 B
Nidera 7709 IPRO	17.0 A a	35.0 A b	26.0	11.8	21.3	16.5 A
Syngenta NK 7201 IPRO	16.0 A a	33.0 A b	24.5	12.3	27.5	19.9 B
Brasmax Ativa RR	18.3 A a	36.3 B b	27.3	17.3	30.3	23.8 C
Mean	18.6	35.4	---	14.9 a	25.2 b	---
F _{int}	2,370*			1,793 ^{NS}		

¹Means followed by the same uppercase letter in the columns or lowercase letter in the rows are not significantly different from each other by the Scott-Knott test at 5% significance level; *Significant at 5% by the F-test; ^{NS}Not significant by the F-test.

Andersen et al. (2004) evaluated toxicity in soybean crops at the V3 stage using different dicamba rates (5.6 to 112 g ha⁻¹). Regarding the application of the highest rates, they found several symptoms ranging from mild (<10%) to severe (96%), including leaf alterations, epinasty, and even death of apical buds. Grain yield losses due to these applications ranged from 14% to 93% when compared to untreated plants. According to Senseman (2007), dicamba-induced injuries in soybean crops are found in newly formed tissues, as the herbicide is translocated to meristematic tissues; alterations in seed germination and vigor may also occur (Costa et al., 2020b).

Regarding the analysis of plant height, the effects of the dicamba rate and cultivar were also found, with no effect of their interaction (Table 4). The highest dicamba rate decreased plant height in both crop seasons when evaluated at 42 DAA. No effect of dicamba on plant stand and pods per plant was found, indicating that the applied rates were not sufficient to

cause plant death or alter branch architecture and pod distribution. The low dicamba rates applied may not have been sufficient to induce flower abscission, thus maintaining the number of pods on the plants. However, the highest dicamba rate affected pod formation, lowering the number of grains per pod (Table 4), which is an important component for estimating final crop yield.

The results of thousand-grain weight (TGW) obtained in both crop seasons are shown in Table 4. TGW is another important production component for calculating crop yield. A negative effect of the dicamba rate of 2.4 g ha⁻¹ on TGW was found in both crop seasons (Table 4). In summary, the highest dicamba rate altered the number of grains per pod and TGW in both crop seasons (Table 4).

The grain yields found for the evaluated soybean cultivars in the two experiments are shown in Table 5. The effect of the interaction between dicamba rate and cultivar was not found in both seasons; however, a

natural difference among cultivars was identified, as well as the effect of the factor dicamba rate was found only in the 2020/2021 crop season. In this crop season, the highest dicamba rate decreased the mean grain yield of the soybean cultivars, differing from the lowest rate and the check plots (Table 5). No production losses

were found in the 2021/2022 crop season. This may be due to the excellent meteorological conditions recorded during this agricultural year (Figure 1), which provided high-water availability, contributing to plant recovery and yield.

Table 4. Plant height (m), plant stand, pods per plant, grains per pod, and thousand-grain weight of 11 different soybean cultivars subjected to application of two low rates of dicamba at the V3 stage (two fully developed trifoliate leaves), in two consecutive crop seasons. Paraguaçu, MG, Brazil, 2023

Variable	Crop season	Dicamba rate		
		Checkplots	0.48 g ha ⁻¹	2.40 g ha ⁻¹
Plant height (28 DAA)*	2020/2021	0.54 a	0.52 a	0.41 b
	2021/2022	0.63 a	0.58 b	0.47 c
Plant stand ^{NS}	2020/2021	14.0	13.5	13.8
	2021/2022	11.5	11.5	11.6
Pods per plant ^{NS}	2020/2021	37.3	38.4	38.8
	2021/2022	40.5	41.0	41.6
Grains per pod*	2020/2021	2.53 a	2.51 a	2.37 b
	2021/2022	2.39 a	2.32 b	2.28 c
Thousand-grain weight *	2020/2021	136.1 a	128.9 b	125.5 b
	2021/2022	182.9 a	182.6 a	177.6 b

DAA = days after application. ¹Means followed by the same lowercase letter in the rows are not significantly different from each other by the Scott-Knott test at 5% significance level; *Significant at 5% by the F-test; ^{NS}Not significant by the F-test.

Table 5. Grain yield¹ (kg ha⁻¹) of 11 soybean cultivars subjected to application of two low rates of dicamba at the V3 stage (two fully developed trifoliate leaves), in two consecutive crop seasons. Paraguaçu, MG, Brazil, 2021

Soybean cultivar	Dicamba			Mean
	Absence	0.48 g ha ⁻¹	2.40 g ha ⁻¹	
2020/2021 crop season				
Monsoy 5917 IPRO	3,540.50	3,479.63	2,767.14	3,262.42 C
Pionner 97R50 IPRO	3,036.41	3,051.11	2,886.17	2,991.23 D
Brasmax Zeus IPRO	4,327.36	4,365.75	3,957.67	4,216.93 A
Monsoy 5838 IPRO	4,110.86	3,650.20	3,752.47	3,837.84 B
Monsoy 6410 IPRO	3,019.37	3,238.87	3,214.75	3,157.66 D
LG 60162 IPRO	3,189.49	3,351.87	2,690.16	3,077.17 D
Brasmax Desafio RR	3,577.55	2,869.03	3,162.87	3,203.15 C
Pioneer 96R29 IPRO	3,789.21	3,576.80	3,251.39	3,539.13 C
Nidera 7709 IPRO	2,926.00	2,902.09	2,734.19	2,854.09 D
Syngenta NK 7201 IPRO	3,438.75	2,992.65	2,879.53	3,103.65 D
Brasmax Ativa RR	3,414.76	3,597.15	2,927.64	3,313.18 C
Mean	3,488.20 a	3,370.47 a	3,111.27 b	---
F _{cult} = 11.104*	F _{treat} = 9.49*	F _{int} = 1.03 ^{NS}	CV(%) = 12.49	
2021/2022 crop season				
Monsoy 5917 IPRO	3,572.18	3,933.30	3,580.73	3,695.40 B
Pionner 97R50 IPRO	3,544.38	3,805.62	3,552.68	3,634.23 B
Brasmax Zeus IPRO	5,264.33	4,534.95	4,264.83	4,688.03 A
Monsoy 5838 IPRO	3,374.70	2,956.15	3,227.25	3,186.03 C
Monsoy 6410 IPRO	3,839.50	3,552.05	3,859.62	3,750.39 B
LG 60162 IPRO	3,773.03	3,950.92	3,744.13	3,822.69 B
Brasmax Desafio RR	4,797.90	4,859.00	4,533.53	4,730.14 A
Pioneer 96R29 IPRO	4,252.85	4,243.90	3,193.95	3,896.90 B
Nidera 7709 IPRO	3,293.30	3,942.85	3,540.68	3,592.28 B
Syngenta NK 7201 IPRO	4,038.85	3,710.95	3,721.30	3,823.70 B
Brasmax Ativa RR	4,491.48	4,250.95	4,973.43	4,571.95 A
Mean	4,022.04	3,976.42	3,835.64	---
F _{cult} = 9.943*	F _{treat} = 1.382 ^{NS}	F _{int} = 1.322 ^{NS}	CV(%) = 13.90	

Solomon and Bradley (2014) evaluated the effect of several auxin herbicides on soybean crops and reported that, in general, a phytotoxicity below 10% two weeks after application did not decrease grain yield. However,

they found that the damage caused by toxicity during the reproductive stage was more severe than that found during the vegetative stage. The literature provides consistent information about higher decreases in grain

yield of soybean crops due to toxicity during reproductive stages (Egan et al., 2014; Silva et al., 2018; Costa et al., 2020a; Carvalho et al., 2023).

Dicamba, even when applied at low-rates, might cause damage to sensitive plants due to drift and even contamination of machinery and sprayers (Bish and Bradley, 2017; Marques et al., 2021; Carvalho et al., 2023). The dicamba's action occurs in the plant's metabolism, stimulating synthesis of nucleic acids and proteins, triggering abnormalities in growth, as it affects cell division, enzymatic activity, and respiration (USEPA, 2013; Carvalho et al. 2023).

The cumulative graphical analysis of the 2020/2021 and 2021/2022 crop seasons (Figure 2) for the grain yield deviation of each cultivar compared to its check plot without herbicide application is shown in Figure 2. A constant negative effect of dicamba on grain yield was found, with emphasis on the highest rate, mainly considering the magnitudes of the yield losses. An exception was found for the cultivar Pioneer 97R50, but with a significant experimental variability. In summary, the application of dicamba rates affected the grain yield of the evaluated soybean cultivars, but with no practical evidence of varietal differences, as the variation in grain yield did not exceed 20% (Figure 2).

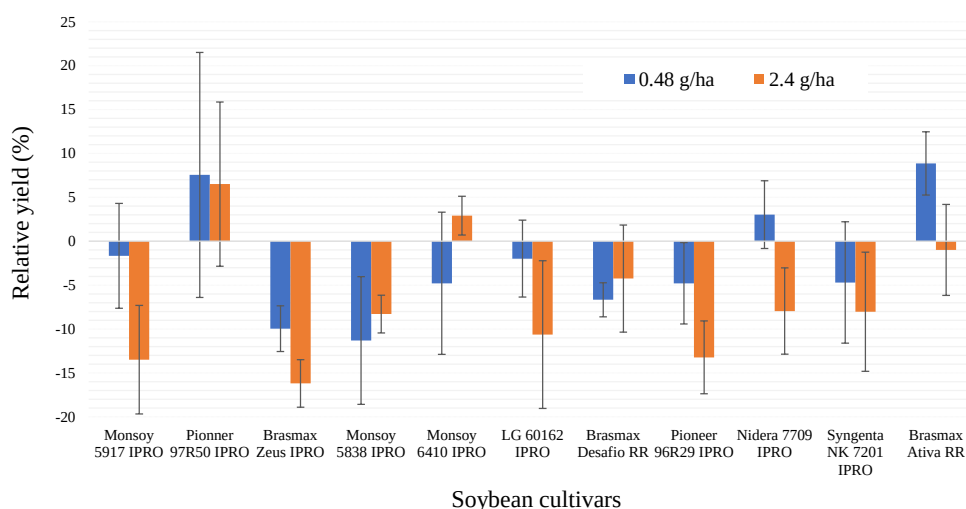


Figure 2. Cumulative relative grain yield (%) (2020/2021 and 2021/2022 crop seasons) of 11 soybean cultivars subjected to application of different rates of dicamba. Paraguaçu, MG, Brazil, 2023.

4. Conclusions

The dicamba rate related to the toxicity process is a more relevant factor for changes in soybean grain yield than the cultivar.

No effect of dicamba on plant stand and pods per plant was found. However, a negative effect of dicamba was found for plant height, grains per pod, thousand-grain weight, and consequently grain yield.

Low differences in cultivar sensitivity to dicamba were found, with low practical relevance in the field.

Authors' Contribution

Saul Jorge Pinto de Carvalho: Data curation, formal analysis, investigation, supervision, writing, Gilmar José Picoli Júnior: Data curation, methodology, project administration, resources, Matheus Gabriel Palhano: Conceptualization, funding acquisition, methodology, resources and Ramiro Fernando López Ovejero: Conceptualization, project administration, supervision, writing.

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