(DOI): 10.5935/PAeT.V9.N1.02

Brazilian Journal of Applied Technology for Agricultural Science, Guarapuava-PR, v.9, n.1, p.17-25, 2016

Cientific Paper

Weed interference on radish crop

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Abstract

This study aimed to evaluate the effect of different periods of weed coexistence with radish culture. The experiment was carried out in Gurupi-TO, in a randomized block design with four replications. The treatments consisted of 6 increasing periods of coexistence with weeds, considered from the rough, valued at five seasons assessments (5, 10, 15, 21, and 30 DAE). Dry stem masses were evaluated, leaf and total shoot, leaf area, root diameter and fresh root biomass. The data were submitted to analysis of variance to compare means by the Scott and Knott test. It was observed that longer periods of coexistence with weeds caused a reduction of 72.1% in the production of fresh weight root culture. Living with weeds up to 15 days after emergence did not significantly alter the radish root diameter in this study.

Key words: Cultivar Vip Crimson, leaf area; Phytomass; *Raphanus sativus*; root diameter.

Interferência de plantas daninhas sobre a cultura do rabanete

Resumo

Objetivou-se avaliar a interferência de diferentes períodos de convivência das plantas daninhas com a cultura do rabanete. O experimento foi conduzido em Gurupi-TO, no delineamento em blocos casualizados, com quatro repetições. Os tratamentos foram constituídos por 6 períodos crescentes de convivência com plantas daninhas, considerados a partir do desbaste, avaliados em cinco épocas de avaliações (5, 10, 15, 21, e 30 DAE). Foram avaliadas as massas secas do caule, da folha e do total da parte aérea, área foliar, diâmetro da raiz e fitomassa fresca da raiz. Os dados foram submetidos à análise de variância para comparação das médias pelo teste de Scott e Knott. Observou-se que maiores períodos de convivência com plantas daninhas provocaram uma redução de 72,1 % na produção de fitomassa fresca da raiz da cultura. A convivência com plantas daninhas até 15 dias após emergência não alterou significativamente o diâmetro da raiz do rabanete nesse estudo.

Palavras chave: Cultivar Vip Crimson; Área foliar; Fitomassa; *Raphanus sativus*; Diâmetro da raiz

Received at: 26/09/15 Accepted for publication at: 16/03/16

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La interferencia de malas hierbas en el cultivo del rábano

Resumen

Este estudio tuvo como objetivo evaluar el efecto de diferentes periodos de convivencia de malas hierbas con el cultivo del rábano. El experimento se realizó en Gurupi-TO, en un diseño de bloques al azar con cuatro repeticiones. Los tratamientos consistieron en seis períodos crecientes de convivencia con las malas hierbas, consideradas desde el debaste, evaluados en cinco épocas (5, 10, 15, 21 y 30 DAE). Se evaluaron las masas secas del tallo, de las hojas y total de la parte aérea, diámetro de la raíz y la biomasa fresca de raíces. Los datos fueron sometidos a análisis de varianza para comparar las medias mediante la prueba de Scott y Knott. Se observó que los períodos más largos de convivencia con las malas hierbas causaron una reducción del 72,1% en la producción de biomasa fresca de la raíz de las plantas. La convivencia con las malas hierbas hasta 15 días después de la emergencia no alteró significativamente el diámetro de raíz de rábano en este estudio.

Palabras clave: Cultivando VIP Crimson; área foliar; biomasa; *Raphanus sativus*; diámetro de la raíz

Introduction

Radish (*Raphanus sativus* L.) is a Brassicaceae of reduced size that, in cultivars of greater acceptance, produces globular roots, of bright-scarlet coloration and white pulp (LINHARES et al., 2010). It develops well in conditions of mild to cold weather, and it adapts better to the planting in autumn-winter, in well drained soils, with good fertility and that present good availability of water during the whole crop cycle (OLIARI et al., 2010).

It is characterized among oleraceous as a plant of very short cycle (about 30 days) and it may become an option for the rural producer by providing fast financial return (OLIARI et al., 2010). However, few studies have been conducted with this crop, and due to this, there is scarcity of information about its cultivation, mainly in Brazil (FONTES et al., 2012).

According to CARVALHO and GUZZO (2008), in agricultural environments, one of main factors that can affect negatively the productivity of crops, both directly and indirectly, is the interference imposed by weeds. Among the factors that affect the degree of interference between weeds and cultivated plants, the period of competition is perhaps the most important (COELHO et al., 2009).

In the initial stage of development, the crop and weeds can live together for a determined period without harming quantitatively or qualitatively the crop production, but after this period, an inadequate management of weeds reduces significantly the crop productivity (OLIVEIRA et al., 2010). Weeds stand out in rapidity and efficiency of the use of environmental resources, taking advantage on crops growth (FIALHO et al., 2011). They interfered in the productive process, competing for environmental resources, mainly water, light and nutrients, releasing allelopathic compounds, acting as hosts of pests and diseases and interfering in the harvesting practices (SANTOS et al., 2010).

Several researchers in different crops have demonstrated the harmful effect caused by the competition period with weeds, like: (CARVALHO; GUZZO, 2008) and (COSTA et al., 2008) in beet; (COELHO et al., 2009) in carrot; (FREITAS et al., 2009) in cowpea; (JOHANNS, CONTIERO, 2006) in cassava.

In view of the above, negative effects that longer periods of competition with weeds can cause in different cultures are clear, being necessary to obtain higher volume of information to determine more precisely the period that the radish crop can live together with weeds.

This way, the objective of this study was to evaluate the interference of different periods of competition of weeds with the radish culture (*Raphanus sativus* L.), cultivar Vip Crimson Special Selection, in order to determine its effect on the plant growth, as well in production.

Materials and Methods

The experiment was conducted in Universidade Federal do Tocantins (Federal University of Tocantins) – Campus Gurupi, in the Experimental Station of Research (ESR), located at

11°43'45''S and 49°04'07''W, with average altitude of 287 meters.

Radish (*Raphanus sativus*) seeds, cultivar Vip Crimsom Special Selection, were sown in beds of 0,8 m of width x 10 m of length x 0,1 m of height. The soil used was classified as Dystrophic Oxisol, whose chemical characteristics are shown in Table 1.

The chemical fertilization of soil was realized according to the chemical analysis of the soil and to crop requirements, where it was realized a fertilization of planting at a dose of 150 g m^{-2} of the NPK 4-14-8 source.

The sowing was realized in the beginning of December 2009, in a spacing of 0,08m between plants and 0,2 m between rows. The thinning was realized at 5 days after sowing. The area was irrigated by sprinkling, once a day; this procedure guaranteed the water availability required during the whole experiment, avoiding restriction or excess of water to the plants. During the experiment conduction, all phytosanitary treatments required to the culture were performed.

The precipitation values and the temperatures occurred during the period of the experiment conduction are presented in Figure 1.

The experiment was conducted in a randomized block design, with four replications. Treatments were constituted of 6 increasing periods of competition with weeds - considered from the thinning (Table 2) - in which radish plants remained under the interference of weeds from planting to the following periods of its development cycle (1-5, 1-10, 1-15, 1-21 days); the crop was maintained always in clean and in competition with weeds during the whole crop cycle. After each period, the weeds were removed of plots through hand weeding until harvesting.

The experiment was assessed in five evaluation times (5, 10, 15, 21 and 30 days after emergence). To determine the characteristics were collected three plants per plot that were harvested, manually, packed in paper bags. Then, the same were transported to the laboratory, where radish plants were separated into stem and leaf. Discs of leaf lamina were removed through a cylindrical awl with known internal area, so as to estimate the leaf area from the relations between dry weight of discs, total area of discs and total dry weight of leaves. Then, all plant parts were maintained in forced circulation oven, with temperature of 70 °C until obtain constant mass. After, stem dry weight, leaf dry weight, total dry weight of leaves and shoot dry weight were determined through a semi-analytical scale.

In the last analysis, root fresh phytomass (g) and horizontal diameter of the root (mm) were evaluated, in order to evaluate the characteristics related to the commercialization, since in determined regions radish is also commercialized as sauce. To obtain the horizontal diameter it was used a steel digital caliper rule (Zaas 150 mm 6¨).

Data were submitted to the regression to obtain the adjusted equations and their respective determination coefficients.

Results and Discussion

For the stem dry weight variable, it was verified that in first, second and third evaluation times there was no difference between treatments (P > 0,05) (Table 3). In Figure 2, growth models in the treatments are illustrated, for the stem dry weight variable. According to the regression equations adjusted for treatments (Table 4), the treatment that kept the crop free from weeds during the whole cycle (Witness 1) and the treatment that kept crop in competition of 5 days after emergence with these plants (CPD 5) showed the highest rates of stem dry weight accumulation, with values of 0,0093 and 0,0077 g day^{-1}, respectively. However, in treatments CPD 21 and in (witness 2), that kept the radish plants living together with weeds during the whole cycle, were observed the smallest rates of stem dry weight accumulation, with values of 0,0053 and 0,0052 g day^{-1}, respectively (Table 4).

Table 1. Chemical analysis of the soil of the beds of this experiment.

Depth	pH	P	K	Al^{3+}	H + Al	Ca^{2+}	Mg^{2+}	SB	T	V	OM
cm	H_2O	mg dm^{-3}			-----------------cmolc dm^{-3}-----------------					%	g dm^{-3}
0-20	4,9	3,5	16,2	0,2	3,8	1,2	0,3	1,5	5,4	28,4	7,8

Chemical attributes of 0-20 cm depth; pH in water – Relation 1:2:5; P and K – Mehich 1 extractor; Al^{3}+, Ca^{2}+ and Mg^{2}+ – KCl Extractor (1 mol L^{-1}); H + Al – SMP Extractor; SB = Sum of Exchangeable Bases; (T) = Cation Exchange Capacity at pH 7,0; V – Base Saturation Index; and OM = organic matter (oxidation: $Na_2Cr_2O_7$ 4N + $H_2SO_{4\ 10}$N).

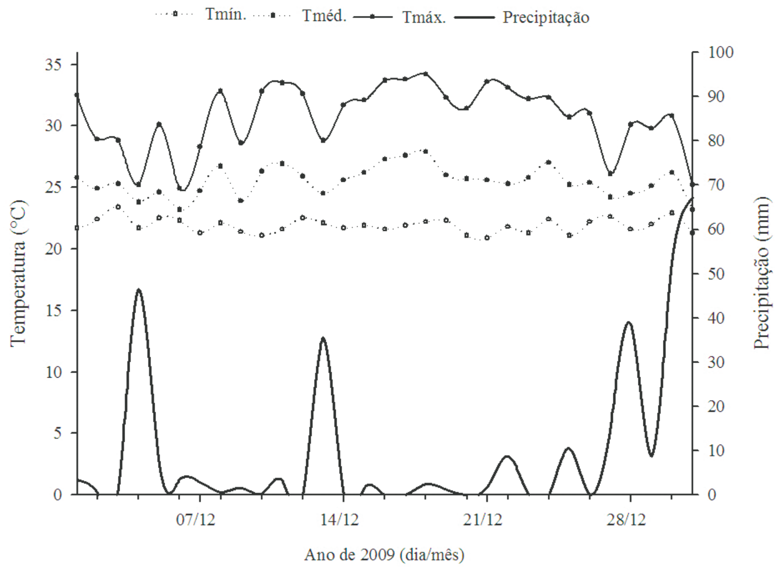

Figure 1. Climatic data concerning the month of December 2009, obtained in the Experimental Station of Research – ESR, located in Campus Gurupi-TO.

Table 2. Description of treatments evaluated in the experiment. Gurupi-TO, 2009.

Treatments	Description
CPD 0 (Witness 1) 1/	Crop maintained always in clean
CPD 3/ 5 4/	Competition with weeds during 5 days after emergence
CPD 10	Competition with weeds during 10 days after emergence
CPD 15	Competition with weeds during 15 days after emergence emergência
CPD 21	Competition with weeds during 21 days after emergence emergência
CPD 30 DAP (witness 2) 2/	Competition with weeds during the whole cycle

1/ Free cultivation of weeds during the whole cycle; 2/ cultivation with weeds during the whole cycle; 3/ competition with weeds; 4/ days after planting.

Comparing both witnesses, in which the crop was kept always in clean (witness 1) and in competition with weeds during the whole cycle (witness 2) in the last evaluation time at 30 days after emergence (Table 3), it is observed that occurred a decrease of 43,52% in stem dry weight variable.

Regarding the variable leaf dry weight, it was verified a relevant difference between treatments just in the last evaluation time at 30 days after emergence (Table 3). The treatment CPD 0 (Witness 1) was superior to the other treatments, presenting greater slope of the line (Figure 2), with higher increases of leaf dry weight at each time interval: 0,0523 g day^{-1}. On the other hand, in the treatment CPD 30 (witness 2), a smaller slope of the line meant lower increases of leaf dry weight at each time interval: 0,017 g day^{-1}.

It is observed, with these results, that in the last evaluation time at 30 days after radish plants emergence (Table 3), for the variable leaf dry weight, that there was a decrease of 69,58% in the values of leaf dry weight comparing both witnesses. There was no significant difference among the damages caused to leaf dry weight by treatments CPD 15, CPD 21 and CPD 30. After 5 days of competition with weeds (CPD 5), occurred significant effect on leaf dry weight in the last evaluation time.

It was verified, regarding the total shoot dry weight variable, significant difference among the treatments just in the last evaluation time (Table 3). The treatment (Witness 1) showed higher increases of total shoot dry weight at each time interval: 0,0616 g day^{-1}, reaching at 30 days after emergence 1,3961 g plant^{-1} (Table 3). On the other hand, in treatment (witness 2), a smaller slope of the line (Figure 2) meant

Table 3. Average values of stem dry weight, leaf dry weight, total shoot dry weight and leaf area, depending on competition periods with weeds.

Treatments	Evaluation Times (Days After Emergence)				
	5	10	15	21	30
			Stem dry weight (g)		
CPD 0 (Witness 1) [1/]	0,010 a	0,018 a	0,063 a	0,173 a	0,216 a
CPD [3/] 5 [4/]	0,008 a	0,017 a	0,056 a	0,134 b	0,185 a
CPD 10	0,007 a	0,016 a	0,049 a	0,128 b	0,171 a
CPD 15	0,008 a	0,015 a	0,048 a	0,119 b	0,126 b
CPD 21	0,009 a	0,017 a	0,047 a	0,117 b	0,125 b
CPD 30 DAP (witness 2) [2/]	0,009 a	0,015 a	0,047 a	0,115 b	0,122 b
			Leaf dry weight (g)		
CPD 0 (Witness 1) [1/]	0,039 a	0,073 a	0,240 a	0,574 a	1,321 a
CPD [3/] 5 [4/]	0,031 a	0,068 a	0,213 a	0,538 a	1,008 b
CPD 10	0,030 a	0,066 a	0,186 a	0,504 a	0,881 b
CPD 15	0,029 a	0,064 a	0,184 a	0,427 a	0,572 c
CPD 21	0,031 a	0,064 a	0,179 a	0,388 a	0,444 c
CPD 30 DAP (witness 2) [2/]	0,031 a	0,063 a	0,178 a	0,388 a	0,402 c
			Total shoot dry weight (g)		
CPD 0 (Witness 1) [1/]	0,049 a	0,091 a	0,303 a	0,747 a	1,538 a
CPD [3/] 5 [4/]	0,039 a	0,084 a	0,268 a	0,672 a	1,193 b
CPD 10	0,038 a	0,082 a	0,235 a	0,632 a	1,052 b
CPD 15	0,037 a	0,079 a	0,232 a	0,546 a	0,698 c
CPD 21	0,040 a	0,081 a	0,226 a	0,505 a	0,570 c
CPD 30 DAP (witness 2) [2/]	0,040 a	0,078 a	0,225 a	0,503 a	0,523 c
			Leaf area (cm^2)		
CPD 0 (Witness 1) [1/]	24,250 a	61,592 a	184,776 a	212,080 a	239,384 a
CPD [3/] 5 [4/]	22,102 a	46,863 a	148,105 b	176,416 b	204,727 b
CPD 10	21,852 a	42,783 a	130,984 c	157,112 b	183,239 b
CPD 15	21,370 a	41,533 a	125,984 c	132,589 c	139,194 c
CPD 21	20,900 a	42,033 a	110,734 c	115,548 c	119,111 c
CPD 30 DAP (witness 2) [2/]	21,750 a	38,194 a	105,984 c	111,264 c	114,295 c

Means followed by the same letter in column do not differ significantly at 5% probability by Scott and Knott test. 1/ Free cultivation of weed during the whole cycle; 2/ cultivation with weeds during the whole cycle; 3/ competition with weeds; 4/ days after emergence.

lower increases of total shoot dry weight at each time interval: 0,0223 g day^{-1}. Comparing both witnesses in Table 3, it is observed that a reduction of 66% occurred in the total shoot dry weight variable. For the leaf area variable, it was verified that there was no significant difference between treatments in first and second evaluation times. In the last evaluation times, the treatments (witness 1), CPD 5 and CPD 10 presented the highest averages with values of 239,384; 204,727 and 189,239 cm^2, respectively (Table 3). Comparing both witnesses in Table 3, it is observed that happened a decrease of 52,25% in the leaf area variable. Similar results were observed by SANTOS et al. (2010) when determining interference periods of weeds in okra culture; they observed decrease of 68% in dry weight and 32% of leaf area, depending on competition

In the root fresh phytomass variable (Table 5) there was statistical difference between treatments. It was verified that the treatment (Witness 1) obtained the highest value of root fresh phytomass: 27,390 g, differing from the other treatments. The treatment CPD 21 showed the lowest value of root fresh phytomass: 7,024 g. For this characteristic it is observed that as the number of days of the competition period with weeds is increased, the

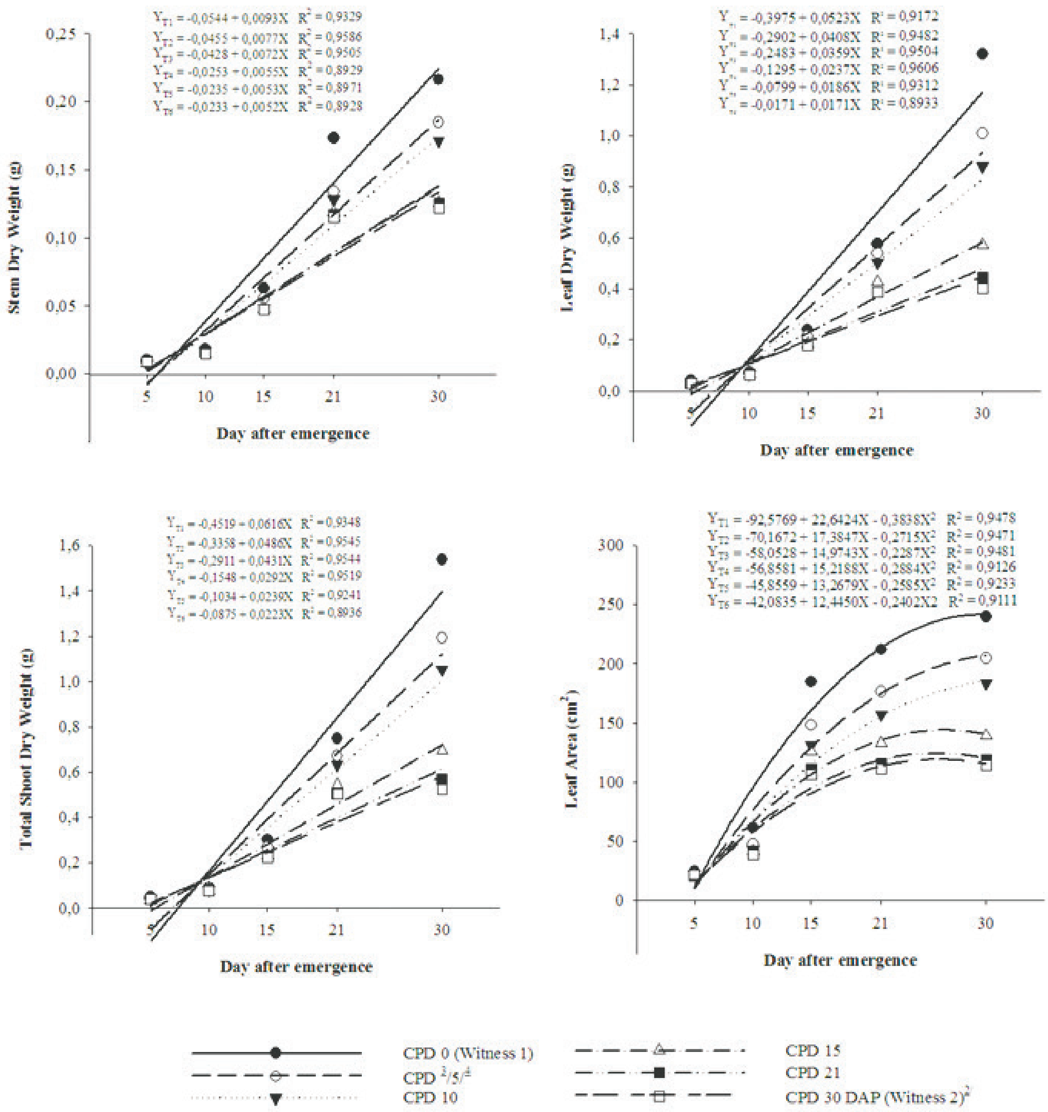

Figure 2. Estimated values for stem dry weight, leaf dry weight, total shoot dry weight and leaf area of radish plants, depending on the days after emergence.

values of root fresh phytomass decrease, with a reduction that reached 74,35% in the treatment CPD 21, demonstrating that bigger competition periods of weeds reduce the production of fresh phytomass of radish plants root.

The production of radish root fresh phytomass was reduced after 5 days of competition of the culture with the weed community (Table 5). Comparing the treatments that remained in bush and in clean during the whole agricultural cycle, there was a reduction of 72,1% in the production of root fresh phytomass of the culture. These results were similar to those found by COELHO et al. (2009), that when evaluating effects of time and extension of different competition periods of weed on carrot productivity, observed a productivity reduction of 88,7%.

Table 4. Adjusted regression equations and their respective determination coefficients for stem dry weight, leaf dry weight, total shoot dry weight and leaf area, based on competition periods with weeds.

Treatment	Regression Equation	R^2
	Stem Dry Weight (g)	
CPD 0 (Witness 1) [1/]	$\hat{Y}$ = -0,0544 + 0,0093 EP**	0,9323
CPD [3/] 5 [4/]	$\hat{Y}$ = -0,0455+0,0077 EP**	0,9586
CPD 10	$\hat{Y}$ = -0,0428+0,0072 EP**	0,9505
CPD 15	$\hat{Y}$ =-0,0253+0,0055 EP**	0,8929
CPD 21	$\hat{Y}$ =-0,235+0,0053 EP**	0,8971
CPD 30 DAP (witness 2) [2/]	$\hat{Y}$ =-0,033+0,0052 EP**	0,8928
	Leaf Dry Weight (g)	
CPD 0 (Witness 1) [1/]	$\hat{Y}$ =-0,3975+0,0523 EP**	0,9172
CPD [3/] 5 [4/]	$\hat{Y}$ =-0,2902+0,0408 EP**	0,9482
CPD 10	$\hat{Y}$ =-0,2483+0,0359 EP**	0,9504
CPD 15	$\hat{Y}$ =-0,1295+0,0237 EP**	0,9606
CPD 21	$\hat{Y}$ =-0,0799+0,0186 EP**	0,9312
CPD 30 DAP (witness 2) [2/]	$\hat{Y}$ =-0,0171+0,017 EP**	0,8933
	Total Shoot Dry Weight (g)	
CPD 0 (Witness 1) [1/]	$\hat{Y}$ =-0,4519+0,0616 EP**	0,9348
CPD [3/] 5 [4/]	$\hat{Y}$ =-0,3358+0,0486 EP**	0,9545
CPD 10	$\hat{Y}$ =-0,2911+0,431 EP**	0,9544
CPD 15	$\hat{Y}$ =-0,1548+0,029 EP**	0,9519
CPD 21	$\hat{Y}$ =-0,1034+0,023 EP**	0,9241
CPD 30 DAP (witness 2) [2/]	$\hat{Y}$ =-0,0875+0,02 23 EP**	0,8936
	Leaf Area (cm^2)	
CPD 0 (Witness 1) [1/]	$\hat{Y}$ =-92,5769+22,64 EP - 0,3838 EP2**	0,9478
CPD [3/] 5 [4/]	$\hat{Y}$ =-70,1672+173847 EP - 0,2715 EP2**	0,9471
CPD 10	$\hat{Y}$ =-58,0528+14,9743 EP - 0,2287 EP2**	0,9481
CPD 15	$\hat{Y}$ =-56,8581+15,2188 EP - 0,2884 EP2**	0,9126
CPD 21	$\hat{Y}$ =-45,8559+13,2679 EP - 0,2585 EP2**	0,9233
CPD 30 DAP (witness 2) [2/]	$\hat{Y}$ =-42,0835+12,4450 EP - 0,2402 EP2**	0,9111

*** Significant at 1% probability by t test (P > 0,01).*

Fontes et al. (2012) working with radish culture intercropped with carrot observed that as the period of weed control was reduced, it was verified loss of commercial productivity, that reached 100% when the culture was not submitted to any weeding.

On the other hand, the root diameter was reduced after 21 days of competition, so that the treatments CPD 21 and CPD 30 DAP (witness 2) [2/] presented the lowest values: 19,907 and 20,679 mm, respectively (Table 5). Therefore, it is possible to conclude that the root diameter is a characteristic that did not show strong relation with the production of root fresh phytomass of the culture, as observed by COELHO et al. (2009).

Thus it is observed that as the number of competition days of culture with weeds increases, occurs a linear decrease in the expression of the variables studied, reflecting significantly on the

Table 5. Average values of root fresh phytomass (RFP) and root diameter (RD), depending on competition periods with weeds, in Gurupi – TO.

Treatments	Root Fresh Phytomass (g)	Root Diameter (mm)
CPD 0 (Witness 1) 1/	27,390 a	32,501 a
CPD 3/ 5 4/	17,704 b	26,756 a
CPD 10	16,603 b	27,438 a
CPD 15	14,030 b	26,028 a
CPD 21	7,024 b	19,907 b
CPD 30 DAP (witness 2) 2/	7,640 b	20,679 b

Means followed by same letter in column do not differ significantly at 5% probability by Tukey test; 1/ Free cultivation of weed during the whole cycle; 2/ cultivation with weeds during the whole cycle; 3/ competition with weeds; 4/ days after planting.

reduction of crop yield. Radish culture presented slow initial growth, associated to a small capacity of shading of the weeds, reflecting in a lower capacity of competitions in more advanced stages of competition. This fact contributes for lower development of culture, mainly regarding leaf area and root fresh phytomass.

Conclusion

The radish culture can be highly susceptible to the interference of weeds, as well as has its production of root fresh phytomass reduced in 72,1%.

The competition with weeds up to 15 days after emergence did not change significantly the root diameter of radish in this study.

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