Scientia Agraria Paranaensis
Scientia Agraria Paranaensis – Sci. Agrar. Parana.
ISSN: 1983-1471 – Online
DOI: https://doi.org/10.18188/sap.v21i1.29134

WEED INTERFERENCE IN CASSAVA IN DIFFERENT CYCLES AND CROPPING SYSTEMS

João Ricardo Pompermaier Ramella[1], Silvio Douglas Ferreira[2*], Jaqueline de Araújo Barbosa[2], Emerson Fey[2], Neumárcio Vilanova da Costa[2]

SAP 29134 Received: 10/12/2021 Accepted: 21/03/2022
Sci. Agrar. Parana., Marechal Cândido Rondon, v. 21, n. 1, jan./mar., p. 45-51, 2022

ABSTRACT - The study aimed to determine the interference periods of weeds in cassava 'IAC 90' cultivated in different cycles and cropping systems. An experiment was conducted in the period 2014/15 (1st cycle) and another was conducted from the pruning of cassava plants in the period 2015/16 (2nd cycle). The experimental design was a randomized block design with split-split plots and four replicates. The plots represented the cropping systems (conventional and no-tillage) and the split-split plots corresponded to the periods with and without coexistence with weeds (0, 25, 50, 75, 100, 125, 150, 175, 200 and 225 days after planting or pruning - DAP/DAPr). In the 1st cycle, there was no interaction between the cropping systems and the coexistence periods and, therefore, based on the acceptable losses of 5% in the root and starch yield of 'IAC 90' cassava, the PCPI was estimated between 20 and 212 DAP and 14 to 214 DAP, respectively. In the 2nd cycle, the CPPWI ranged from 17 to 176 DAPr and 30 to 216 DAPr based on the root and starch yield obtained in the conventional method, respectively. While in no-tillage, the estimated CPPWI ranged from 18 to 198 DAPr and 9 to 218 DAPr based on root and starch yield, respectively. In general, the data indicate that conventional weed management should be carried out in a more intensified way than in no-tillage. In addition, CPPWI based on starch losses can avoid losses in root production.
Keywords: *Manihot esculenta* Crantz, weed competition, cover crops, conservation systems.

INTERFERÊNCIA DAS PLANTAS DANINHAS NA MANDIOCA EM DIFERENTES CICLOS E SISTEMAS DE CULTIVOS

RESUMO - Objetivou-se determinar os períodos de interferência das plantas daninhas na mandioca 'IAC 90' cultivada em diferentes ciclos e sistemas de cultivos. Um experimento foi conduzido em 2014/15 (1º ciclo) e outro foi conduzido a partir da poda das plantas de mandioca em 2015/16 (2º ciclo). O delineamento experimental foi blocos casualizados, com parcelas subdivididas e quatro repetições. As parcelas representaram os sistemas de cultivos (convencional e plantio direto) e as subparcelas corresponderam aos períodos com e sem convivência com as plantas daninhas (0, 25, 50, 75, 100, 125, 150, 175, 200 e 225 dias após plantio ou poda - DAP/DAPo). No 1º ciclo, não houve interação entre os sistemas de cultivos e os períodos de convivências e, portanto, com base nas perdas aceitáveis de 5% na produtividade raiz e fécula da mandioca 'IAC 90', estimou-se o PCPI entre 20 a 212 DAP e 14 a 214 DAP, respectivamente. No 2º ciclo, o PCPI variou entre 17 a 176 DAPo e 30 a 216 DAPo com base na produtividade raiz e de fécula obtida no convencional, respectivamente. Enquanto que no plantio direto, o PCPI estimado variou entre 18 a 198 DAPo e 9 a 218 DAPo com base na produtividade de raízes e fécula, respectivamente. De maneira geral, os dados indicam que o manejo das plantas daninhas no convencional deve ser realizado de modo mais intensificado do que no plantio direto. Além de que o PCPI baseado nas perdas de fécula pode evitar as perdas na produção de raízes.
Palavras-chave: *Manihot esculenta* Crantz, matocompetição, plantas de cobertura, sistemas conservacionistas.

INTRODUCTION

The relatively long cassava crop cycle exposes plants to the negative effects of weed interference that can reduce yield by up to 100% (JOHANNS; CONTIERO, 2006; BIFFE et al., 2010). This fact highlights the importance of the implementation of control measures to guarantee the yield and economic return of the cassava crop.

Cassava can be harvested from the 10th to 12th month after planting (1st cycle). In some cases, during this period, producers prune the plants for a new growth cycle of another 10 to 12 months (2nd cycle) (TAKAHASHI; GONÇALO, 2001). However, literature data on weed interference periods refer only to the 1st cycle, with very scarce data available on the 2nd cycle of the crop.

In the 1st crop cycle, the weed control period can extend up to 305 days after planting (DAP) (SOARES et al., 2019). These results suggest that sometimes weed control must be carried out during almost the entire 1st cycle of the crop. It should also be noted that the periods of weed community interference are strongly influenced by the variety's tolerance to weed competition, floristic composition of the weed population and soil and climatic

[1]Centro Universitário Univel, Cascavel, PR, Brasil. E-mail: agrosilvio@outlook.com. *Corresponding author.
[2]Universidade Estadual do Oeste do Paraná (Unioeste), Marechal Cândido Rondon, PR, Brasil.

conditions (COSTA et al., 2013). Moreover, the agronomic aspects of the adopted cropping system can be explored to give a greater competitive advantage to the crop in relation to the weed community and reduce the critical period of control.

Cassava is usually grown in a conventional tillage system (OTSUBO et al, 2008). This system favors the root development of cassava, but on the other hand, it also stimulates the emergence of the seed bank in the early growth stage of the crop, which is the most sensitive phase to weed competition. Alternatively, several studies have shown good results in the yield of cassava in no-tillage system (GABRIEL FILHO et al., 2000; FIGUEIREDO et al., 2017). The use of conservation systems is an excellent strategy in the integrated management of weeds because it uses cover crops as a physical barrier and releases allelopathic compounds that inhibit the emergence of the seed bank, providing a competitive advantage to the crop (OTSUBO et al., 2012).

Therefore, it is believed that the CPPWI of the weed community in the cassava crop may differ depending on the crop cycle and cropping system adopted and that such information can help in the development of more efficient strategies for integrated weed management. Thus, the present study aimed to determine the periods of weed interference for the 1st and 2nd cycle of cassava variety 'IAC 90' grown in conventional and no-tillage systems.

MATERIAL AND METHODS

The experiments were installed simultaneously under field conditions. The first was conducted in the 2014/15 period, referring to the 1st cycle and the second, from the pruning of cassava plants, in the 2015/16 period, referring to the 2nd cycle. The planting of the 'IAC 90' variety was carried out on September 18, 2014, with the aid of a two-row cultivator (Planti center, Bazooka two rows model), base fertilization (NPK) was not performed during the planting of cassava.

The soil in the area was classified as Eutroferric RED LATOSOL (LVef), with a clayey texture (SANTOS et al., 2018), with the following characteristics: pH ($CaCl_2$) = 5.95; Al^{3+} = 0.0 cmol$_c$ dm^{-3}; Ca^{2+} = 4.14 cmol$_c$ dm^{-3}; Mg^{2+} = 3.67 cmol$_c$ dm^{-3}; P = 31.30 mg dm^{-3}; K = 0.88 cmol$_c$ dm^{-3}; OM = 6.12 g dm^{-3}, V% = 75.80.

The experimental design was a randomized block design with split-split plots and four replicates. The plots represented the two cropping systems (conventional and no-tillage) and the split-split plots corresponded to the periods with and without coexistence with weeds (0, 25, 50, 75, 100, 125, 150, 175, 200 and 225 days after planting or pruning - DAP/DAPr). Each split-split plot consisted of four lines, spaced at 0.90 m (3.6 m) and 8 m in length, totaling an area of 28.8 m^2, with cassava stakes spaced at 0.60 m. The periods with and without coexistence with weeds were established by manual weeding.

The experiment intended for the 2nd cycle was weeded during the entire period of the 1st cycle, in order to avoid the interference of the weed community on the cassava plants. The installation of the 2nd cycle treatments, with and without coexistence, was conducted after pruning the plants at 300 DAP.

In the conventional system, the soil was plowed before planting and two screenings were performed. On the other hand, in the no-tillage system, the experimental area was previously cultivated with corn (*safrinha*) and, after harvesting, the area was desiccated with 1260 g ha^{-1} of glyphosate, which provided the maintenance of 7.74 t ha^{-1} of plant residue as cover crop. The meteorological data observed in the experimental period are shown in Figure 1.

Phytosociological characterization of the weed community was performed in each experiment using the square inventory method (BRAUN-BLANQUET, 1979). In each split-split plot, a 0.25 m^2 metallic frame was randomly used, and the species inside it were collected for later identification. At the end of each crop cycle, the relative importance index of the species present in the weed community was determined, according to the Mueller-Dombois proposal; Ellenberg (1974). The similarity index (Equation 1) of the weed community between the soil tillage systems, in both experiments, was also determined, according to the method proposed by Sorensen (1972).

$$SI = \frac{2 \text{ x no of species common to both habitats}}{\text{No. of species in environment A + No. of species in environment B}}$$

(Equation 1)

Where:
SI = Similarity index

During the harvest, the plants of the central lines of the split-split plots were collected and weighed to determine root yield (t ha^{-1}), while starch yield (t ha^{-1}) was determined according to the methodology proposed by Oliveira et al. al. (2011).

Root and starch yield data were submitted to analysis of variance, and the significant results to regression analysis, and the model was selected based on the significance of regression, approval in the normality test, high R^2 and biological logic. The determination of the periods of interference: Period Before Interference (PBI), Total Period of Interference Prevention (TPIP) and the Critical Period of Prevention of Weed Interference (CPPWI) was carried out considering arbitrary data of acceptable loss of 5% of roots and starch yield (BIFFE et al., 2010; SOARES et al., 2019).

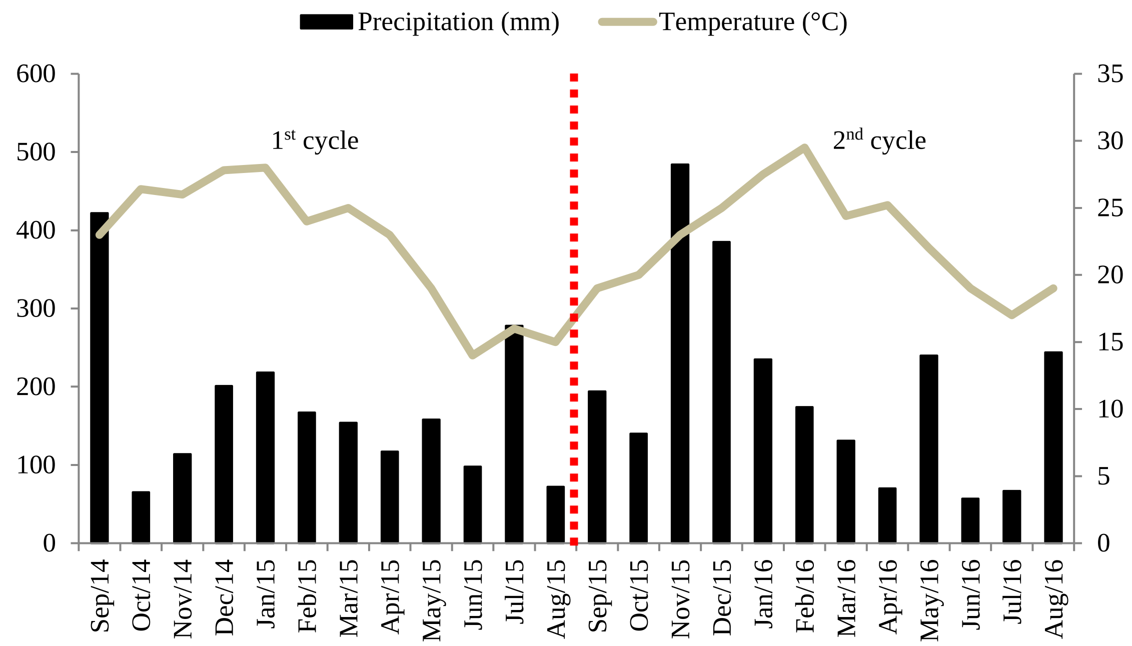

FIGURE 1 - Cumulative monthly precipitation and average temperatures from 2014 to 2016**.**

RESULTS AND DISCUSSION

The weed community present in conventional tillage (CT) and in no-tillage system (NT) during the experimental period was composed of 11 families and 14 species (Table 1). The families *Asteraceae* and *Poaceae* had the highest number of species, with three and two, respectively. In the 1st cycle, 75% of the species belonged to the class *Magnoliopsid*a in both cropping systems, while 25% of the species belonged to the class *Liliopsida.* In the 2nd cycle, 80% and 90% belonged to the *Magnoliopsida* class in CT and NT, respectively. Only 20% and 10% belonged to the *Liliopsida* class in CT and NT, respectively.

Commelina benghalensis was the species with the highest IRR (%) in CT and NT, in both crop cycles. This species is frequent in cassava growing areas due to its high infestation potential and regrowth capacity (SILVA et al., 2012), in addition to being tolerant to chemical control (FERREIRA et al., 2017).

TABLE 1 - Relative importance index (RII %) of the species occurring in the weed community and similarity index between conventional tillage (CT) and no-tillage (NT) systems of cassava crop in the 1st and 2nd cycle of cropping.

Families	Species	Cropping cycles			
		1st cycle		2nd cycle	
		CT	NT	CT	NT
	Class Magnoliopsida				
Asteraceae	*Bidens pilosa*	4.2	12.4	0.9	11.5
Asteraceae	*Conyza* sp.	5.0	2.2	2.6	6.9
Asteraceae	*Sonchus oleraceus*	1.7	1.1	2.6	1.1
Convolvulaceae	*Ipomoea* sp.	1.7	--	2.6	--
Euphorbiaceae	*Euphorbia heterophylla*	--	7.9	2.6	10.3
Lamiaceae	*Leonurus sibiricus*	1.7	--	4.3	4.6
Malvaceae	*Sida* sp.	18.3	2.2	8.7	--
Phyllanthaceae	*Phyllantus niruri*	--	10.1	4.3	5.7
Polygonaceae	*Rumex obtusifolius*	2.5	2.2	0.9	1.1
Rubiaceae	*Richardia brasiliensis*	1.7	2.2	--	--
Solanaceae	*Solanum americanum*	--	4.5	1.7	3.4
	Class Liliopsida				
Commelinaceae	*Commelina benghalensis*	55.8	44.9	64.3	49.4
Poaceae	*Digitaria insularis*	2.5	4.5	4.3	5.7
Poaceae	*Zea mays*	5,0	5.6	--	--
SI (%)		88.0		90.9	

--- = absence of the species in cropping systems. SI (%) = Similarity index between systems in each crop cycle.

The similarity of weed communities between cropping systems was 88.0% and 90.9%, for the 1st and 2nd cycle, respectively. These indices indicate that the identified species present adaptation both in the CT and in the NT and that the interference on the crop was made practically by the same group of species. Likewise, in no-tillage, the remaining corn straw on the soil (7.74 t ha^{-1}) was not enough to provide a physical barrier to prevent the emergence of the seed bank from the soil.

In the 1st cycle, there was only significance for coexistence periods of the crop with the weeds, considering the root and starch yield data (Table 2). However, in the 2nd cropping cycle, there was interaction between cropping systems and periods of coexistence of the crop with the weeds.

TABLE 2 - Summary of analysis of variance for 'IAC 90' cassava root and starch yield data, in the 1st and 2nd cropping cycles.

1st cycle		Mean squares	
Sources of variation	GL	Root yield (t ha^{-1})	Starch yield (t ha^{-1})
Block	3	2.565716^{ns}	0.196335^{ns}
Cropping system (S)	1	0.005176^{ns}	0.178222^{ns}
Error 1	3	0.151552	0.022484
Coexistence periods (P)	19	88.457377**	12.932821**
(S) x (P)	19	0.275980^{ns}	0.059499^{ns}
Error 2	114	0.528334	0.048182
Total	159		
CV1 (%)		4.52	6.82
CV2 (%)		8.44	9.98
2nd Cycle			
Block	3	24.874828^{ns}	0.714937^{ns}
Cropping system (S)	1	404.604127*	24.284547*
Error 1	3	36.923318	3.927447
Coexistence periods (P)	19	558.993973**	112.593400**
(S) x (P)	19	22.950815**	1.944159**
Error 2	114	1.746722	0.605269
Total	159		
CV1 (%)		25.31	26.51
CV2 (%)		5.50	10.41

** and * significant at 1% and 5% by F test, respectively, ^{ns} = not significant.

The crop showed a linear reduction of 32 kg day^{-1} in root yield with the coexistence with the weed community. On the other hand, there was also a linear increase (53 kg day^{-1}), as the weed control periods increased, regardless of the cropping system used in the 1st cycle. (Figure 2A).

In the 2nd cycle, the differences between the cropping systems became evident, with root yield in the conventional system being 8.6% higher than that obtained in the no-tillage system (Figure 2B). However, the coexistence of weeds with the crop can reduce root yield by up to 66.4% and 65.3% in the conventional and no-tillage systems, respectively.

Although the maximum root yield obtained in the no-tillage system (34.9 t ha^{-1}) was lower than in the conventional system (38.8 t ha^{-1}), it should be mentioned that the production was still higher than the Brazilian average (15.2 t ha^{-1}), for the 2020/2021 harvest (IBGE, 2021). According to Gabriel Filho et al. (2000), minimum tillage of cassava can replace conventional soil preparation, reducing the costs of planting the crop and significantly reducing the environmental impacts caused by water erosion. Otsubo et al. (2008) reported that minimum tillage in the cassava crop, associated with the cover crop use, promotes increases in yield compared to conventional tillage. Cassava cultivated in oat straw can also reduce the need for weed control (OTSUBO et al., 2012).

The starch yield results showed a behavior similar to those observed for root yield data. In the 1st cycle, there was a reduction of 85.3% in starch yield when the crop was in coexistence with the weed community throughout the cycle (Figure 3). In the 2nd cycle, coexistence of weeds with the crop reduced starch yield by up to 37.9% and 77.7% in the conventional and no-tillage systems, respectively.

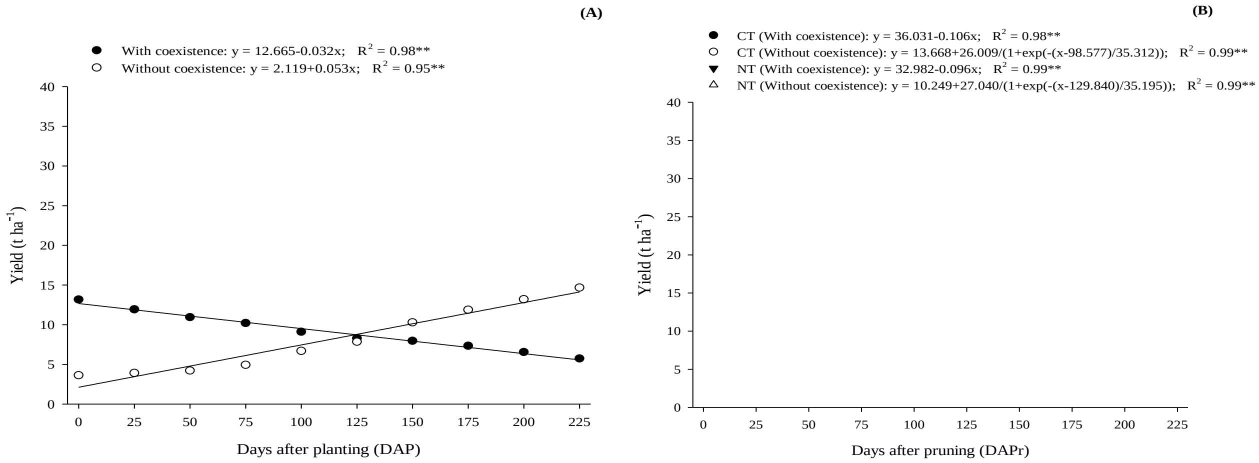

FIGURE 2 - Root yield of 'IAC 90' cassava, as a result of periods of coexistence with weeds, in different cropping systems, in the 1st cycle (A) and in the 2nd cycle (B).

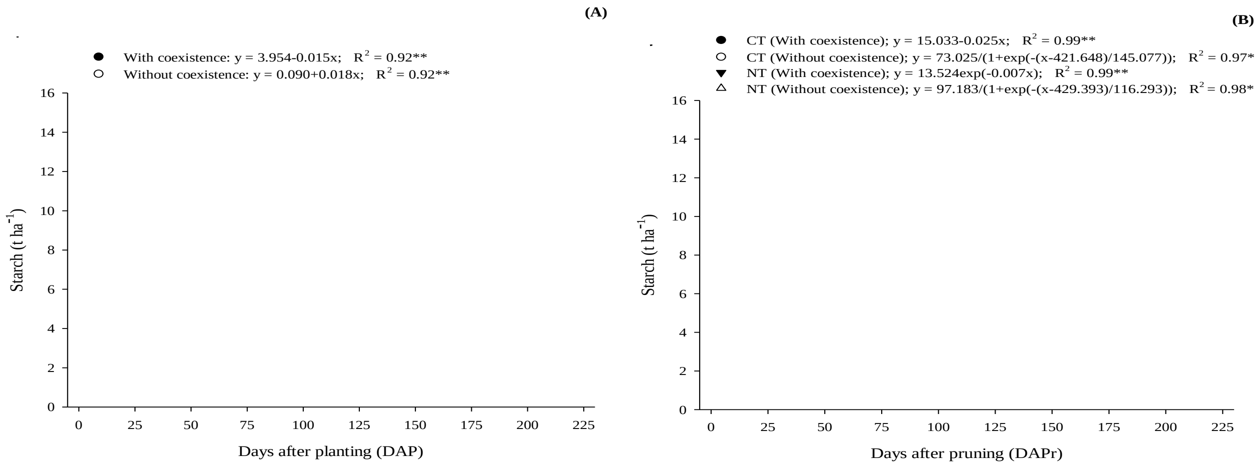

FIGURE 3 - Yield of 'IAC 90' cassava starch, as a result of periods of coexistence with weeds, in different cropping systems, in the 1st cycle (A) and in the 2nd cycles (B).

Considering a loss of 5% of 'IAC 90' cassava root and starch yield as acceptable in the 1st cycle, the CPPWI was estimated between 20 to 212 DAP and 14 to 214 DAP, respectively (Table 3). However, decision making on control using the CPPWI based on starch yield could have greater practical validity, as it would avoid further loss in root production, indicating a longer and earlier period for carrying out the control of the weeds.

This reasoning could also be used in the no-tillage system in the 2nd cycle, in which the CPPWI estimated based on starch yield (9 to 218 DAPr) was higher than the CPPWI based on root yield (18 to 198 DAPr). In conventional tillage in the 2nd cycle, it would be more appropriate to adopt the CPPWI based on root yield (17 to 176 DAPr) than on starch yield (30 to 216 DAPr).

There is very little data on the CPPWI in the cassava crop in the no-tillage system for the 1st and 2nd cropping cycles in the literature. However, there is more data on the conventional system and in the 1st cycle (up to 12 months). In this regard, Albuquerque et al. (2008) determined the CPPWI between 25 and 75 DAP for 'Cacauzinha' cassava, and for the variety 'Fécula Branca', CPPWI between 60 and 90 DAP can be found (JOHANNS; CONTIERO, 2006) and between 18 and 100 DAP (BIFFE et al., 2010). For this variety Costa et al. (2013), were unable to determine the CPPWI, since the PBI (87 DAP) was greater than the TPIP (80 DAP). For a longer cycle (18 months), without pruning 'Caitité' cassava plants, Soares et al. (2019) determined the CPPWI from 36 to 173 DAP and 17 to 305 DAP, with and without fertilization, respectively.

TABLE 3 - Periods of weed interference in the 'IAC 90' cassava crop, considering acceptable a loss of 5% of root and starch yield obtained in different cropping systems, in the 1st and 2nd cycles.

Cropping system	Root yield (t ha^{-1})			Starch yield (t ha^{-1})		
	1st cycle (DAP)					
	PBI	TPIP	CPPWI	PBI	TPIP	CPPWI
	20	212	20-212	14	214	14-214
Cropping system	2nd cycle (DAPr)					
	PBI	TPIP	CPPWI	PBI	TPIP	CPPWI
Conventional	17	176	17-176	30	216	30-216
No-tillage	18	198	18-198	09	218	09-218

PBI = period before interference, TPIP = Total period of interference prevention, CPPWI = critical period or prevention of weed interference, CT = conventional tillage, NT = no-tillage, DAP = days after planting, DAPr = days after pruning.

These results are generally consistent with those obtained in the present study and indicate that due to the slow initial growth of cassava in each growth cycle, it is necessary to manage the weeds until the aerial part of the crop completely cover the soil (SILVA et al., 2012; A'IHI et al., 2017). Physiologically, cassava sensitivity at the beginning of the 1st cycle may be explained by the period of formation of fibrous roots in tuberous roots, while at the beginning of the 2nd cycle, it may be more related to the resumption of the translocation of sugars to the roots after the formation of new leaves, due to pruning management (EL-SHARKAWY, 2004; ANDRADE et al., 2011; SOUZA et al., 2017).

There was a change in the competitive and productive capacity of cassava in coexistence with the weed community, and consequently, this fact can influence the adoption of criteria for the decision making of the best moment to carry out weed control, since the determination of the CPPWI was variable according to the cropping system and the parameter evaluated, being more evident in the 2nd crop cycle. Therefore, the adoption of the CPPWI can help to establish integrated weed management strategies for different cropping systems and avoid the negative effects of weed competition on root yield and consequently on cassava starch yield.

In general, the data indicate that weed management in the conventional system should be more intensified than in the no-tillage system. In addition, CPPWI based on starch losses can avoid losses in root production.

CONCLUSIONS

In the 1st cycle, there was no interaction between the cropping systems and the coexistence periods and, therefore, based on the acceptable losses of 5% in the root and starch yield of 'IAC 90' cassava, the CPPWI was estimated between 20 and 212 DAP and 14 to 214 DAP, respectively.

In the 2nd cycle, CPPWI varied between 17 to 176 DAPr and 30 to 216 DAPr based on root and starch yield obtained in the conventional system, respectively. On the other hand, in no-tillage, the estimated CPPWI ranged from 18 to 198 DAPr and 9 to 218 DAPr based on root and starch yield, respectively.

REFERENCES

AIHI, A.M.; JURAIMI, A.S.; HAMDANI, M.S.A.; HALIM, R.A.; HAKIM, A. A review of critical period of weed competition in cassava fields. **International Journal of Innovative Research & Development**, v.6, n.4, p.174-177, 2017.

ALBUQUERQUE, J.A.A.; SEDIYAMA, T.; SILVA, A.A.; CARNEIRO, J.E.S.; CECON, P.R.; ALVES, J.M.A. Interferência de plantas daninhas sobre a produtividade da mandioca (*Manihot esculenta*). **Planta Daninha**, v.26, n.2, p.279-289, 2008.

ANDRADE, J.S.D.; VIANA, A.E.S.; CARDOSO, A.D.; MATSUMOTO, S.N.; NOVAES, Q.S.D. Épocas de poda em mandioca. **Revista Ciência Agronômica**, v.42, n.3, p.693-701, 2011.

BIFFE, D.F.; CONSTANTIN, J.; OLIVEIRA Jr., R.S.; FRANCHINI, L.H.M.; RIOS, F.A.; BLAINSKI, E.; ARANTES, J.G.Z.; ALONSO, D.G.; CAVALIERI, S.D. Período de interferência de plantas daninhas em mandioca (*Manihot esculenta*) no noroeste do Paraná. **Planta Daninha**, v.28, n.3, p.471-478, 2010.

BRAUN-BLANQUET, J. **Fitossociologia:** bases para el estudio de las comunidades vegetales. Madri: H. Blume. 1979, 820p.

COSTA, N.V.; RITTER, L.; PERES, E.J.L.; SILVA, P.V.; VASCONCELOS, E.S. Weed interference periods in the 'Fécula Branca' cassava. **Planta Daninha**, v.31, n.3, p.533-542, 2013.

EL-SHARKAWY, M.A. Cassava biology and physiology. **Plant Molecular Biology**, v.56, n.4, p.481-501, 2004.

FERREIRA, S.D.; SALVALAGGIO, A.C.; MORATELLI, G.; VASCONCELOS, E.D.; COSTA, N.V. *Commelina* species control with desiccants alone and in mixtures. **Planta Daninha**, v.35, n.e017165664, p.1-9, 2017.

FIGUEIREDO, P.G.; BICUDO, S.J.; CHENB, S.; FERNANDESC, A.M.; TANAMATIA, F.Y.; DJABOU-FONDJO, A.S.M. Effects of tillage options on soil physical properties and cassava-dry-matter partitioning, **Field Crops Research**, v.204, n.1, p.191-198, 2017.

GABRIEL FILHO, A.; PESSOA, A.C.S.; STROHHAECKER, L.; HELMICH, J.J. Preparo convencional e cultivo mínimo do solo na cultura de mandioca em condições de adubação verde com ervilhaca e aveia preta. **Ciência Rural**, v.30, n.6, p.953-957, 2000.

IBGE. INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. **Levantamento sistemático da produção agrícola.** 2021. Available in: <https://www.ibge.gov.br/estatisticas/economicas/agricultura-e-pecuaria/9201-levantamento-sistematico-da-producao-agricola.html?=&t=downloads>. Access in: 12 oct. 2021.

JOHANNS, O.; CONTIERO, R.L. Efeitos de diferentes períodos de controle e convivência de plantas daninhas com a cultura da mandioca. **Revista Ciência Agronômica**, v.37, n.3, p.326-331, 2006.

MUELLER-DOMBOIS, D.; ELLEMBERG, H. A. **Aims and methods of vegetation ecology.** New York: John Wiley, 1974. 574p.

OLIVEIRA, N.T.; ALVES, J.M.A.; UCHÔA, S.C.P.; RODRIGUES, G.S.; MELVILLE, C.C.; ALBUQUERQUE, J.A.A. Caracterização e identificação de clones de mandioca produzidos em Roraima para consumo *in natura*. **Agroambiente**, v.5, n.3, p.188-193, 2011.

OTSUBO, A.A.; BRITO, O.R.; PASSOS, D.P.; ARAÚJO, H.S.; MERCANTE, F.M.E.; OTSUBO, V.H.N. Formas de preparo de solo e controle de plantas daninhas nos fatores agronômicos e de produção da mandioca. **Semina:** Ciências Agrárias, v.33, n.6, p.2241-2246, 2012.

OTSUBO, A.A.; MERCANTE, F.M.; SILVA, R.F.; BORGES, C.D. Sistemas de preparo do solo, plantas de cobertura e produtividade da cultura da mandioca. **Pesquisa Agropecuária Brasileira**, v.43, n.3, p.327-332, 2008.

SANTOS, H.G.; JACOMINE, P.K.T.; ANJOS, L.H.C.; OLIVEIRA, V.A.; LUMBRERAS, J.F.; COELHO, M.R.; ALMEIDA, J.A.; ARAUJO FILHO, J.C.; OLIVEIRA, J.B.; CUNHA, T.J.F, **Sistema Brasileiro de Classificação de Solos.** 5a. Ed. Brasília: Embrapa Produção de Informação, 2018, 356p.

SILVA, D.V.; SANTOS, J.B.; FERREIRA, E.A.; SILVA, A.A.; FRANÇA, A.C.; SEDIYAMA, T. Manejo de plantas daninhas na cultura da mandioca. **Planta Daninha**, v.30, n.4, p.901-910, 2012.

SOARES, M.R.S.; JOSÉ, A.R.S.; NUNES, R.T.C.; SILVA, R.D.A.; CAETANO, A.P.O.; OLIVEIRA, D.S.; NOLASCO, C.A. RAMPAZZO, M. C. Períodos de interferência de plantas infestantes na cultura da mandioca, submetida ou não à adubação NPK, em Vitória da Conquista-BA. **Revista de Ciências Agrárias**, v.42, n.1, p.231-240, 2019.

SORENSEN, T.A. **Method of establishing groups equal amplitude in plant society based on similarity of species content**. In: ODUM, E.P. Ecologia. 3a. Ed. México: Interamericana, p.341-405, 1972.

SOUZA, A.P.; MASSENBURG, L.N.; JAISWAL, D.; CHENG, S.; SHEKAR, R.; LONG, S.P. Rooting for cassava: insights into photosynthesis and associated physiology as a route to improve yield potential. **New Phytologist**, v.213, n.1, p.50-65, 2017.

TAKAHASHI, M.; GONÇALO, S. **A cultura da mandioca.** Paranavaí: IAPAR, 2001, 88p.