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METHODS FOR ESTIMATING THE OPTIMAL PLOT SIZE FOR BLACK OAT, COMMON VETCH AND FORAGE TURNIP INTERCROPPING[1]

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ABSTRACT - The objective of this work was to compare three methods of estimating the optimal plot size to evaluate the fresh matter in black oat (*Avena strigosa* Schreb), common vetch (*Vicia sativa* L.) and forage turnip (*Raphanus sativus* L.) intercropping. Six uniformity trials with black oat, common vetch and forage turnip intercropping were carried out. Three trials were evaluated at 84 days after sowing and the other three trials at 119 days after sowing. The fresh matter was evaluated in 216 basic experimental units (36 per trial) of 1 m × 1 m. The optimal plot size was determined using the methods of modified maximum curvature, linear response and plateau model and quadratic response and plateau model. The optimal plot size differs between the methods and decreases in the following order: quadratic response and plateau model (15.13 m^2), linear response and plateau model (8.24 m^2) and modified maximum curvature (5.62 m^2). The optimal plot size for assessing the fresh matter of black oat, common vetch and forage turnip, grown in intercropping, is 15.13 m^2. This size can be used as a reference for future experiments.

Keywords: *Avena strigosa* Schreb. *Vicia sativa* L. *Raphanus sativus* L. Uniformity trial. Experiment planning.

MÉTODOS DE ESTIMAÇÃO DO TAMANHO ÓTIMO DE PARCELA EM AVEIA PRETA, ERVILHACA E NABO FORRAGEIRO CULTIVADAS EM CONSÓRCIO

RESUMO - O objetivo deste trabalho foi comparar três métodos de estimação do tamanho ótimo de parcela para avaliar a matéria fresca de aveia preta (*Avena strigosa* Schreb), ervilhaca (*Vicia sativa* L.) e nabo forrageiro (*Raphanus sativus* L.), cultivadas em consórcio. Foram conduzidos seis ensaios de uniformidade com o consórcio de aveia preta, ervilhaca e nabo forrageiro, sendo três ensaios avaliados aos 84 dias após a semeadura e os outros três ensaios aos 119 dias após a semeadura. Foi avaliada a matéria fresca em 216 unidades experimentais básicas (36 por ensaio) de 1 m × 1 m. Foi determinado o tamanho ótimo de parcela por meio dos métodos da curvatura máxima modificado, do modelo linear de resposta com platô e do modelo quadrático de resposta com platô. O tamanho ótimo de parcela difere entre os métodos e decresce na seguinte ordem: modelo quadrático de resposta com platô (15,13 m^2), modelo linear de resposta com platô (8,24 m^2) e curvatura máxima modificado (5,62 m^2). O tamanho ótimo de parcela para avaliar a matéria fresca de aveia preta, ervilhaca e nabo forrageiro, cultivadas em consórcio é de 15,13 m^2. Esse tamanho pode ser utilizado como referência para futuros experimentos.

Palavras-chave: *Avena strigosa* Schreb. *Vicia sativa* L. *Raphanus sativus* L. Ensaio de uniformidade. Planejamento de experimento.

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INTRODUCTION

Intercropping of black oat (*Avena strigosa* Schreb), common vetch (*Vicia sativa* L.) and forage turnip (*Raphanus sativus* L.) (O+V+T) has promoted increments in the grain yields of common bean (RIGON et al., 2011) and maize (MICHELON et al., 2019), cultivated in succession. The O+V+T intercropping has a balanced carbon/nitrogen ratio (ZIECH et al., 2015), high capacity of soil cover by the canopy of plants (WOLSCHICK et al., 2016; HASKEL et al., 2020) and increases organic matter contents and the availability of phosphorus and potassium in soil (MICHELON et al., 2019).

Due to the importance of these crops, when planning an experiment with them, it is important to define the optimal plot size in order to minimize the experimental error and, consequently, increase the precision of the inferences (BANZATTO; KRONKA, 2006). This size can be calculated using data from uniformity trials (blank experiments), of these same agricultural crops, by different methods (STORCK et al., 2016).

Plot size has been investigated in sole cropping of black oat (CARGNELUTTI FILHO et al., 2014a), common vetch (CARGNELUTTI FILHO et al., 2017) and forage turnip (CARGNELUTTI FILHO et al., 2011, 2016), through the method of maximum curvature of the coefficient of variation model (PARANAÍBA; FERREIRA; MORAIS, 2009a) and also in forage turnip (CARGNELUTTI FILHO et al., 2014b) and black oat with common vetch (CARGNELUTTI FILHO et al., 2020) through the methodologies of Smith (1938) and Hatheway (1961).

Comparative studies involving the methods of modified maximum curvature (MMC) (MEIER; LESSMAN, 1971), linear response and plateau model (LRP) (PARANAÍBA; FERREIRA; MORAIS, 2009a) and quadratic response and plateau model (QRP) (PEIXOTO; FARIA; MORAIS, 2011) have been carried out with rice (PARANAÍBA; FERREIRA; MORAIS, 2009a), wheat and cassava (PARANAÍBA; MORAIS; FERREIRA, 2009b), passion fruit (PEIXOTO; FARIA; MORAIS, 2011), papaya (BRITO et al., 2012) and cactus pear (GUIMARÃES et al., 2019), showing distinct results between the methods.

From uniformity trials it is possible to plan different plot sizes (X) by grouping adjacent basic experimental units (BEU) and estimate the coefficient of variation ($CV_{(X)}$) between the BEU (STORCK et al., 2016). The values of $CV_{(X)}$ and X can be related through the MMC, LRP and QRP methods for determining the optimal plot size (Xo) and the coefficient of variation in the optimal plot size (CV_{Xo}).

Applications of the MMC, LRP and QRP methods in the O+V+T intercropping, commonly used with soil cover crops, have not been found. It is supposed that these methodologies generate different experimental planning patterns for the O+V+T intercropping and provide useful information to be used as reference in the planning of experiments, aiming at higher experimental precision. Thus, the objective of this work was to compare three methods of estimating the optimal plot size to evaluate the fresh matter of black oat (*Avena strigosa* Schreb), common vetch (*Vicia sativa* L.) and forage turnip (*Raphanus sativus* L.), grown in intercropping.

MATERIAL AND METHODS

Six uniformity trials with the intercropping of black oat (*Avena strigosa* Schreb), Embrapa 139 cultivar, common vetch (*Vicia sativa* L.), common cultivar, and forage turnip (*Raphanus sativus* L.), IPR-116 cultivar (O+V+T), were conducted in an experimental area located at 29º42'S, 53º49'W and at 95 m altitude. In this site, the climate is humid subtropical Cfa, according to Köppen's classification, with hot summers and without dry season (ALVARES et al., 2013), and the soil is classified as *Argissolo Vermelho Distrófico Arênico* (Ultisol) (SANTOS et al., 2018).

On June 2, 2020, basal fertilization was carried out with 20 kg ha^{-1} of N, 80 kg ha^{-1} of P_2O_5 and 80 kg ha^{-1} of K_2O (N-P-K only, of the 05-20-20 formulation), followed by broadcast sowing of the O+V+T intercropping, with the following sowing densities: black oat (60 kg ha^{-1}) + common vetch (30 kg ha^{-1}) + forage turnip (15 kg ha^{-1}).

Three trials were evaluated at 84 days after sowing (August 25, 2020) and the other three trials at 119 days after sowing (September 29, 2020). In each uniformity trial, the central area with size of 6 m × 6 m (36 m^2) was divided into 36 basic experimental units (BEU) of 1 m × 1 m (1 m^2), forming a matrix of six rows and six columns. In each BEU, the plants were cut near the soil surface and the fresh matter (FM) was weighed, in g m^{-2}, on a digital scale (accuracy: 1 g). Weighing was performed immediately after cutting in order to minimize possible variations of moisture content in the plants.

For each uniformity trial, from the FM data of the 36 BEU, plots with X_R BEU adjacent in the row and X_C BEU adjacent in the column were planned. Plots with different sizes and/or shapes were planned as being ($X=X_R \times X_C$), that is, (1×1), (1×2), (1×3), (1×6), (2×1), (2×2), (2×3), (2×6), (3×1), (3×2), (3×3), (3×6), (6×1), (6×2) and (6×3). The terms X_R, X_C, and X respectively mean number of BEU adjacent in the row, number of BEU adjacent in the column, and plot size in number of BEU.

For each plot size (X), the following parameters were determined: n - number of plots with X BEU size (n=36/X); $M_{(X)}$ - mean of plots with X BEU size; and $CV_{(X)}$ - coefficient of variation

(%) between plots with X BEU size. In each of the six trials, the optimal plot size (Xo) was determined using the methods of modified maximum curvature (MMC) (MEIER; LESSMAN, 1971), linear response and plateau model (LRP) (PARANAÍBA; FERREIRA; MORAIS, 2009a) and quadratic response and plateau model (QRP) (PEIXOTO; FARIA; MORAIS, 2011). In these three methods, models of the dependent variable ($CV_{(X)}$, %) are fitted as a function of the independent variable (X, BEU).

In relation to the modified maximum curvature method (MMC) (MEIER; LESSMAN, 1971), the *a* and *b* parameters and the coefficient of determination (R^2) of the model $CV_{(X)} = a/X^b + \varepsilon$ were estimated. These parameters were estimated by logarithmic transformation and linearization of $CV_{(X)} = a/X^b + \varepsilon$, that is, $\log CV_{(X)} = \log a - b \log X + \varepsilon$, whose estimation was weighted by the degrees of freedom (DF = n-1) associated with each plot size, according to the application of Sousa, Silva and Assis (2016). The point corresponding to the optimal plot size (Xo) was algebraically determined by the expression: $Xo = [a^2b^2(2b+1)/(b+2)]^{1/(2b+2)}$. The coefficient of variation corresponding to the optimal plot size (CV_{Xo}) was determined by $CV_{Xo} = a/Xo^b$.

For the linear response and plateau model (LRP) (PARANAÍBA; FERREIRA; MORAIS, 2009a), two segmented lines were fitted and the estimates of the *a*, *b* and *p* parameters and coefficient of determination (R^2) were obtained. The first line $(CV_{(X)} = a + bX + \varepsilon)$ is fitted up to the point corresponding to the optimal plot size (Xo), with angular coefficient (b) different from zero. The second line $(CV_{(X)} = p + \varepsilon)$ starts from Xo and has angular coefficient equal to zero, that is, it is a line parallel to the abscissa, where *p* = plateau, that is, *p* corresponds to CV_{Xo}. The LRP model was as follows: $CV_{(X)} = \begin{cases} a + bX + \varepsilon & if\ X \leq Xo \\ p + \varepsilon & if\ X > Xo \end{cases}$. In the LRP model, the optimal plot size was determined by $Xo = (p-a)/b$ and the coefficient of variation in the optimal plot size by $CV_{Xo} = a + bXo$.

For the quadratic response and plateau model (QRP) (PEIXOTO; FARIA; MORAIS, 2011), the fit was performed using two segmented equations. Estimates of the *a*, *b*, *c* and *p* parameters and coefficient of determination (R^2) were obtained. Up to the Xo point, the quadratic part of the model $(CV_{(X)} = a + bX + cX^2 + \varepsilon)$ was fitted. After Xo, the model turns into a zero-slope line, called plateau, whose model is described by $(CV_{(X)} = p + \varepsilon)$, where *p* = plateau, that is, *p* = CV_{Xo}. Therefore, the QRP model was as follows: $CV_{(X)} = \begin{cases} a + bX + cX^2 + \varepsilon & if\ X \leq Xo \\ p + \varepsilon & if\ X > Xo \end{cases}$. In the QRP model, the optimal plot size was determined by $Xo = -b/2c$ and the coefficient of variation in the optimal plot size by $CV_{Xo} = a - b^2/4c$. In the LRP and QRP models, the point of union between the two segments corresponds to the Xo in the abscissa and CV_{Xo} in the ordinate. The ε is the residual or random error of the model, for the three models (MMC, LRP and QRP), which were considered as showing normal distribution, independent and with constant variance.

The coefficient of determination (R^2), the residual sum of squares and the Willmott's index (WILLMOTT, 1981) were used to evaluate the fit of the three models (MMC, LRP and QRP). It is interpreted that the closer the residual sum of squares is to zero and the closer the R^2 and Willmott's index are to 1.00, the better the model fits the data.

Thus, for each of the three uniformity trials (repetitions), of each of the evaluation times, the fresh matter of the trial (FM, g m^{-2}), the coefficient of variation of the trial (CV, %) and the estimates of the coefficient of determination (R^2), optimal plot size (Xo) and coefficient of variation in the optimal plot size (CV_{Xo}) were obtained with the MMC, LRP and QRP methods. In order to compare the means between the two evaluation times (84 DAS *versus* 119 DAS, with n=3 uniformity trials per time), Student's t-test (two-sided) was performed for independent samples, at 5% significance level. The comparisons of means of the estimates of R^2, Xo and CV_{Xo} between the methods (MMC *versus* LRP, MMC *versus* QRP and LRP *versus* QRP), regardless of the evaluation time (n = 6 uniformity trials), were performed by Student's t-test (two-sided), for dependent samples, at 5% significance level. The results of these comparisons were represented by letters next to the means. Statistical analyses were performed with the Microsoft Office Excel® application, R software (R Development Core Team, 2021) and Sisvar software (FERREIRA, 2019).

RESULTS AND DISCUSSION

The fresh matter (FM) of the intercropping of black oat (*Avena strigosa* Schreb), Embrapa 139 cultivar, common vetch (*Vicia sativa* L.), common cultivar, and forage turnip (*Raphanus sativus* L.), IPR-116 cultivar (O+V+T), evaluated at 84 days after sowing (DAS) was 3367, 2953, and 2656 g m^{-2} in uniformity trials 1, 2 and 3, respectively. In the evaluation performed at 119 DAS, FM was 2860, 3134, and 3267 g m^{-2} in uniformity trials 1, 2 and 3, respectively (Table 1). Therefore, among the six uniformity trials, the FM varied between 2656 and 3367 g m^{-2}, that is, 26.56 and 33.67 Mg ha^{-1}, respectively. The FM means of the trials evaluated at 84 and 119 DAS were 2992 and 3087 g m^{-2}, respectively, and did not differ from each other (t = -0.39707; p-value = 0.7116; 4 degrees of freedom), while the overall mean of the six trials was 3040 g m^{-2}.

Table 1. Planned plot size ($X=X_R \times X_C$), in basic experimental units (BEU), with X_R BEU adjacent in the row and X_C BEU adjacent in the column; number of plots with X BEU size (n=36/X); mean of plots with X BEU size [$M_{(X)}$], in g; and coefficient of variation (in %) between the plots with X BEU size [$CV_{(X)}$]. Fresh matter data of black oat, common vetch and forage turnip, grown in intercropping, obtained in the evaluations at 84 and 119 days after sowing.

X_R	X_C	X	n	$M_{(X)}$	$CV_{(X)}$	$M_{(X)}$	$CV_{(X)}$	$M_{(X)}$	$CV_{(X)}$
				Evaluation at 84 days after sowing					
				Trial 1[(1)]		Trial 2		Trial 3	
1	1	1	36	3367	28.77	2953	29.24	2656	25.22
1	2	2	18	6735	23.43	5907	22.13	5312	18.31
1	3	3	12	10102	14.13	8860	15.61	7968	13.53
1	6	6	6	20204	12.22	17721	12.68	15936	11.02
2	1	2	18	6735	24.88	5907	23.48	5312	21.86
2	2	4	9	13469	19.63	11814	17.15	10624	14.32
2	3	6	6	20204	6.16	17721	6.49	15936	12.72
2	6	12	3	40408	5.60	35442	6.14	31871	11.52
3	1	3	12	10102	23.25	8860	24.24	7968	18.86
3	2	6	6	20204	18.16	17721	18.51	15936	9.31
3	3	9	4	30306	3.59	26581	7.47	23903	7.78
3	6	18	2	60613	3.84	53163	8.59	47807	1.13
6	1	6	6	20204	22.83	17721	23.45	15936	17.07
6	2	12	3	40408	18.30	35442	18.16	31871	4.32
6	3	18	2	60613	2.15	53163	3.04	47807	8.14
				Evaluation at 119 days after sowing					
				Trial 1		Trial 2		Trial 3	
1	1	1	36	2860	30.68	3134	27.74	3267	30.39
1	2	2	18	5721	23.25	6267	19.14	6534	20.76
1	3	3	12	8581	18.66	9401	10.20	9801	22.11
1	6	6	6	17163	17.90	18801	5.63	19601	18.32
2	1	2	18	5721	26.49	6267	19.09	6534	24.40
2	2	4	9	11442	21.54	12534	15.37	13067	14.88
2	3	6	6	17163	17.58	18801	7.21	19601	15.79
2	6	12	3	34325	18.63	37603	4.28	39202	12.47
3	1	3	12	8581	25.53	9401	21.34	9801	21.01
3	2	6	6	17163	21.13	18801	18.19	19601	8.54
3	3	9	4	25744	18.30	28202	8.40	29402	13.27
3	6	18	2	51488	20.37	56404	0.23	58803	0.12
6	1	6	6	17163	17.10	18801	9.59	19601	19.77
6	2	12	3	34325	13.85	37603	8.46	39202	6.36
6	3	18	2	51488	2.54	56404	5.38	58803	11.98

[(1)]Each uniformity trial with size of 6 m × 6 m (36 m^2) was divided into 36 BEU of 1 m × 1 m (1 m²), forming a matrix of six rows and six columns.

The coefficient of variation (CV) of the FM of the O+V+T intercropping evaluated at 84 DAS was 28.77, 29.24, and 25.22% in uniformity trials 1, 2 and 3, respectively. In the evaluation performed at 119 DAS, the CV was 30.68, 27.74, and 30.39% in uniformity trials 1, 2 and 3, respectively (Table 1). Therefore, the CV obtained among the 36 BEU of each of the six uniformity trials ranged from 25.22 to 30.68%, with a mean of 28.67%. The means of CV of the three trials of each evaluation time were 27.74 and 29.60%, for the evaluations at 84 and 119 DAS, respectively, and by the Student's t-test (two-sided), for independent samples, at 5% significance level, they did not differ from each other (t = -1.18258; p-value = 0.3025; 4 degrees of freedom). This suggests that experiments with intercropping of black oat, common vetch and forage turnip have similar experimental precision between these evaluation times.

No classification ranges for the coefficients of variation specific to the O+V+T intercropping were found in the literature. Thus, taking as reference the classification ranges for the coefficients of variation established by Pimentel-Gomes (2009) for field agricultural trials, these means are within the class of low experimental precision (CV between 20% and 30%), which demonstrates that it is necessary to use a plot size larger than 1 m^2 to improve experimental precision.

In the six uniformity trials of the O+V+T intercropping, there was a reduction in the coefficient of variation [$CV_{(X)}$] with the increase in the planned plot size (X) (Table 1). Therefore, this indicates an improvement in experimental precision (reduction in $CV_{(X)}$) with the increase in plot size. Although it is possible to evaluate fresh matter (FM) in plots of 1 m², as performed in this study, it is important to evaluate the precision in larger sizes, that is, it is essential to plan the experiment with optimal plot size to ensure adequate discrimination of treatments under evaluation and reliability in the inferences. It is also important to consider that smaller sizes may not represent plant development.

For the methods of modified maximum curvature (MMC), linear response and plateau model (LRP) and quadratic response and plateau model (QRP), the means of the coefficient of determination (R^2), optimal plot size (Xo) and coefficient of variation in the optimal plot size (CV_{Xo}) did not differ between the two evaluation times (Table 2). Thus, based on this finding and on the absence of difference in the coefficient of variation of the trials between the evaluation times, it can be inferred that the experimental planning regarding plot size is similar for evaluations performed at 84 and 119 DAS.

Table 2. Coefficient of determination (R^2), optimal plot size (Xo, m^2) and coefficient of variation in optimal plot size (CV_{Xo}, %), for the methods of modified maximum curvature (MMC), linear response and plateau model (LRP) and quadratic response and plateau model (QRP), obtained from the fresh matter of black oat, common vetch and forage turnip, grown in intercropping, evaluated at 84 and 119 days after sowing (DAS).

Evaluation time	Trial [1]	MMC	LRP	QRP
		Coefficient of determination (R^2)		
84 DAS	1	0.61	0.65	0.64
84 DAS	2	0.65	0.61	0.61
84 DAS	3	0.74	0.77	0.79
	Mean	0.66 a	0.67 a	0.68 a
119 DAS	1	0.63	0.53	0.56
119 DAS	2	0.66	0.71	0.73
119 DAS	3	0.49	0.69	0.73
	Mean	0.59 a	0.65 a	0.68 a
Overall mean		0.63 A	0.66 A	0.68 A
		Optimal plot size (Xo, m^2)		
84 DAS	1	6.00	8.30	18.32
84 DAS	2	5.67	8.70	11.83
84 DAS	3	5.27	8.58	14.02
	Mean	5.65 a	8.53 a	14.72 a
119 DAS	1	4.88	7.71	18.61
119 DAS	2	5.78	7.59	11.27
119 DAS	3	6.08	8.58	16.73
	Mean	5.58 a	7.96 a	15.54 a
Overall mean		5.62 C	8.24 B	15.13 A
		Coefficient of variation in the optimal plot size (CV_{Xo}, %)		
84 DAS	1	12.05	6.69	4.20
84 DAS	2	13.61	8.68	8.84
84 DAS	3	11.73	6.58	5.80
	Mean	12.46 a	7.32 a	6.28 a
119 DAS	1	19.02	14.74	12.24
119 DAS	2	9.12	5.35	4.98
119 DAS	3	12.62	8.84	6.67
	Mean	13.59 a	9.64 a	7.96 a
Overall mean		13.03 A	8.48 B	7.12 C

[1]Each uniformity trial with size of 6 m × 6 m (36 m^2) was divided into 36 BEU of 1 m × 1 m (1 m²), forming a matrix of six rows and six columns. Means of R^2, Xo and CV_{Xo} not followed by the same lowercase letter in the column (comparison of evaluation times within each method) differ at 5% significance level by the Student's t-test (two-sided), for independent samples with 4 degrees of freedom. Means not followed by the same uppercase letter in the row (comparison of methods regardless of the evaluation time, n = 6 uniformity trials) differ at 5% significance level by the Student's t-test (two-sided), for dependent samples with 5 degrees of freedom.

The coefficients of determination (R^2), among the six uniformity trials, varied from 0.49 to 0.74, 0.53 to 0.77, and 0.56 to 0.79 for the MMC, LRP and QRP methods, respectively (Table 2). It should be considered that $0.00 \leq R^2 \leq 1.00$, and it is interpreted that the closer to 1.00, the better the model fits the data. In the comparisons of the methods, regardless of the evaluation time, there was no difference in relation to R^2, and all methods showed good fit ($R^2 \geq 0.63$). In the mean of the six uniformity trials, the residual sum of squares was 268, 273 and 261, and the Willmott's index (WILLMOTT, 1981) was 0.90, 0.89 and 0.89 for the MMC, LRP and QRP methods, respectively, proving the similarity of fit of the models.

The optimal plot sizes (Xo), among the six uniformity trials, were higher in the QRP method (11.27 ≤ Xo ≤ 18.61 m^2), intermediate in LRP (7.59 ≤ Xo ≤ 8.70 m²) and lower in MMC (4.88 ≤ Xo ≤ 6.08 m^2). Regardless of the evaluation time, the Xo differed among the three methods, being 15.13 m^2 by QRP, 8.24 m^2 by LRP and 5.62 m² by MMC. Thus, it can be inferred that the plot size can be the same for these two evaluation times and depends on the estimation method.

The coefficients of variation in the optimal plot size (CV_{Xo}, in %), among the six uniformity trials, varied from 9.12 to 19.02%, 5.35 to 14.74%, and 4.20 and 12.24% for the MMC, LRP and QRP methods, respectively (Table 2). In the comparisons of the methods, regardless of the evaluation time, the CV_{Xo} differed among the three methods, being equal to 7.12% by QRP, 8.48% by LRP, and 13.03% by MMC. These results indicate better experimental precision with the use of plot sizes determined by the QRP method compared to LRP and MMC, in this order, regardless of evaluation time.

In general, that is, regardless of the evaluation time, the means of R^2 did not differ between the methods, being 0.68 in QRP, 0.66 in LRP and 0.63 in MMC. The means of Xo were decreasing in the following order: QRP = 15.13 m^2; LRP = 8.24 m^2; and MMC = 5.62 m², and differed from each other. The means of CV_{Xo} differed from each other, being higher in MMC (13.03%), intermediate in LRP (8.48%) and lower in QRP (7.12%). Thus, it can be inferred from the QRP, which had the lowest CV_{Xo} (highest experimental precision), that plots with 15.13 m² are suitable for experimental planning. This indication of 15.13 m² plots is supported by the practical feasibility in the field and stabilization of precision from this size and can be used as a reference for the planning of experiments with the O+V+T intercropping.

This size of 15.13 m^2 is relatively larger than those established to evaluate the fresh matter of sole crops of black oat (CARGNELUTTI FILHO et al., 2014a), common vetch (CARGNELUTTI FILHO et al., 2017) and forage turnip (CARGNELUTTI FILHO et al., 2011, 2016) and the intercropping of black oat and common vetch (CARGNELUTTI FILHO et al., 2020), which was equal to 4.14, 4.52, 1.20, and 10 m², respectively. Additionally, this size of 15.13 m^2 is relatively smaller than those used in experiments with the O+V+T intercropping, together with other soil cover species, by Rigon et al. (2011), Ziech et al. (2015), Wolschick et al. (2016), Michelon et al. (2019) and Haskel et al. (2020), which ranged from 18 to 48 m².

Higher estimates of R^2 and CV_{Xo} and lower estimates of Xo were obtained with the MMC method compared to LRP in rice (PARANAÍBA; FERREIRA; MORAIS, 2009a), wheat and cassava (PARANAÍBA; MORAIS; FERREIRA, 2009b) and papaya (BRITO et al., 2012). In passion fruit, higher R^2 and Xo and lower CV_{Xo} were obtained with the QRP method compared to LRP (PEIXOTO; FARIA; MORAIS, 2011). Therefore, in general, these studies with the approach of comparing methods to determine the optimal plot size found results similar to those of the present study.

CONCLUSIONS

The optimal plot size differs between the methods and decreases in the following order: quadratic response and plateau model (15.13 m^2), linear response and plateau model (8.24 m²) and modified maximum curvature (5.62 m²). The optimal plot size to evaluate the fresh matter of black oat, common vetch and forage turnip, grown in intercropping, is 15.13 m^2. This size can be used as a reference for future experiments.

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