ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Journal of Agronomy 14 (2): 98-101, 2015
ISSN 1812-5379

RESEARCH ARTICLE OPEN ACCESS

DOI: 10.3923/ja.2015.98.101

Sample Dimension for Estimation of Biomass and Yield of Sunn (*Crotalaria juncea* L.) and Showy Rattlebox (*C. spectabilis* Roth.)

[1]Paulo Eduardo Teodoro, [2]Carlos Antônio da Silva Junior, [1]Larissa Pereira Ribeiro, [1]Flávia Alves da Silva, [1]Caio César Guedes Corrêa, [1]Angelita dos Santos Zanuncio and [1]Francisco Eduardo Torres
[1]State University of Mato Grosso do Sul (UEMS), 87020-900, Aquidauana, Mato Grosso do Sul, Brazil
[2]Departament of Agronomy, State University of Maringá (UEM), Av. Colombo, 5790-Bloco J45, Postal Code 87020-900, Maringá, Paraná, Brazil

ARTICLE INFO
Article History:
Received: March 20, 2015
Accepted: May 23, 2015

Corresponding Author:
Carlos Antonio da Silva Junior,
Department of Agronomy,
State University of Maringa,
Av. Colombo, 5790-Bloco J45,
Postal Code 87020-900, Maringá,
Paraná, Brazil

ABSTRACT
Green manure brings numerous benefits that promote, essentially, the maintenance and conservation of agro-systems and its implementation is fundamental to Brazilian Cerrado region. In this scenario, the present research aimed to determine the sample size for estimation biomass and productivity of sunn and showy rattlebox. The experiment was installed in the experimental area of the State University of Mato Grosso do Sul-Unit University Aquidauana (UEMS/UUA), located in the Brazilian Cerrado. It were randomly selected 45 plants in the experimental area of each crop to determine Fresh Mass (FM), Dry Mass (DM) and yield (YI), being the measures of central tendency, variability, asymmetry and kurtosis were calculated and checked for normality by Lilliefors's test. In sunn and showy rattlebox, 340 and 197 plants, respectively, are sufficient for the estimation of evaluated descriptors, with confidence interval of 95%. The species evaluated did not differ for the characters FM and DM, both of which are recommended for cultivation in the Cerrado.

Key words: Experimental design, green manure, indirect selection

INTRODUCTION

The Cerrado occupation has occurred quickly, based on intensive production systems which have increased the processes of soil degradation. These processes result in impacts that often generate the inefficiency of agricultural systems, with frequent need for interventions through conservation practices to maintain productive potential of the soil. In this context, green manure becomes fundamental to the Cerrado region, because it promotes protection, improvement and maintenance of soil quality, as well as substantial increases in soil organic matter and nutrients, benefiting agroecosystems (Torres *et al*., 2014). Among the desirable characteristics for selection of species for green manure, stands out mainly dry mass production, because it is related to the capacity to increase nutrient by symbiosis with microorganisms, soil cover and recycling of nutrients (Calegari *et al.*, 1993; Carvalho *et al.*, 1999; Chaves and Calegari, 2001).

Among the various botanical families species that can be grown as green manures, stand out those of the Fabaceae family. The legumes in addition to providing similar benefits to other species, have the ability to accumulate N through biological fixation (Melo, 2012; Da Silva *et al*., 2009; Leite *et al*., 2010).

Among the various legumes used as green manure, the species of the genus *Crotalaria* are very efficient as producers of biomass and as N fixing, being widely used in research (Silva *et al*., 1994; Carvalho and Amabile, 2006; Teodoro *et al*., 2011). However, so there is reliability of data obtained in a given study, it is important to consider the sample size to be measured to obtain an estimate of average with highest reliability. The sample size is directly proportional to data variability and to desired confidence degree in the estimate and inversely proportional to the estimation error allowed, initially established by the researcher (Barbetta *et al*., 2004; Bussab and Morettin, 2004; Spiegel *et al*., 2004).

Thus, the objective of this study was to determine the sample size for estimation biomass and productivity average in sunn and showy rattlebox and identify the most recommended species to cultivation in the Brazilian Cerrado.

MATERIAL AND METHODS

The experiment was installed in the experimental area of the State University of Mato Grosso do Sul-Unit University Aquidauana (UEMS/UUA), in the Municipality of Aquidauana (MS), located in the Brazilian Cerrado (or Savanna), comprising the coordinates 20º27'S and 55º40'W, with an average elevation of 170 m.

The soil was classified as Ultisol sandy loam texture, with the following chemical characteristics in the layer 0-0.20 m: pH (H_2O) = 6.2; Al exchangeable ($cmol_c\ dm^{-3}$) = 0.0; Ca+Mg ($cmol_c\ dm^{-3}$) = 4.31; P ($mg\ dm^{-3}$) = 41.3; K ($cmol_c\ dm^{-3}$) = 0.2; organic matter ($g\ dm^{-3}$) = 19.7; V (%) = 45.0; m (%) = 0.0; sum of bases ($cmol_c\ dm^{-3}$) = 2.3 and Cation Exchange Capacity (CEC) ($cmol_c\ dm^{-3}$) = 5.1. The climate of the region according to the classification described by Köppen-Geiger is Aw (Savanna Tropical) with average annual rainfall of 1200 mm and maximum and minimum temperatures of 33 and 19°C, respectively (Torres *et al*., 2013).

Sunn and showy rattlebox were sown manually on April 16, 2013 in experimental areas with 50 m^2. The spacing used was 0.45 m between rows at a density of 15 plants m^{-1} linear. No base fertilization and coverage for any culture were performed.

At maturation, it were randomly selected 45 plants in the experimental area of each crop to determine Fresh Mass (FM), Dry Mass (DM) and yield (YI). The FM was obtained through weighing of the plants on an analytical balance. After the plants were placed in paper bags and dried in forced circulation oven for 72 h at 65°C. The YI was obtained by weighing the grain in analytical balance and its moisture corrected to 13%. Measures of central tendency, variability, asymmetry and kurtosis were calculated and checked for normality by Lilliefors's test (Campos, 1983).

To each character, in each crop, the sample size was calculated (η), considering the 45 plants for a semi-amplitude of the confidence interval (estimation error) equal to 1, 2, ... and 30% of the estimated average (a), with a confidence degree (1-α) of 95%, by the expression:

$$\eta = \frac{t_{\alpha/2} s^2}{\varepsilon^2}$$

(Fonseca and Martins, 1995; Barbetta *et al*., 2004; Bussab and Morettin, 2004; Spiegel *et al*., 2004), where, $t_{\alpha/2}$ is the critical value of Student t distribution, whose right area is equal to $p(t>t_{\alpha/2}) = \alpha/2$, with (n-1) liberty degrees, α/=5% of error probability and variance estimate (s^2).

The statistical analysis was performed with assistance of the Genes computational program (Cruz, 2006) and Office Excel® software.

RESULTS AND DISCUSSION

The measures of central tendency, variability, asymmetry, kurtosis and Lilliefors's test, in relation to characters FM, DM and YI in sunn and showy rattlebox, from 45 plants evaluated, data showed good adjustment to the distribution normal ($p>0.05$) (Table 1). However, according to the central limit theorem, even if the basic population is not normal, the distribution of the sample average will be approximately normal for samples greater than 30 observations (Fonseca and Martins, 1995; Bussab and Morettin, 2004). Given these considerations, in relation to normality can be inferred that the data from these characters provide credibility to the sizing of the sample size study by t-test.

Analyzing the standard deviation of both green manures verifies a superior magnitude of FM and DM on YI, suggesting higher sample sizes for the estimation of the fresh and dry mass relative to average productivity. Similar results were found in research on the sample design for evaluation of characters in other green manures (Burin *et al*., 2014; Cargnelutti Filho *et al*., 2014, 2015; Teodoro *et al*., 2014).

Moreover, the statistical parameters revealed existence of genetic variability among plants of sunn and showy rattlebox. These species did not differ how much biomass production (FM and DM), being within the limit recommended by Calegari *et al.* (1993), Darolt (1998), Carvalho *et al.* (1999) and Alvarenga *et al*. (2001) for cultivation in the Brazilian Cerrado region, furthermore sunn had a higher YI compared to showy rattlebox. It is important to mention that in front of observed results, these species of green manure provides greater dry mass production and consequently greater soil cover which entails numerous benefits such as increased weed suppression, greater soil humidity and smaller temperature oscillation, among others. In addition, sunn can be considered for family farms because of its high seed production and high prices in the market.

Sample size (plants number) to estimate the average of each character in sunn, with semi-amplitude of the confidence interval equal to 1% of average estimate and 95% confidence degree, ranged between 2,974 and 8,510 plants (Table 2), whereas, for the showy rattlebox this variation was 1,108-4,915 plants. Results in similar magnitude was obtained by Burin *et al.* (2014), Cargnelutti Filho *et al.* (2014), Teodoro *et al.* (2014) and Cargnelutti Filho *et al.* (2015) which too identified variability in sample size of others green manure species.

From a practical standpoint, it can be inferred that it is difficult to obtain average estimates of the descriptors evaluated in sunn and showy rattlebox, with estimation error of 1%, due to the large plants number to be measured. Does not fit in this study the judgment of maximum estimation error acceptable, getting the use this information to the researcher for his experimental design.

If the option is to obtain averages with 5% estimation error, taking into account the density of 15 plants m^{-1}, 0.45 m spacing and the evaluation these characters in 5 rows useful length of 5.0 m, plots with rows of 7 and 7.0 m length would be suitable for experiments with sunn, according to Fig. 1.

Table 1: Statistical parameters of the fresh mass, dry mass and yield of 45 plants of sunn and showy rattlebox. Aquidauana, MS, Brazil, 2013

	Sunn			Showy rattlebox		
	FM	DM	YI	FM	DM	YI
Parameters	(g plant^{-1})					
Minimum	60.88	24.06	3.30	53.03	31.29	3.20
Maximum	302.79	130.07	11.80	197.58	101.80	6.30
Average[(1)]	136.28[a]	61.39[a]	7.28[a]	102.67[a]	61.24[a]	4.45[b]
Variance	3,891.00	520.35	3.88	1,275.54	336.19	0.54
Standard deviation	62.38	22.81	1.97	35.71	18.34	0.73
Asymmetry[(2)]	0.36[ns]	0.94[ns]	0.01[ns]	0.94[ns]	0.32[ns]	0.59[ns]
Kurtosis + 3[(3)]	4.33[ns]	3.74[ns]	2.78[ns]	3.48[ns]	2.26[ns]	3.06[ns]
p-value[(4)]	0.24	0.17	0.08	0.20	0.16	0.14

[(1)]Averages of each character measured in sunn and showy rattlebox, followed by the same letter do not differ by bilateral t-test at a significant level of 0.05, [(2)]*Asymmetry differs from zero by t-test at a significant level of 0.05, [ns]Not significant, [(3)]*Kurtosis differs from three by t-test at 5% probability,[(4)]p-value by Lilliefors's test at 5% probability, FM Fresh mass, DM: Dry mass and YI: Yield

Table 2: Sample size to estimate the average of fresh mass, dry mass and yield of sunn and showy rattlebox for a interval semi-amplitude with 95% confidence and errors equal to 1, 2, ..., 30% of the estimated average

	Sunn			Showy rattlebox		
Errors (%)	FM	DM	YI	FM	DM	YI
1	8,510	5,608	2,974	4,915	3,641	1,108
2	2,127	1,402	743	1,229	910	277
3	946	623	330	546	405	123
4	532	351	186	307	228	69
5	340	224	119	197	146	44
6	236	156	83	137	101	31
7	174	114	61	100	74	23
8	133	88	46	77	57	17
9	105	69	37	61	45	14
10	85	56	30	49	36	11
11	70	46	25	41	30	9
12	59	39	21	34	25	8
13	50	33	18	29	22	7
14	43	29	15	25	19	6
15	38	25	13	22	16	5
16	33	22	12	19	14	4
17	29	19	10	17	13	4
18	26	17	9	15	11	3
19	24	16	8	14	10	3
20	21	14	7	12	9	3
21	19	13	7	11	8	3
22	18	12	6	10	8	2
23	16	11	6	9	7	2
24	15	10	5	9	6	2
25	14	9	5	8	6	2
26	13	8	4	7	5	2
27	12	8	4	7	5	2
28	11	7	4	6	5	1
29	10	7	4	6	4	1
30	9	6	3	5	4	1

FM: Fresh mass, DM: Dry mass and YI: Yield

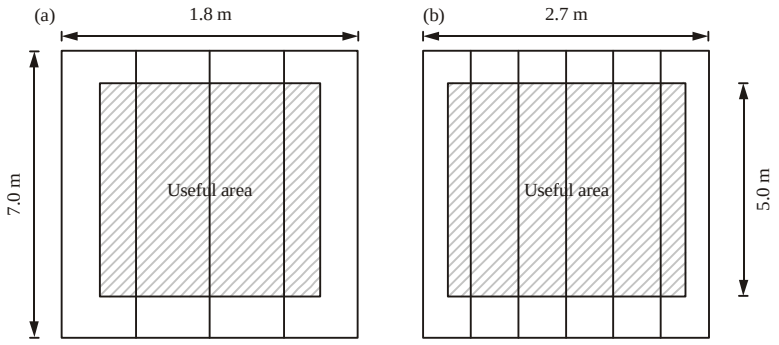

Fig. 1(a-b): Sample sized plots for average with 5% estimation error in (a) *Crotalaria juncea* and (b) *Crotalaria spectabilis*

Considering these same variables for the showy rattlebox, plots of 5 rows with 7.0 m long would be suitable. However, according Teodoro *et al.* (2014), other factors must be analyzed for planning experiments with these green manures, such as seed germination, plant density, spacing to be used and type of harvesting and weeding (manual or mechanical).

CONCLUSION

In sunn and showy rattlebox, 340 and 197 plants, respectively, are sufficient for the estimation of evaluated descriptors, with confidence interval of 95%. The species evaluated did not differ for the characters FM and DM, both of which are recommended for cultivation in the Cerrado and similar regions of the world.

REFERENCES

Alvarenga, R.C., W.A.L. Cabezas, J.C. Cruz and D.P. Santana, 2001. [Ground cover plants for no-tillage]. Informacao Agropecuaria, 22: 25-36, (In Portuguese).

Barbetta, P.A., M.M. Reis and A.C. Bornia, 2004. Statistics for Engineering and Computer Courses. Atlas Publisher, Sao Paulo, Brazil, Pages: 410.

Burin, C., A. Cargnelutti Filho, M. Toebe, B.M. Alves and A.L. Fick, 2014. [Sample size for estimating the average and median character of white lupine (*Lupinus albus* L.)]. Comunicata Scientiae, 5: 205-212, (In Portuguese).

Bussab, W.O. and P.A. Morettin, 2004. Basic Statistics. 5th Edn., Saraiva Publisher, Sao Paulo, Brazil, Pages: 526.

Calegari, A., P.B. Alcantara, S. Miyasaka and T.J.C. Amado, 1993. Characteristics of the Main Species of Green Manure. In: Green Manure in South of Brazil, Costa, M.B.B. (Ed.). AS-PTA, Rio de Janeiro, pp: 206-319.

Campos, H., 1983. Non-Parametric Statistical Experimental. 4th Edn., Departamento de Matematica e Estatistica-ESALQ, Piracicaba, Brazil, Pages: 349.

Cargnelutti Filho, A., G. Facco, A.D. Lucio, M. Toebe, C. Burin, A.L. Fick and I.M.M. Neu, 2014. [Sample size to estimate the average of morphological and productive traits of turnip]. Ciencia Rural, 44: 223-227, (In Portuguese).

Cargnelutti Filho, A., M. Toebe, B.M. Alves, C. Burin, G.O. dos Santos, G. Facco and I.M.M. Neu, 2015. [Sample size to evaluate morphological and productive characters in black oat in evaluation times]. Ciencia Rural, 45: 9-13, (In Portuguese).

Carvalho, A.M., M.L. Burle, J. Pereira and M.A. Silva, 1999. Management of Green Manure in the Savanna. Embrapa Publisher, Brazil, pp: 28.

Carvalho, A.M. and R.F. Amabile, 2006. Cerrado: Fertilization Green. Embrapa Cerrados Publ., Brasilia, Brazil, Pages: 369.

Chaves, J.C.D. and A. Calegari, 2001. [Green manuring and crop rotation]. Informacao Agropecuaria, 22: 53-60, (In Portuguese).

Cruz, C.D., 2006. Genes program: Experimental and statistical matrices. Universidade Federal de Vicosa, Vicosa, MG., Brasil, pp: 285.

Da Silva, P.C.G., J.S.S. Foloni, L.B. Fabris and C.S. Tiritan, 2009. [Biomass and C/N ratio in intercrops of sorghum and maize with cover crops]. Pesquisa Agropecuaria Brasileira, 44: 1504-1512, (In Portuguese).

Darolt, M.R., 1998. Principles for Maintenance and Implementation of the System. In: No Tillage: Small Sustainable Property, Darolt, M.R. (Ed.). IAPAR Circular, Londrina, pp: 101.

Fonseca, J.S. and G.A. Martins, 1995. Statistical Course. 5th Edn., Atlas Publisher, Sao Paulo, Brazil, Pages: 317.

Leite, L.F.C., R.C.A. de Freitas, E. Sagrilo and S.R.S. Galvao, 2010. [Decomposition and nutrients release from crop residues placed on a Yellow Latosol in the savanna of the Maranhao State]. Revista Ciencia Agronomica, 41: 29-35, (In Portuguese).

Melo, I.G.C., 2012. Seeding rates of legumes in improving soil quality and productivity of maize. Master's Thesis, Universidade Federal Rural do Semi-Arido, Brazil.

Silva, J.E., J. Lemainski and D.V.S. Resk, 1994. Loss of organic matter and its relations with the cation exchange capacity in soils of the Cerrado region of Western Bahia. Revista Brasileira Ciencia Solo, 18: 541-547, (In Portuguese).

Spiegel, M.R., J.J. Schiller and R.A. Srinivasan, 2004. Probability and Statistics. 2nd Edn., Bookman Publisher, Porto Alegre, Brazil, Pages: 398.

Teodoro, R.B., F.L. de Oliveira, D.M.N. da Silva, C. Favero and M.A.L. Quaresma, 2011. [Agronomic aspects of leguminous to green fertilization in the Cerrado of the high Jequitinhonha Valley]. Revista Brasileira Ciencia Solo, 35: 635-640, (In Portuguese).

Teodoro, P.E., L.P. Ribeiro, F.A. da Silva, C.C.G. Correa, R.A.A. da Luz Jr. and F.E. Torres, 2014. [Sample size to estimate biomass and productivity of *Canavalia ensiformis* and *Dolichos lablab*]. Revista Ciencias Agrarias, 37: 348-353, (In Portuguese).

Torres, F.E., L.R. Toledo, M.H.P.G. Ribeiro, P.E. Teodoro, L.P. Ribeiro and C.C.C. Guedes, 2013. [Influence of weed management and nitrogen in oil content in seven varieties of castor bean (Ricinus communis)]. Revista de Ciencias Agrarias (Lisboa), 36: 357-362, (In Portuguese).

Torres, F.E., L.C.F. Souza, L.H.L. Andrade, F.F. Pedroso and A.O. Matoso *et al*., 2014. Influence of cover crops and nitrogen rates in winter corn crop. Revista Brasileira de Ciencias Agrarias, 9: 36-41, (In Portuguese).