Corn yield in two planting densities under different cover forages

Produtividade de milho em duas densidades de plantio sob diferentes forrageiras

Bernardo Melo Montes Nogueira BORGES[1;2] ; Fábio Teixeira LUCAS[3]; Marcelo Abreu LANZA[4]; José Mauro Valente PAES[5]

[1] Trabalho de iniciação científica do primeiro autor; Pesquisa e bolsa financiada pela Fundação de Amparo a Pesquisa do Estado de Minas Gerais – FAPEMIG
[2] Autor para correspondência: Doutorando em Agronomia (Produção Vegetal) Unesp/FCAV; bernardonog@hotmail.com
[3] Doutorando em Agronomia (Produção Vegetal) Unesp/FCAV. fabiotlucas@hotmail.com
[4] Pesquisador Doutor Empresa de Pesquisa Agropecuária de Minas Gerais – EPAMIG. mlanza@epamig.br
[5] Pesquisador Doutor Empresa de Pesquisa Agropecuária de Minas Gerais – EPAMIG. jmpaes@epamig.br

Recebido em: 26-07-2013; Aceito em: 13-04-2014

Abstract

Due to the great exploration of Cerrado soils (Brazilian Savannah) and the use of no tillage system as a conservation method, aiming to increase crop productivity and the importance of the sector to the country economic balance, it gives the relevance of the study in question. The objective was to evaluate the productivity and development of maize sown under different plant populations and land cover. The experiment was established in IFTM in Uberaba, State of Minas Gerais, Brazil, Oxisol. We used an experimental design of randomized blocks in a 2x6 factorial design with three replications and with two planting densities (80 and 100 thousand plants ha^{-1}) and six cover crops (*Brachiaria decumbens*, *Brachiaria brizantha* cv. Marandu, *Panicum maximum* cv. Mombasa, *Panicum maximum* cv. Tanzania, *Brachiaria brizantha* cv. Xaraés, *Cynodon* spp. cv. Tifton-85). At harvest time we evaluated plant height, ear height and final population and after harvesting we evaluated the prolificacy and yield. The different coverage did not influence the culture development and production. The smallest population provided better results regarding corn production.

Additional keywords: cover grasses; no-till; population; *Zea mays.*

Resumo

Devido à grande exploração de solos de cerrados com a utilização do sistema de plantio direto como manejo de conservação, visando a aumentar a produtividade das culturas, e devido à importância do setor para a balança econômica do País, dá-se a relevância do estudo em questão. O objetivo foi avaliar a produtividade e o desenvolvimento do milho semeado em diferentes populações e plantas de cobertura do solo. O experimento foi implantado no IFTM, em Uberaba-MG, Latossolo Vermelho, textura média. Foi utilizado um delineamento experimental de blocos casualizados, em fatorial 2x6, com três repetições e duas densidades de semeadura (80 e 100 mil plantas ha^{-1}) e seis plantas de cobertura (*Brachiaria decumbens, Brachiaria brizantha* cv. Marandu, *Panicum maximum* cv. Mombaça, *Panicum maximum* cv. Tanzânia, *Brachiaria brizantha cv.* Xaraés, *Cynodon* spp. cv. Tifton-85). Na época da colheita, avaliamos altura de planta, altura de espiga e população final, e, após a colheita, profilicidade e produção. As Coberturas não influenciaram no desenvolvimento da cultura e na produção. A menor população proporcionou melhores resultados em relação à produção de milho.

Palavras-chave adicionais: gramíneas de cobertura; plantio direto; população; *Zea mays.*

Introduction

In general, the natural soil state already has some permeability, structure, density and porosity suitable for the normal development of plants but as the soil is exploited the physical properties change, generally unfavourably for plant development (SPERA et al., 2004; MARTINS et al., 2009 and CARDOSO & COUTINHO, 2013). Therefore, in a national agricultural scenario, a no-till system has been one of the best alternatives for maintaining the sustainability of natural resources (OLIVEIRA et al., 2002). For an example of increasing soil quality with no-till system, MARTINS et al. (2012) in a seven year study increased aggregate stability with the no-till system using corn, millet and sorghum.

The use of minimum tillage systems can promote an improvement in the structure, porosity, water retention and infiltration and biological

activity, of mostly poor tropical soils. The climate promotes rapid trash decomposition. Therefore, grasses can be used as cover as they produce high amounts of dry matter and they are able to form a more stable protection to soil surface (LEAL et al., 2008).

Together with this improvement in structure and soil protection, the use of higher populations may produce an increase in corn yield. With reduced spacing, where cover crops enhance the soil properties, the promotion of a better development of plants is possible. BORGHI & CRUSCIOL (2007) state that the grain yields of corn is higher with reduced spacing, when intercropped with *B. brizantha.*

The tendency has been to decrease the distance between lines and increase the plant population. A plant population close to 74 thousand plants ha^{-1} provides an increase of production in short and normal cycle materials (FLESCH & VIEIRA, 2004). De SOUZA et al. (2013) found out that an increase of the population from 40,000 to 100,000 plants ha^{-1} had also an increase in the yield, sweet corn. According to SANGOI et al. (2006) and FLESCH & VIEIRA (2004) modern corn hybrids are more resistant to high population stress, by being more efficient in absorbing water and nutrients (CLOVER & MALLARINO, 2012). Contrasting the findings of ROSSATO JUNIOR et al. (2013) where the increase of corn population promoted a reduction on number of grains by ear, smaller prolificacy and grains mass loss.

There were no studies found in the literature, by the authors, documenting the interaction of these two treatments, where two populations of maize are sown under different forage species in a no-tillage system, thus highlighting the relevance of this work.

We aimed to evaluate the productivity and development of corn sown under different plant populations and cover forage.

Material and methods

The experiment was conducted at the Experimental Farm of the Instituto Federal de Educação, Ciência e Tecnologia do Triângulo Mineiro (IFTM) 790 m above sea level, located at 19°39'43"S and 47°57'47"W. The region's climate is tropical semi-humid and the average annual rainfall is 1684.6 mm. The region's average temperature is 21.4 °C, with the warmest months averaging 23.2 °C and the colder, averaging 19.4 °C. The average relative air humidity is 71.4%. These data were obtained from the Climatological Station of Uberaba, State of Minas Gerais, Brazil – EPAMIG / INMET (2009).

The experimental area has a gentle topography and soil classified as Oxisol (EMBRAPA, 2006).

Sampling was performed in the experimental area 0-0.2 m; 20 single samples were collected to form a composite and were subjected to physical and chemical analysis following the method described by ALVAREZ VENEGAS et al. (1999). The results of chemical analysis of the soil revealed: pH = 4.7; M.O. = 12 g dm^{-3}, P resin = 30 mg dm^{-3}, K = 0.9 mmol dm^{-3}, Ca = 16 mmol dm^{-3}; Mg = 7 mmol dm^{-3}, H+Al = 31 mmol dm^{-3}; CTC = 48.9 mmol dm^{-3}, V% = 49, S-SO_4 = 2 mg dm^{-3} and that the application of lime was not necessary. The planting fertilization was 400 kg ha^{-1} of 00-30-15 plus 225 kg ha^{-1} of ammonium sulphate and topdressing of 400 kg ha^{-1} of ammonium sulphate.

The sowing of forage plants took place in early November, 2008, and the sowing of the corn was held until February, 2009. The treatments were arranged using the experimental design of randomized blocks in factorial 2x6 with three replications. A simple hybrid was tested in two planting densities, 80,000 and 100,000 plants ha^{-1} under six cover forages: *Brachiaria decumbens*, *Brachiaria brizantha* cv. Marandu, *Panicum maximum* cv. Mombasa, *Panicum maximum* cv. Tanzania, *Brachiaria brizantha* cv. Xaraés, *Cynodon* spp. cv. Tifton-85. Each plot had five rows, spaced 0.75 m apart, with 6 or 7.5 plants m^{-1} for the 80,000 and 100,000 population, 5 m in length, giving a study area of 18.75 m².

The experiment was set out manually in a no-tillage system. Weed control was done by the use of herbicides. The densities of the pre-established crop in each treatment were adjusted by pruning when the plant had grown to have three leaves.

At the time of harvest the: plant height, ear height (main ear) and final population were evaluated. Following the harvest prolificacy and yield estimated at 13% humidity were calculated. The prolificacy was measured by dividing the number of ears for the final stand.

We used analysis of variance (ANOVA) to test the treatments effect. The differences among the treatments were evaluated by Tukey with 5% of probability.

Results and discussion

When considering plant height, ear height, prolificacy and the final population, the results showed no significant difference (Table 1). SANGOI et al. (2006) and FLESCH & VIEIRA (2004) attribute such results to the genetics of modern hybrids, in that they respond to different populations without any major change in vegetative characteristics.

Even with modern corn hybrids, been more efficient (CLOVER & MALLARINO, 2012) and by that they are able to tolerate high population competition, at this present study, grain yield

was compromised just as in ROSSATO JUNIOR et al. (2013). The higher plant population generated a smaller grain yield, probably due to the increase of competition with the highest of population. What contrasts with VON PINHO et al. (2008) and De SOUZA et al. (2013) study who observed that an increase in plant density resulted in an increase in grain yield.

When comparing all the evaluated characteristics in maize with different types of forage, there was no difference in most characteristics, except when evaluating the final population where Mombasa, Xaraés, Decumbens and Tanzania produced final corn populations higher than the Marandu, but still with no influence on the final yield. This shows that all of them had the same quality as coverage to corn, improving soil quality (MARTINS et al., 2012).

We observed that even forages that had a greater resistance to the herbicide, as in the case of Tanzania, which took longer to dry out than the others, did not influence corn yield. Even forage that decomposes quickly, such as Tifton, didn't influence the final results of the experiment, as shown in Table 1.

Table 1 - Effect of treatment on plant height, ear height, prolificacy, final population and yield at the time of harvest.

Population (P) (pl ha^{-1})	Plant height (m)	Ear height (m)	Prolificacy	Final population	Yield (kg ha^{-1})
80,000	2.39	1.34	1.34	80381.96	9034.08
100,000	2.26	1.35	0.92	84548.50	7992.08
F Test	2.55^{NS}	0.01^{NS}	1.38^{NS}	1.52^{NS}	5.86*
Forages (F)					
Marandu	2.43	1.34	2.04	66458.12 c	8683.62
Tifton	2.43	1.41	0.91	78229.25 bc	8480.50
Decumbens	2.16	1.35	0.94	78749.87 abc	8389.12
Mombasa	2.29	1.29	0.92	96354.00 a	8089.37
Xaraés	2.37	1.37	0.97	86354.12 ab	8807.12
Tanzânia	2.28	1.32	1.01	88646.00 ab	8628.75
F Test	1.19^{NS}	0.73^{NS}	1.03^{NS}	6.26**	0.23^{NS}
	---------- F Test ----------				
(P)x(F)	0.79^{NS}	1.68^{NS}	1.11^{NS}	1.11^{NS}	0.55^{NS}
C.V. (%)	11.8	10.2	109.5	14.2	17.5

Means followed by same letter in columns are not different according Tukey (P<0,05).

SEVERINO et al. (2006) believe that *Brachiaria brizantha* and *Panicum maximum* exhibit interspecific competition with corn, as they had a higher fresh mass production when compared with *Brachiaria decumbens*. The opposite is revealed in this study, which shows that there was no difference in the evaluated characteristics of corn and that all forage was at the same level of competition with the culture, despite a significant difference in the final population made up by increasing production on a small population.

As quoted by CONSTANTIN et al. (2009) and observed at the field, there was a reduction in weed numbers requiring fewer herbicide applications to keep the area free.

The significant difference in the final population, without affecting the yield, is provided by the better soil structure when there is straw on the soil surface (MARTINS et al., 2012), (CARDOSO & COUTINHO, 2013) e (BORGES & COUTINHO, 2013). COSTA et al. (2009) say that when comparing a no-till system to a conventional tillage system, the roots of corn plants are concentrated in the surface layer with higher growth regardless of how the fertilization was done.

When considering the interaction between the treatments, there wasn't any significant difference in any of the variables used to evaluate the culture. Showing that the higher grain yield with the 80,000 plants ha^{-1} population occurs independently of what forage is used as soil cover.

Once all forages had good soil cover, the purpose of the forage after the corn harvest has to be considered. LEONEL et al. (2009) and this work both imply that the corn yield was not affected by intercropping with forage, showing that forage does not influence the final yield.

Conclusions

The use of different forage plants as mulch for corn did not influence the development and yield in a no-tillage system. This shows that these forages provided a favourable environment for the culture's development.

Using a population of 80,000 plants ha^{-1} in a no-tillage system promoted a greater yield compared with a higher population, regardless of cover forage cultivated in the area.

References

ALVAREZ VENEGAS, V. H.; RIBEIRO, A. C. Calagem. In: RIBEIRO, A. C.; GUIMARÃES, P. T. G.; ALVAREZ VENEGAS, V. H. (Ed.). **Recomendações para o uso de corretivos e fertilizantes em Minas Gerais**: 5ª aproximação. Viçosa: Imprensa Universitária, 1999. p.43-60.

BORGES, B. M. M. N.; COUTINHO, E. L. M. Importância da palhada da cana-de-açúcar para a qualidade física do solo. In: FERNANDES, C. (Coord). **Tópicos em física do solo**. Jaboticabal: FUNEP, 2013. v.2, p.70-72.

BORGHI, E.; CRUSCIOL, C. A. C. Produtividade de milho, espaçamento e modalidade de consorciação com *Brachiaria brizantha* em sistema de plantio direto. **Pesquisa Agropecuária Brasileira**, Brasília, v.42, n.2, p.163-171, 2007.

CARDOSO, S. S.; COUTINHO E. L. M. Sistema plantio direto e qualidade física do solo. In: FERNANDES, C. (Coord.). **Tópicos em física do solo**. Jaboticabal: FUNEP, 2013. v.2, p.41-52.

CLOVER, M. W.; MALLARINO, A. P. Corn and soybean tissue potassium content responses to potassium fertilization and relationshpis with grain yield. **Soil Science Society of America Journal**, Madison, v.77, p.630-642, 2012.

CONSTANTIN, J.; OLIVEIRA JÚNIOR, R. S.; INOUE, M. H.; CAVALIERI, S. D.; ARANTES, J. G. Z. Sistemas de manejo de plantas daninhas no desenvolvimento e na produtividade da soja. Bragantia, Campinas, v.68, n.1, p.125-135, 2009.

COSTA, S. E. V. G. A.; SOUZA, E. D.; ANGHINONI, I.; FLORES, J. P. C.; ANDRIGUETTI, M. H. Distribuição de potássio e de raízes no solo e crescimento de milho em sistemas de manejo do solo e da adubação em longo prazo. Revista Brasileira de Ciência do Solo, Viçosa, MG, v.33, n.5, p.1291-1301, 2009.

De SOUZA, R. S.; VIDIGAL FILHO, P. S.; SCAPIM, C. A.; MARQUES. O. J.; QUEIROZ, D. C.; OKUMURA, R. S.; RECHE, D. L.; CORTINOVE, V. B. Produtividade e qualidade do milho doce em diferentes populações de plantas. Semina: Ciências Agrárias, Londrina, v.35, n.3, p.995-1010, 2013.

EMBRAPA. **Sistema brasileiro de classificação de solos**. Rio de Janeiro: Embrapa Solos, 2006. 306p.

EPAMIG/INMET. Estação Climatológica Principal de Uberaba. **Dados climáticos de Uberaba**. Uberaba, 2009.

FLESCH, R. D.; VIEIRA, L. C. Espaçamentos e densidades de milho com diferentes ciclos no oeste de Santa Catarina, Brasil. **Ciência Rural**, Santa Maria, v.34, n.1, p.25-31, 2004.

LEAL, A. J. F.; LAZARINI, E.; RODRIGUES, L. R.; MURAISHI, C. T.; BUZETTI, S.; MASCARENHAS, H. A. A. Aplicação de calcário e culturas de cobertura na implantação do sistema plantio direto em cerrado. Revista Brasileira de Ciência do Solo, Viçosa, MG, v.32, n.spe, p.2771-2777, 2008.

LEONEL, F. P.; PEREIRA, J. C.; COSTA, M. G.; MARCO JÚNIOR, P.; LARA, L. A.; QUEIROZ, A. C. de. Comportamento produtivo e características nutricionais do capim-braquiária cultivado em consórcio com milho. **Revista Brasileira de Zootecnia,** Viçosa, MG, v.38, n.1, p.177-189, 2009.

MARTINS, M. R.; ANGERS, D. A; CORÁ, J. E. Carbohydrate composition and water-s-table aggregation of an Oxisol as affected by crop sequence under no-till. **Soil Science Society of America Journal**, Madison, v.76, p.475-484, 2012.

MARTINS, M. R.; CORÁ, J. E.; JORGE, R. F.;MARCELO, A. V. Crop type influences soil aggregation and organic matter under no-tillage. **Soil & Tillage Research**, Amsterdam, v.104, p.22-29, 2009.

OLIVEIRA, F. H. T.; NOVAIS, R. F.; ALVAREZ, V. H. V.; CANTARUTTI, R. B.; BARROS, N. F. Fertilidade do solo no sistema plantio direto. In: ALVAREZ, V. H. V.; SCHAEFER, C. E. G. R.; BARROS, N. F.; MELLO, J. W. V.; COSTA, L. M. (ed.). **Tópicos em ciência do solo**. Viçosa: Sociedade Brasileira de Ciência do Solo, 2002. v.2. p.393-486.

ROSSATO JUNIOR, J. A. S.; CAZZETA, D. A.; BARBOSA, J. C. ; FORNASIERI FILHO, D. Popping expansion and yield responses of popcorn cultivars under different row spacing and plant populations. **Pesquisa Agropecuária Brasileira,** Brasília, v.48, n.12, p.1538-1545, 2013.

SANGOI, L.; GUIDOLIN, A. F.; COIMBRA, J. L. M.; SILVA, P. R. F. Resposta de híbridos de milho cultivados em diferentes épocas à população de plantas e ao despendoamento. **Ciência Rural,** Santa Maria, v.36, n.5, p.1367-1373, 2006.

SEVERINO, F. J.; CARVALHO, S. J. P.; CHRISTOFFOLETI, P. J.. Interferências mútuas entre a cultura do milho, espécies forrageiras e plantas daninhas em um sistema de consórcio: II - implicações sobre as espécies forrageiras. Planta Daninha, Rio de Janeiro, v.24, n.1, p.45-52, 2006.

SPERA, S. T.; SANTOS, H. P.; FONTANELI, R. S.; TOMM, G. O. Efeitos de sistemas de produção de grãos envolvendo pastagens sob plantio direto nos atributos físicos de solo e na produtividade. **Revista Brasileira de Ciência do Solo**, Viçosa, MG, v.28, n.3, p.533-542, 2004.

VON PINHO, R. G.; GROSS, M. R.; STEOLA, A. G. MENDES, M. C. Adubação nitrogenada, densidade e espaçamento de híbridos de milho em sistema de plantio direto na região sudeste do Tocantins. Bragantia, Campinas, v.67, n.3, p.733-739, 2008.