Original Research Article

Evaluation of grain yield of two varieties of Cowpea (*Vigna unguiculata*) subjected to four agricultural practices in Gùrué District, Mozambique

ABSTRACT

To evaluate the effect of four agricultural practices in grain yield, two varieties (IT 16 and IT- 18) of cowpeas were installed in the agricultural year 2016/2017 an experimental field where the following agricultural practices were tested: tillage, tillage + mulch, zero tillage and zero tillage + mulch. The Randomized Complete Blocks Design, a scheme consisting of two factors: agronomic practices and varieties was used. The plant height, number of pods per plant, weight of 100 seeds and grain yield in kgha-1 were considered as parameters for analysis. The data collected from the field were statistically analyzed by ANOVA test, and the statistically different results were submitted to Tukey test at 5 % significance for comparison of their means. From the results, it was concluded that for the yield of grain of different varieties under study, the variety IT- 18 subjected to zero tillage + mulch and the variety IT- 16 subjected to tillage had better performance achieving 2600.00 kgha-1 and 1725.00 kgha-1 respectively; therefore, recommended to the farmers.

Keywords: Agricultural practices, cowpea (*Vigna unguiculata*), grain yield, varieties, Gùrué.

---

1. INTRODUCTION

Nowadays, supplying the crescent worldwide population index with adequate food, when people are getting low grain yields, with food scarcity and additional nutrients becoming one of the major factors facing the challenges of food security, is the major focus in the field of agriculture (Olusanya et al. 2016). For instance, there are different agronomic practices with great effect on the quality of the harvested crops (Putnam, Orloff, and Ackerly 2000).

The most known agronomic practices are the tillage, zero tillage and mulch. While tillage is a system of managing crop residue on the soil surface with minimum or no tillage (Unger and McCalla 1980); the zero tillage is conceptualized as a tillage system in which soil disturbance is reduced to sowing operations and traffic only, and where weed control must be achieved by chemical means involving higher water content in the top soil layer, reduced soil aeration, stronger mechanical resistance to root penetration, smaller soil temperature amplitudes, and a different pattern of nutrient distribution in the soil profile (Baeumer and Bakermans 1973).

The mulch systems offers a great agro-ecological potential providing innumerous services such as water conservation, enhancement of crop yield and improvement of the soil ecology (Erenstein 2003). It conserves the humidity in the soil, thus increasing the yield of crops by about 20% (Maduakor, Lal, and Opara-Nadi 1984).

Apart from the climatic conditions and soil ecology, the yield of many crops is also seriously affected by the agronomic practices, varieties utilized and the application or not of fertilizers. For the farmers who experience challenges of using fertilizers due to the costs, the usage of varieties which have the capacity of fixing Nitrogen into the soil such as Soybean (Glycine max) and Cowpea, is the better alternative. The Cowpea, scientifically known as *Vigna unguiculata* (Haruna and Usman 2013), is an annual legume originated in Africa and widely expanded to Asia and America (Iruhvwu 2015). In fact, in the selected study area, this crop is farmed by small scale farmers for subsistence and for research activities by local research companies. Many studies are being developed to increase the actual yield acquired by the small-scale farmers, which has been reported to be less than 100kgha^{-1}. The National average is at 250kgha^{-1} (Walker and Cunguara 2016).

This study aimed to evaluate the grain yield of 2 (two) varieties of cowpea subjected to 4 (four) agricultural practices (Tillage, Zero Tillage, Tillage + Mulch and Zero Tillage + Mulch), so as to recommend the best agronomic practice with the ability to produce a better grain yield in Cowpea varieties.

2. MATERIAL AND METHODS

The experiment was carried out in the fields of the sheepfold of NCBA CLUSA International company, in the region of Tetete, District of Gùrué, located to the North of Zambezia Province, in the region of high Zambezia (Figure 1); which according to the Ministry of State Administration-MAE (2005); is situated in a region dominated by the rock of the plateau zone and the mountainous area whose altitude varies between 500 to 1000m, (pp.14-18). The average annual rainfall is around 1,995.7 mm, mean annual evapotranspiration is 1,226.7 mm. The average annual temperature is 21.90C. The highest temperature is registered in the month of November (32.50ºC) and the lowest in the month of July (12ºC), (MAE, 2005).

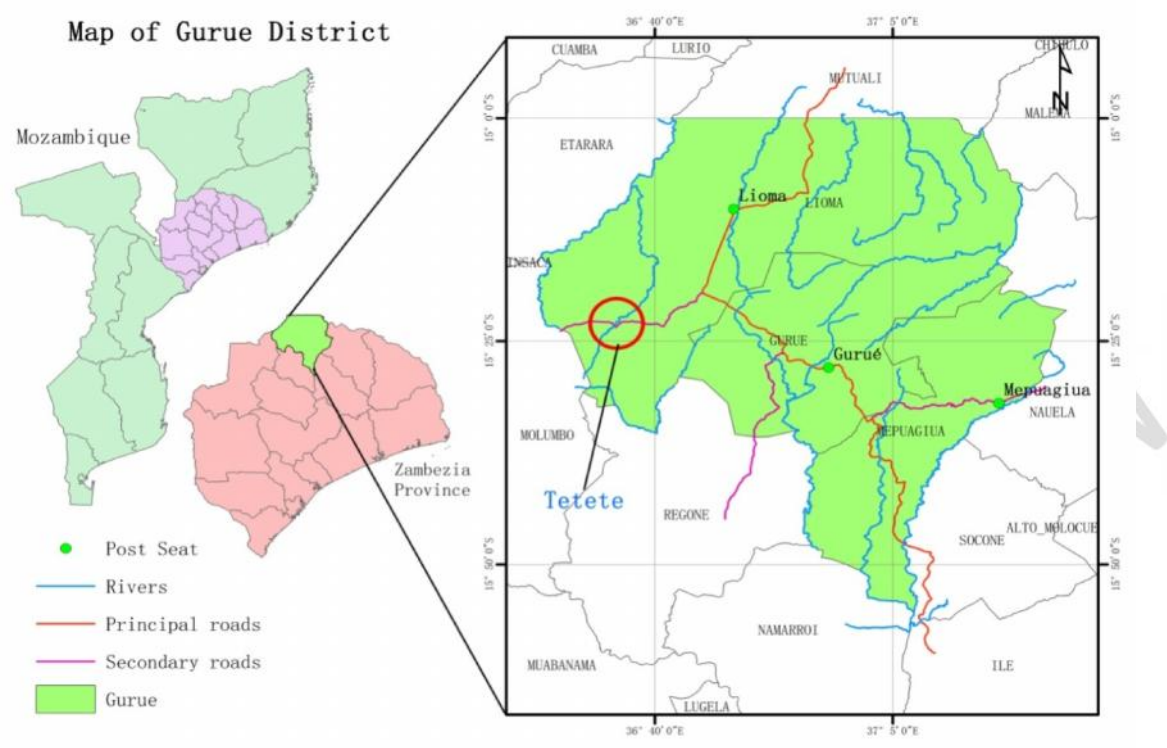

Fig. 1. Location of the study area. This figure shows the location map of the experiment, which is Tetete site in Gùrué District, Zambezia Province.

The experimental design used was the randomized complete block design in bi-factorial scheme (4x2); the first factor composed of four agricultural practices and the second composed of two varieties (TI-16 and TI-18), where the combination of the two factors were given 8 repeated treatments in 4 blocks, totaling 32 plots. Each experimental unit occupied an area of 20 m2 with 5 simple lines each. The separation between the parcels was 0.5m and between blocks 1 m. The productive area was 640m2 and the total area of the test was 826.5 m2 (figure 2). The description of the treatments is shown in table 1.

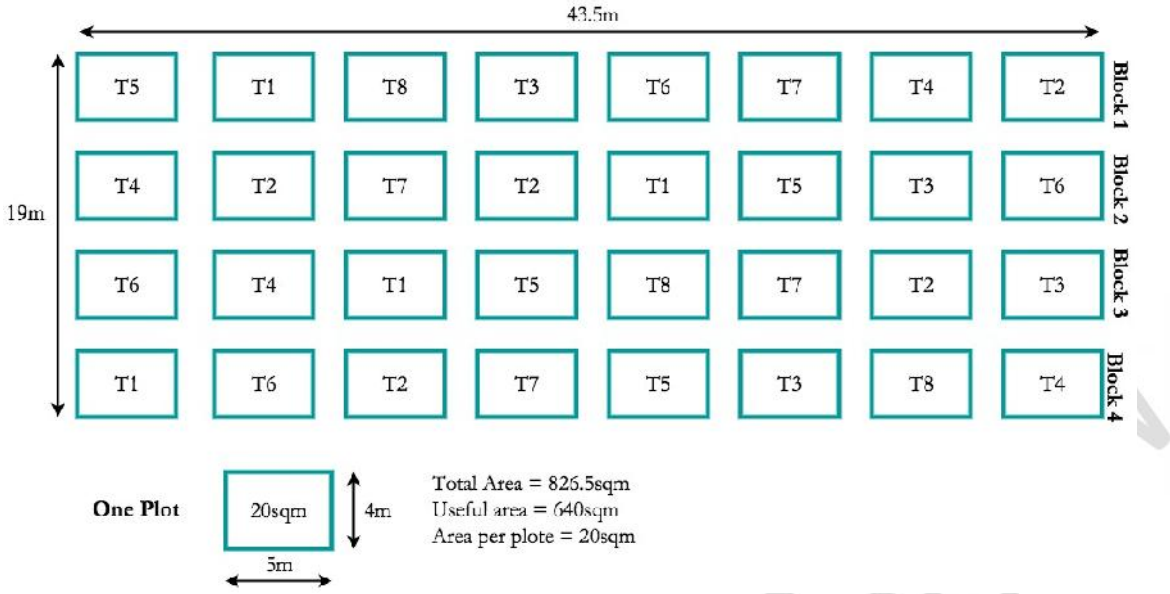

Fig. 2. Experimental design. This figure shows the experimental field design, which was divided into four blocks and eight treatments replicated in these four blocks.

Table 1. Description of the treatments including their codes, and specifications.

Treat.	Code	Agronomic practices
1	T1	Zero tillage + var. IT16
2	T2	Zero tillage + Mulch + var IT16
3	T3	Tillage + var. IT16
4	T4	Tillage + Mulch + var IT16
5	T5	Zero tillage + var. IT18
6	T6	Zero tillage + Mulch + var. IT18
7	T7	Tillage + var. IT18
8	T8	Tillage + Mulch + var. IT18

During the experiment, data about plant height (cm), number of pods per plant, 100 seed weight (g) and grain yield (kg ha-1) were collected. The data collected from the experiment were organized in Microsoft Excel and analyzed using the statistical package SISVAR for the Analysis of Variance (ANOVA). The data that were significantly differentiated in the ANOVA, were submitted to the Tukey test at 5% of significance for the comparison of averages of the treatments. To determine the ANOVA; the schema of analysis of variance for experiment in randomized blocks for 2 factors was used.

3. Results and discussion

Growth and Phonological Parameter (Plant Height)

The results of plant height showed in table 2, reveals that the varieties as well as the treatments (Agronomic practices) were differentiated when compared with their averages. However, the variety IT-18 presented a good average result, especially in the practice Tillage+Mulch, where the plants in this practice are revealed to be tall (with an average of 101.43cm) when compared to others.

Table 2. Results of the plant height in two varieties analyzed under different agronomic practices.

Agronomic practices	Varieties	
	IT-16	IT-18
Tillage	69.43 aB	62.37 aA
Zero Tillage	88.10 bA	84.18 bA
Zero Tillage + Mulch	82.12 bA	90.63 bB
Tillage + Mulch	83.93 bA	101.43 cB
General Average	82.77	
CV (%)	5.12	
DMS	5.91	

*Means followed by the same lower-case letter in the columns, did not present significant differences between treatments at 5% level of significance and means followed by the same capital letter in the lines did not present significant differences between the varieties at the level of 5% of significance.

The results obtained in this study, are in agreement with the results verified by Mekonnen and JJ (2016), while studying the Growth and Yield Response of Cowpea (Vigna unguiculata L. Walp.) to Integrate the Use of Planting Pattern and Herbicide Mixtures in Wollo, Northern Ethiopia. The average of plant height registered was between 86.0cm to 96.0cm. These results also show that the different agronomic practices applied may have significant influence on plant height when compared to the study developed by Science, Aikins, and Afuakwa (2008), where the results obtained were below the average of 70.0cm.

Number of pods per plant

Significant differences (5%) from Tukey analysis were verified in the analysis of the number of pods per plant (table 3). In this parameter, the variety IT-18 showed better results when compared with the variety IT-16 and the treatment Tillage+Mulch had better performance in both varieties, registering 15.90 and 23.90 for IT-16 and IT-18 respectively.

As expected from the plant height, the tillage showed lowest results when compared with the other treatments in both varieties and results of low average of number of pods were verified by Afuakwa & Aikins (2010) in their study of the Effect of Four Different Tillage Practices on

Cowpea Performance. Considering that the plant height is an important parameter linked with the productivity of the crops (Afuakwa and Aikins 2010), the results obtained in this study can also be justified based on the results obtained on plant height.

Table 3. Results of the average number of pods per plant in two varieties analyzed under different agronomic practices.

Agronomic practices	Varieties	
	IT-16	IT-18
Tillage	9.95 aA	16.33 aB
Zero Tillage	15.20 bA	19.85 abB
Zero Tillage + Mulch	15.13 bA	21.23 bcB
Tillage + Mulch	15.90 bA	23.90 cB
General Average	17.17	
CV (%)	10.71	
DMS	3.63	

*Means followed by the same lower-case letter in the columns did not present significant differences between treatments at 5% level of significance and means followed by the same capital letter in the lines did not present significant differences between the varieties at the level of 5% of significance.

In other study developed by Polthanee & Wannapat (2000) about the Tillage and Mulching effect on Growth and Yield of Cowpea Grown Following Rice in the Post-Monsoon Season of Northeastern Thailand, the values of number of pods per plant were low when compared to the results obtained here, even on the treatment where the Mulch were applied. However, in this study, it was reported that the Tillage affected the number of pods per plant. Based on this result, it can be inferred that the number of pods per plant does not depend only on the agronomic practices applied, but also on the varieties under analysis.

Hundred seed weight (grams)

For the results of hundred seeds weight (in grams) (Table 4), it can be seen that the different varieties showed different responses, the variety IT-16, which registered lowest values of plant height and average of number of pods, presented better results in this parameter. However, for this parameter, the treatments Zero Tillage and Zero Tillage+Mulch, showed better results for both varieties.

The results obtained in our study, are in agreement with the results observed by A H, Abdel-Ati, El-Damarany, and Rashwan (2015), where they found an average of hundred seed weight of about 11 grams for one of the varieties under analysis. However, those results are low when compared to the results obtained by Relation and Duration (2008) while studying the Stability analysis of components characters in cowpea (Vigna unguiculata (L.) Walp), where the results obtained were based on an average of 18 grams.

Table 4: Results of the average hundred seed weight in two varieties analyzed under different agronomic practices.

Agronomic practices	Varieties	
	IT-16	IT-18
Tillage	12.60 aB	9.33 aA
Zero Tillage	12.90 aB	11.60 bA
Zero Tillage + Mulch	12.90 aB	10.28 aA
Tillage + Mulch	12.93 aB	9.10 aA
General Average	11.44	
CV (%)	5.36	
DMS	1.21	

*Means followed by the same lower-case letter in the columns, did not present significant differences between treatments at 5% level of significance and means followed by the same capital letter in the lines, did not present significant differences between the varieties at the level of 5% of significance.

On the other hand, the results obtained in this study are superior to the results observed by Khaemba, Kinama, and Chemining'wa (2017), whereby in their evaluation of the effect of tillage practice on growth and yield of three selected Cowpea varieties (same as the practices under analysis in this study), obtained averages between 7-10 grams. The highest average of hundred seeds weight were verified in the agronomic practice convectional tillage. From these results, it can be concluded that the hundred seeds averages do not rely only on the agronomic practices, but also on the varieties.

Grain Yield (kgha-1)

Considered to be one of the major elements leading to improved results of grain yields; the hundred-seed weight showed a different trend in this study. The variety which had the better results of hundred seeds weight (IT-16) had a low grain yield average compared to the IT-18. The best results of grain yield were recorded in the variety IT-18 with an average of 2,600kgha-2. This value was observed in the treatment Zero Tillage + Mulch. On the other hand, the variety IT-16 showed a high grain yield of 1,950 Kgha-1 in the treatment Zero Tillage (Table 5).

These results are in agreement with the results reported by Khaemba, Kinama, and Chemining'wa (2017) who recorded a grain yield of a value between 890kgha and 1,720kgha, where the more valuable results were observed in zero tillage and tillage+mulch agronomic practices. However, for the grain yield, in this study, the varieties as well as the agronomic practices had a major contribution.

Table 5: Results of the average of grain yield in two varieties analyzed under different agronomic practices.

Agronomic practices	Varieties	
	IT-16	IT-18
Tillage	1,725.0 bcA	1,862.5 bA
Zero Tillage	1,950.0 cB	718.78 aA
Zero Tillage + Mulch	656.0 aA	2,600.0 cB
Tillage + Mulch	1,502.5 bA	1,737.5 bA
General Average	1594.06	
CV (%)	12.47	
DMS	391.83	

*Means followed by the same lower-case letter in the columns, did not present significant differences between treatments at 5% level of significance and means followed by the same capital letter in the lines, did not present significant differences between the varieties at the level of 5% of significance.

In other approach, it is documented that the zero tillage can reduce the input costs and labour, and conserve the soil, however it can lead to the negative effects on plant growth due to the soil compaction (Ewansiha, Udensi, and Kamara 2015). This affirmation is not in agreement with the results from the current study, where the high yield averages in both varieties (IT-16 and IT-18) were observed in the agronomic practices in which the zero tillage was used.

Correlation between variables

A positive relationship between the plant height, number of pods per plant, 100 seeds weight and grain yield were observed. However, the number of pods per plant and grain yield were not correlated. The relationship observed between hundred seeds weight and grain yield was positive, though it does not mean that an increment on the value of one will increase the value of the other one. This can be confirmed from the results of hundred seed weight (table 4) and grain yield (table 5), especially in the variety IT-18 where the mean of hundred seed weight was high in agronomic practice zero tillage, but then again registered lowest grain yield mean.

Table 6: Correlation between the different analyzed parameters with the grain yield.

Parameters	Plant height	Nº of pods per plant	Hundred seeds weight
Plant height			
Nº of pods per plant	0.669		
100 seeds weight	0.114	0.092	
Grain yield	0.010	-0.204	0.037

4. CONCLUSION

Based on the results, it can be concluded that in Gùrué District, Mozambique, the Cowpea grain yield is not only affected by the agronomic practices, but also by the varieties applied. Based on these findings, the usage of a combination of the varieties IT-16 and IT-18 in agronomic practice zero tillage and zero tillage + mulch respectively is recommended since they are the combinations which showed more greater results.

REFERENCES

A H, El-Shaieny A, Y Y Abdel-Ati, A M El-Damarany, and A M Rashwan. 2015. "Stability Analysis of Components Characters in Cowpea (Vigna Unguiculata (L.) Walp)." *Journal of Horticulture and Forestry* 7(2): 24–35. http://www.academicjournals.org/JHF.

Afuakwa, J J, and S.H.M Aikins. 2010. "Effect of Four Different Tillage Practices on Cowpea Performance." *World Journal of Agricultural Sciences* 6(6): 644–51.

Baeumer, K, and W A P Bakermans. 1973. "Zero-Tillage." *Advances in Agronomy* 25: 77–123.

Erenstein, Olaf. 2003. "Smallholder Conservation Farming in the Tropics and Sub-Tropics: A Guide to the Development and Dissemination of Mulching with Crop Residues and Cover Crops." *Agriculture, Ecosystems and Environment* 100(1–3): 17–37.

Ewansiha, Sylvester, Udensi Udensi, and Alpha Kamara. 2015. "Effect of Tillage on the Growth and Yield of Cowpea Varieties in Sudan Savanna Agroecology of Northern Nigeria." *Annual Research & Review in Biology* 5(3): 275–84. http://www.sciencedomain.org/abstract.php?iid=668&id=32&aid=6486.

Haruna, I. M., and A Usman. 2013. "Agronomic Efficiency of Cowpea Varieties (Vigna Unguiculata L. Walp) under Varying Phosphorus Rates in Lafia, Nasarawa State, Nigeria." *Asian Journal of Crop Science* 2(5): 209–2015.

Iruhvwu, Djulfxowxuh. 2015. "Production Guidelines for Cowpeas." *Department of Agriculture, Forestry and Fisheries, South Africa.* 1: 24.

Khaemba, R, J Kinama, and G Chemining'wa. 2017. "Effect of Tillage Practice on Growth and Yield of Three Selected Cowpea Varieties." *Journal of Experimental Agriculture International* 14(3): 1–11. http://www.sciencedomain.org/abstract/16494.

Maduakor, H. O., R. Lal, and O. A. Opara-Nadi. 1984. “Effects of Methods of Seedbed Preparation and Mulching on the Growth and Yield of White Yam (Dioscorea Rotundata) on an Ultisol in South-East Nigeria.” *Field Crops Research* 9(C): 119–30.

Mekonnen, Getachew, and Sharma JJ. 2016. “Growth and Yield Response of Cowpea (Vigna Unguiculata L. Walp.) to Integrated Use of Planting Pattern and Herbicide Mixtures in Wollo, Northern Ethiopia.” *Advances in Crop Science and Technology* 04(06). http://www.esciencecentral.org/journals/growth-and-yield-response-of-cowpea-vigna-unguiculata-l-walp-tointegrated-use-of-planting-pattern-and-herbicide-mixtures-in-wollon-2329-8863-1000245.php?aid=83077.

Olusanya, A. OLATUNJI et al. 2016. “Yield and Growth Characteristics of Cowpea (Vigna Unguiculata) as Affected by Prior Heat Stress and Nutrient Addition.” *African Journal of Agricultural Research* 11(43): 4269–76. http://academicjournals.org/journal/AJAR/article-abstract/CDFC79161373.

Polthanee, A., and S. Wannapat. 2000. “Tillage and Mulching Affect on Growth and Yield of Cowpea Grown Following Rice in the Post-Monsoon Season of Northeastern Thailand.” *Kasetsart Journal of Natural Science* 34(2): 197–204.

Putnam, By Dan, Steve Orloff, and Tracy Ackerly. 2000. “Agronomic Practices and Forage Quality.” *Changes*: 10–12.

Relation, L In, and Sunshine Duration. 2008. “Growth and Yield Response of Soybean.” 1(2): 45–50.

Science, Biological, S H M Aikins, and J J Afuakwa. 2008. “Growth and Dry Matter Yield Responses of Cowpea.” *ARPN Journal of Agricultural and Biological Science* 3(586): 50–54.

Unger, P. W., and T. M. McCalla. 1980. “Conservation Tillage Systems.” *Advances in Agronomy* 33(C): 1–58.

Walker, Tom, and Benedito Cunguara. 2016. “Avaliação Dos Rumos Da P & D Do Feijão Nhemba No Programa ‘ Feed the Future ’, Da USAID , Em Moçambique Em 2016.”