

Association of Organic and Mineral Fertilization on Crop Yield and Theoretical Cachaça in Sugarcane

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Abstract: We evaluated several organic fertilizers associated or not to mineral fertilizers, in the cane yield and theoretical sugarcane brandy in plant cane. The experimental design was randomized blocks, with nine treatments and four replications, constituted of: T1: Liming (1) + reactive rock phosphate (2) + chemical fertilizer (3); T2: 2 + 3; T3: 1 + 3 (control); T4: 1 + 2 + 3 + cattle manure (4); T5: 1 + 2 + 4; T6: 1 + 2 + 3 + chicken manure (5); T7: 1 + 2 + 5; T8: 1 + 2 + 3 + cane bagasse (6); T9: 1 + 2 + 6. It was applied the fertilizers in the following doses: cattle manure, 30 t ha⁻¹; chicken manure, 3.5 t ha⁻¹; cane bagasse, 24 t ha⁻¹; reactive rock phosphate, 400 kg ha⁻¹ and 120 kg ha⁻¹ of K₂O and P₂O₅, in the planting furrow. The limestone was distributed in the dose of 2.5 t ha⁻¹. The variety was used SP 79-1011. The cattle manure substituted the chemical fertilization of plant cane. The cane bagasse, when used as organic source should always be complemented with the chemical fertilization; there were no effect of treatments in the principal technological characteristics of the cane.

Key words: Sugarcane, organic manuring, liming, reactive phosphate, cachaça.

1. Introduction

In the State of Minas Gerais - Brazil, the production of handcrafted *cachaça* is of major importance for agribusiness, since according to the survey performed by Sebrae [1] there are around eighty five hundreds of stills responsible for about two hundred and forty thousand jobs, whether it be direct or indirect.

The use of organic matter for fertilizing sugarcane plantations destined for handcrafted production of *cachaça* may be an alternative for rural producers, since the consumption of products obtained through an organic or more sustainable manner is on the rise and becoming more and more appreciated, either by the internal or external market, which in fact may contribute for a bigger increase and development of

this sector.

This way, some residues of the producer unity itself may be used for organic fertilization, considering that in handcrafted production of still *cachaça* there is a huge amount of residue of sugarcane bagasse generated by the millstones, which are less efficient than the sugar and alcohol mills, extracting smaller volumes of juice, although leaving richer bagasse in terms of nutritional aspects, which is suitable for using as organic fertilizing. When evaluating the possibility of the use of bagasse as a soil amendment, verified increases on sugar yield with the application of 37 to 74 t ha⁻¹ decomposed bagasse, mainly due to the improvement of the physics properties of the soil, which enabled a better distribution of the plant root system [2]. Applied 120 t ha⁻¹ of sugarcane bagasse as a dead cover, and observed increases of up to 11 t cane.ha⁻¹, when compared to control, without the

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application of bagasse on the soil [3]. However, Zambello Jr & Orlando Filho cited by Orlando Filho and Silva [4], applying 2 t ha^{-1} of non humic bagasse in the planting furrow in different types of soil in the State of São Paulo, did not observe any effect of this residue on the sugarcane productivity, which would not make feasible its recommendation without the correct humification.

Other sources of organic fertilizers that may be used are cattle and chicken manure, since the southern region of Minas Gerais, as it is distinguished as the national's largest milk producer [5], produces huge amounts of manure, favoring the acquisition of such inputs. However, in Brazil there are few works that associate the utilization of bovine and chicken manure on sugarcane organic fertilization. Evaluating the effects of organic fertilizer and harvest date on quality of raw materials and agricultural yield of brown sugar and two varieties of cane sugar, it was found that fertilization with manure bovine and chicken showed the same results as chemical fertilizer [6]. Likewise Leite et al. [7], studying the yield of sugarcane fertilized with pig manure, it was found that the dose of 40 m^3 , the yield of stems yield was similar to that provided by chemical fertilizers, and at doses of 80, 120, 160 and 200 m^3 of pig manure, there was an increase in the productivity of sugarcane.

Some works have been developed in India, evaluating the effects of bovine manures. For instance, Andrade et al. [8] studied the effect of corral manure in the doses of 0 e 20 t ha^{-1} and mineral fertilization with N, P, K in doses of (0, 100, 150, 200 kg N; 0, 30, 60 kg P_2O_5 ; and 0, 30, 60 kg K_2O), and verified higher yields with manure application, although these values were higher with the application of 150 kg N and 60 kg $\text{P}_2\text{O}_5 \text{ ha}^{-1}$, applied isolated. The application of K_2O in a mineral form did not significantly increase yields.

Moreover, within this context about the utilization of organic fertilizers, the Normative Instruction N° 7 [9] allows the use of ground rocks as soil fertilizers and amendments, such as limestone and natural reactive

phosphate.

By this way, the main goal of this work was to evaluate the effect of the source of organic fertilization, associated or not with chemical fertilization, liming and phosphate application in the agronomic and sugarcane cachaça yields, in plant cane.

2. Material and Methods

2.1 Experimental Design, Treatments and Parcels

The experiment was initiated in March 2002, in the area within the "João Mendes-JM"-still, located in the city of Perdões, State of Minas Gerais-Brazil, which is characterized by having a Typic Haplustox Soil with intermediate texture (info concerning chemical analysis may be found in Table 1). The experiment was set in a randomized blocks design with nine treatments and 4 repetitions. Treatments consisted of organic and mineral fertilizers, and associations of both, as following: Liming + reactive rock phosphate + chemical fertilizer; reactive rock phosphate + chemical fertilizer; liming + chemical fertilizer (control); Liming + reactive rock phosphate + chemical fertilizer + cattle manure; Liming + reactive rock phosphate + cattle manure; Liming + reactive rock phosphate + chemical fertilizer + chicken manure; Liming + reactive rock phosphate + chicken manure; Liming + reactive rock phosphate + chemical fertilizer + cane bagasse; Liming + reactive rock phosphate + cane bagasse.

Liming was performed using 2.5 t ha^{-1} dolomitic limestone (CaO 36%, MgO 14%, PRNT 100%), according to CFSEMG [10], supplied before planting in the entire area of the experiment, except for the non-limestone treatment. Reactive rock phosphate used was the natural reactive phosphate Djebel Onk-Argélia (total levels of 29% P_2O_5 and 35% CaO), supplied in as much as 400 kg ha^{-1} into the planting furrow. Chemical fertilization during planting was performed with $120 \text{ kg ha}^{-1} \text{ K}_2\text{O}$ and $120 \text{ kg ha}^{-1} \text{ P}_2\text{O}_5$, applied into the furrow, as recommended by CFSEMG [10], using potassium hydrochloride and simple superphosphate pre-mixed in a concrete mixer machine for better

Table 1 Chemical features of the soil in the experimental area, between 0-20 cm depths.

Description	Units	Levels
Al	cmol dm ⁻³	0.6
Ca	cmol dm ⁻³	0.3
MG	cmol dm ⁻³	0.1
K	mg dm ⁻³	17
P	mg dm ⁻³	0.6
H + Al	cmol dm ⁻³	4.5
SB	cmol dm ⁻³	0.4
T	cmol dm ⁻³	1.0
T	cmol dm ⁻³	4.9
M	(%)	58
V	(%)	8.9
M.O	dag kg ⁻¹	3.1
pH	-	5.4

Analyses performed by the Soil Fertility Lab from Soil Sciences Department of the Federal University of Lavras-UFLA. P and K: extractor Mehlich-1; Ca, Mg and Al: extractor KCl 1 N; H + Al extracted with calcium acetate 1N, pH 7.0.

homogenization. Nitrogen fertilization was neither performed during planting nor during covering. Cattle manure was applied in as much as 30 t ha⁻¹, and chicken manure as a total of 3.5 t ha⁻¹, both wet basis, in the planting furrow [10]. Their chemical analysis may be found in Table 2.

Cane bagasse, obtained in JM still, was applied in a wet basis in a total of 24 t ha⁻¹, without placing a great volume within the furrow, which could make the planting too shallow. Chemical analysis of the utilized cane bagasse may be found in Table 2.

Sugarcane plants of cultivar SP 79 1011 used for the experiments are characterized as having good tillering capacity and good interlines covering, high agronomic yield, intermediate soil demand, semi-early maturation, high sucrose content, low fiber content, absence of lodging, absence of flowering and pith process [11].

Experimental parcels consisted of six sugarcane lines, with 1.4 m spacing and 12 meters width. Total area of the parcel was 100.8 m². Four central lines were considered as the useful area of each parcel, totalizing 67.2 m².

In order to avoid the interference of previous fertilizations, mainly from chemical fertilizers, we chose to use a resting area, which was cultivated with

Table 2 Results from chemical analyses of sugarcane bagasse, corral and chicken manure used in the experiment.

Material	C/N	Humidity	N P K Ca Mg S					
			%					
Bagasse	158	75	1.69	0.16	0.11	0.21	0.16	0.29
Corral manure	23	60	1.10	0.80	1.80	1.60	0.50	0.10
Chicken manure	12	45	2.10	0.90	1.20	2.10	0.30	0.15

Analyses performed by the Soil Fertility Lab from Soil Sciences Department of the Federal University of Lavras-UFLA. Data are presented based on dry matter.

brachiaria grass (*Brachiaria decumbens* Stapf), with no fertilizer management for at least three year before planting. After the conventional preparation of the soil, with plowing and grading harrowing, the sugarcane planting was performed in March 2002, in depths ranging from 20 to 30 cm, with a two lines furrower, and 1.4 spacing among them.

Weed control was performed through manual hoe, while the control of pests was not necessary and therefore not done. Harvest was manually performed without burning the sugarcane plantation, in August 2003.

2.2 Characteristics Studied

2.2.1 Number of Culms per Meter

After 40 days planting (initial stand) and by occasion of harvest, counting of culm numbers in the useful area of each parcel was performed, for further calculation of the mean number of culms per meter.

2.2.2 Mean Culm Yield per Hectare

Culm yield was obtained during harvest, in August 2003, according to the methodology described by Mariotti & Lascano, cited by [12].

2.2.3 Sugarcane Juice Yield per Ton of Cane

For calculating the juice yield per ton of cane, fifteen culms were harvested in a line up, for each of the lines in the useful area, totalizing 60 culms, and the grinding of the sheaf was performed in order to obtain the volume of sugarcane juice in liters. Further, after weighting and measuring the volume of the 60 culms, we proceeded with the transformation of these data in liters of juice per ton of cane.

2.2.4 Sugarcane Juice Yield per Hectare

Knowing the yield of tons of cane per hectare and the sugarcane yield per tons of cane, the juice yield per hectare was then calculated.

2.2.5 Chemical-technological Analyses of Sugarcane

Due to the harvest, 12 culms were cut off in the line of the useful area of each parcel, excluding the leaf roll and the straw. After identification, culms were sent to the laboratory of the Coimbra-Luciânia Mill, in Lagoa da Prata, State of Minas Gerais, for the determination of fiber content (%) cane, Pol (%) cane, RS (%) cane and Purity (%) cane [11], and also for calculation of TPH values.

2.2.6 Theoretical Yield of Cachaça per Ton and per Hectare

Calculations for the theoretical yield of cachaça were based on the yield of alcoholic fermentation [13]. After obtaining the theoretical yield of cachaça per tons of cane, and the yield of cane per tons per hectare, the yield of cachaça per hectare was calculated.

2.2.7 Statistical Analyses

Parameters evaluated were submitted to variance analyses as proposed by Gomes [14] for randomized blocks experimental designs.

3. Results and Discussion

3.1 Mean Number of Culms

As it may be observed in Table 3, organic fertilizers used in the trial, either associated or not the chemical fertilizers proportioned similar values to the number of tillers in the 40th day (initial stand), and during harvest (final stand), except for the treatment that had bagasse as a source of organic matter, which showed lower number of culms per meter, however, when it was complemented with chemical fertilization, plants recovered their capacity to tillering, becoming similar to the rest of the treatments. The cultivar chosen for this study, which typically has intermediate requirements for soil fertility, had its tillering capacity decreased, due probably to nutritional limitations.

Table 3 Mean values obtained for number of tillers per meter 40 days after planting and during harvest and culm yield for treatments, for plant cane.

Treatments	Culm number per meter 40 dap harvest		Mean culm yield (t ha ⁻¹)
L + RP + CF	9.74 a	11.36 a	75.08 a
RP + CF	9.38 a	11.58 a	81.66 a
L + CF (Control)	9.70 a	11.90 a	84.98 a
L + RP + CF + CM	10.42 a	12.38 a	89.37 a
L + RP + CM	10.11 a	11.97 a	82.82 a
L + RP + CF + CM	10.58 a	11.98 a	96.75 a
L + RP + CM	9.94 a	12.23 a	86.42 a
L + RP + CF + B	10.06 a	12.16 a	89.47 a
L + RP + B	7.96 b	10.42 b	51.32 b
CV (%)	10.01	3.93	16.88

L: Liming; RP: Reactive phosphate; CF: Chemical fertilization; CM: Corral manure; CM: Chicken manure and B: Bagasse. Means followed by similar lower-case letters in the column do not differ among themselves through the Scott-Knott test at 5% probability.

Zotareli [15] studied liming and plastering applied isolated or combined in sugarcane cultivation, and concluded that the presence of limestone increased initial sprouting in sugarcane plantation. Nevertheless, the results found by our study are more likely to confirm the results achieved by Dhillon et al. [16], which did not report the influence of limestone application in the initial sugarcane sprouting either.

3.2 Culm Yield

As shown in Table 3, bagasse does not substitute chemical fertilization during planting, opposite to cattle and chicken manure, which propitiated similar results to chemical fertilization in terms of culm yield. When bagasse was applied in the planting furrow aiming its utilization as a source of organic fertilization, mineral complementation was necessary for achieving satisfactory levels of productivity, as it has already been reported in a previous work performed by Zambello Jr. & Orlando Filho, and cited by Orlando Filho and Silva [4], who did not observe any effect of bagasse in sugarcane productivity when applied in the planting furrow.

The results obtained for culm yield with the use of corral manure were not statistically different from those obtained by chemical fertilization, differently from what was reported by some works developed in India [17-20], which showed increases on yield with the application of manure when compared to chemical fertilization. In Brazil [6], evaluating the effects of organic fertilizer and harvest date on quality of raw materials and agricultural yield of brown sugar and two varieties of cane sugar, it was found that fertilization with manure bovine and chicken showed the same results as chemical fertilizer. Likewise, Leite et al. [7] studying the yield of sugarcane fertilized with pig manure, it was found that the dose of 40 m³, the yield of stems yield was similar to that provided by chemical fertilizers, and at doses of 80, 120, 160 and 200 m³ of pig manure, there was an increase in the productivity of sugarcane.

The basic requirement of the cultivar regarding soil fertility is an important factor that has to be taken into account. In our study, organic fertilization resulted in yields similar to mineral nutrition for a cultivar of intermediate requirements, as it is the case of 'SP79-1011'. The use of a demanding cultivar, in a favorable environment may result in different overcomes of those achieved by this work.

Application of reactive rock phosphate did not result in increases on culm yield for plant cane (Table 3), which is consistent with the results obtained by the work of Cantarella et al. [21], where the authors evaluated mixes with different proportions of natural reactive phosphate and water soluble phosphate for sugarcane, and concluded that they had no effect in culm or sugar productivity.

With regard to liming, the mean culm yield was not statistically different with or without limestone application, which is similar to the results obtained by Azeredo et al. and Hermann [22, 23]. This may be explained due to the fact that sugarcane is relatively tolerant to aluminum and soil acidity [24] although this

feature may vary due to the genetic variability or in relation to the cultivar used in the study.

Marinho and Albuquerque [25] evaluated more than twenty field trials with the application of dolomitic limestone in sugarcane and observed that for most of the trials there were significant increases in culm increases due to limestone application. Similar results were obtained by Morelli et al. and Zotareli [26, 15].

Treatments without liming received, in its turn, 400 kg ha⁻¹ of reactive phosphate (35% CaO), supplying approximately 140 kg ha⁻¹ calcium oxide. Although reactive phosphate does not play a corrective action in the soil, it may have supplied calcium needs in the plant, equalizing with the treatments where limestone was applied, which could explain the similarity between treatments that received or not liming.

3.3 Fiber

As shown in Table 4, fiber levels were not affected with the application of the following treatments: corral manure + liming + reactive phosphate; chicken manure + liming + reactive phosphate, associated or not with mineral fertilizing and with or without the use of liming.

Table 4 Mean values obtained for fiber, reductor sugars and theoretical recoverable sugar, for treatments applied in plant cane.

Treatments	Fiber (%) cane	RS (%) cane
L + RP + CF	13.52 a	0.31 a
RP + CF	13.16 a	0.35 a
L + CF (Control)	13.06 a	0.37 a
L + RP + CF + CM	13.27 a	0.33 a
L + RP+ CM	13.43 a	0.37 a
L+ RP + CF + CM	13.08 a	0.40 a
L + RP+ CM	13.12 a	0.35 a
L + RP+ CF + B	13.57 a	0.35 a
L + RP + B	14.15 b	0.33 a
CV (%)	2,94	12,88

L: Liming; RP: Reactive phosphate; CF: Chemical fertilization; CM: Corral manure; CM: Chicken manure and B: Bagasse. Means followed by similar lower-case letters in the column do not differ among themselves through the Scott-Knott test at 5% probability.

The only treatment that showed increments on fiber levels and, therefore, was superior to the others consisted of liming + reactive phosphate + sugarcane bagasse.

Concerning liming, similar results were achieved by Rolim [27] who also did not verify the influence of limestone application in sugarcane fiber levels. However, these results are in disagreement with the findings of Vargas [28], who evaluated the application of limestone in different depths and its effect on soil and in sugarcane crop and observed a reduction in fiber levels.

3.4 Reductor Sugars

This parameter (RS) shows the values of glucose and fructose content in sugarcane, which were not statistically different for all sources of fertilizers applied. The use of organic fertilization in the form of corral manure, chicken manure and sugarcane bagasse along with liming plus reactive phosphate, associated or not with chemical fertilization, did not promote significant shifts on sugar reductor values in plant cane. Similar results were obtained for isolated applications of reactive phosphate or for liming.

The overcomes obtained for liming are not in agreement for those observed by Vargas [28] who applied limestone in two depths and two forms of application, incorporated with harrow at 20 cm and plough at 40 cm, and reported a reduction on reductor sugar levels in response to limestone application, when compared to the non-application treatment.

The use of limestone, beyond regulating soil pH, stimulates the supplying and equilibrium between calcium and magnesium for the soil. Although the soil the experiment was conducted is relatively poor in calcium and magnesium content (Table 1), treatments that received correction of calcium and magnesium through limestone application did not influence reductor sugars levels in plant cane, when compared to the ones that did not receive such correction. However, Barrows and Drosdoff [29], reported that nourishment

disequilibrium existent between the cations calcium, magnesium and potassium, may be responsible for the accumulation or reduction of sucrose content, as a consequence of an increase of fiber and reductor sugars levels.

3.5 Pol (%) Cane

Table 5 shows that the application of corral manure + liming + reactive phosphate; chicken manure + liming + reactive phosphate; and bagasse + liming + reactive phosphate, associated or not with chemical fertilizing, as well as the use of reactive phosphate or liming, did not result in significant changes in pol (%) cane levels, for plant cane.

Results found by this work, with the use of organic fertilization in the form of corral manure differs from those achieved by Nema et al. [17] in India, which associated the organic fertilization in the form of corral manure, isolated or with filter pie, with mineral fertilization, verified a diminishment of pol (%) cane levels with the application of isolated mineral fertilizer, and increases on pol (%) cane levels when they used organic fertilizers associated or not to chemical

Table 5 Mean values obtained for pol and purity (%) cane levels and for ton pol per hectare, for treatments applied in plant cane.

Treatments	Pol (%) cane	Purity cane (%)	TPH
L + RP + CF	17.81 a	90.65 a	13.25 a
RP + CF	17.61 a	89.83 a	14.29 a
L + CF (Control)	17.50 a	89.17 a	14.84 a
L + RP + CF + CM	18.00 a	90.14 a	16.08 a
L + RP+ CM	17.35 a	88.77 a	14.40 a
L+ RP + CF + CM	17.24 a	87.97 a	16.53 a
L + RP+ CM	17.59 a	89.68 a	15.21 a
L + RP+ CF + B	17.33 a	89.40 a	15.52 a
L + RP + B	17.36 a	89.57 a	8.93 b
CV (%)	2.46	1.73	17.30

L: Liming; RP: Reactive Phosphate; CF: Chemical Fertilization; CM: Corral Manure; CM: Chicken Manure and B: Bagasse. Means followed by similar lower-case letters in the column do not differ among themselves through the Scott-Knott test at 5% probability.

fertilization. Vijav and Verma [30] studied the isolated and the combined effect of organic and mineral fertilizers, and noticed that the application of inorganic fertilizers combined with organic fertilizers resulted on significant increases in pol (%) cane levels. With regard to liming, Rolim [27] achieved similar results for plant cane, first and second ratooning, in agreement with the results found by this present work.

3.6 Cane Purity

Purity indicates the percent of apparent sucrose from soluble solids. As shown in Table 5, there was no difference among treatments. This way, the use of corral manure + reactive phosphate + liming; chicken manure + reactive phosphate + liming; and bagasse + reactive phosphate + liming, applied either separated or complemented with chemical fertilization did not influence cane purity (%) for plant cane.

The application or non-application of liming did not influence sugarcane purity (%) either, in agreement with the achievements of Vargas [28], who verified the positive influence of limestone in the technological characteristics of sugarcane, considering cane purity (%) one of them.

3.7 Mean Sugar Yield (pol ha⁻¹)

Treatments which consisted of organic fertilization from corral and chicken manure isolated or in association with chemical fertilization, and with or without the application of liming and reactive phosphate, propitiated means statistically similar to yield of pol.ha⁻¹, expressed in TPH, except for the treatment liming + reactive phosphate + bagasse, which had statistically lower means in comparison to the other treatments, as shown in Table 5. However, when associated with chemical fertilization, it reached yields similar to TPH, concerning the other treatments.

TPH yields are directly related to the values obtained for pol (%) and yield. ha⁻¹. Although pol (%) yields were similar for all the different sources of fertilization (Table 5), mean culm yield obtained for t of cane ha⁻¹

were lower for the treatment consisting of application of liming + reactive phosphate + sugarcane bagasse for plant cane (Table 6), which explains the differences observed for TPH values.

3.8 Juice Yields (L t⁻¹ and L ha⁻¹)

There was no difference among treatments for juice yield in L t⁻¹, as shown in Table 6. One of the factors that may explain the volume of juice extracted is the quantity of fibers present in sugarcane, that is, the higher the level of fiber the higher the difficult for the crusher to extract culm's juice, and therefore a smaller volume of juice is extracted.

Although the quantity of fiber was higher in the treatment that received liming + reactive phosphate + bagasse, without complementation of chemical fertilization, such difference was not reflected in the final juice volume extracted per ton of cane for plant cane.

Another factor that may interfere on volume of juice extracted is the type and quality of crusher used in the process. According to Sales [31], in sugar mills, distilleries and large-scale cachaça producers, the capacity of crusher extraction surpassed 90%. Crushers

Table 6 Mean values obtained for juice yield in liters per ton and per hectare (plant cane) for the treatments applied.

Treatments	Juice yield (L t ⁻¹)	Juice yield (L ha ⁻¹)
L + RP + CF	520.84 a	39,228.92 a
RP + CF	514.25 a	41,807.17 a
L + CF (Control)	519.80 a	44,337.97 a
L + RP + CF + CM	535.77 a	47,863.68 a
L + RP+ CM	523.05 a	43,407.49 a
L+ RP + CF + CM	528.60 a	51,121.37 a
L + RP+ CM	539.01 a	46,541.22 a
L + RP+ CF + B	526.38 a	47,133.55 a
L + RP + B	513.15 a	26,388.06 b
CV (%)	3.17	17.25

L: Liming; RP: Reactive Phosphate; CF: Chemical Fertilization; CM: Corral Manure; CM: Chicken Manure and B: Bagasse. Means followed by similar lower-case letters in the column do not differ among themselves through the Scott-Knott test at 5% probability.

that do not have pressure regulators are the most common in small properties, extracting about 60 to 70 % juice, and in some cases, even less than this. Culms crushing was performed in a simple crusher, type VM 9 ½ × 14, used in the still João Mendes for juice extraction in cachaça production, which is consistent with the reality for most of the producers of the region, obtaining maximum extraction levels of about 53.9%.

Regarding juice yield in L ha⁻¹, according to the data shown in Table 6, it is observed that the treatment consisting of application of bagasse + reactive phosphate + liming resulted in lower culm yield when compared to the remaining treatments, whereas they were not different among themselves for this parameter. According to results shown in Table 3, the treatment consisting of liming + reactive phosphate + bagasse has also propitiated better culm yield, which may have directly reflected on juice yield in liters per hectare.

3.9 Theoretical Cachaça Yield (L t⁻¹ and L ha⁻¹)

Cachaça yield was similar for all treatments, which led us to conclude that organic fertilization in the form of corral manure + reactive phosphate + liming; chicken manure + reactive phosphate + liming; sugarcane bagasse + reactive phosphate + liming, associated or not to chemical fertilization, did not statistically differ in theoretical cachaça yield per ton of cane, as well as the application or non-application of limestone did not influence this trait either, as shown in Table 7. Pol (%) cane and juice yield per ton of cane values, either for plan cane or ratoon, were not significantly influenced by the various treatments, as it may be inferred from data found on Tables 5 and 6. It may explain the similarity among values obtained for theoretical cachaça yield per ton of cane, which are closely related to the values of Pol (%) cane (which indicates apparent sucrose content that will be converted into ethanol through fermentation) and juice yield, what was similar for all treatments.

Table 7 Mean values obtained for juice yield, in liters per ton and per hectare (plant cane) for the treatments applied.

Treatments	Theoretical cachaça yield (L t ⁻¹ cane)	Theoretical cachaça yield (L ha ⁻¹ cane)
L + RP + CF	113.25 a	8,534.85 a
RP + CF	111.05 a	9,024.85 a
L + CF (Control)	112.27 a	9,568.44 a
L + RP + CF + CM	117.46 a	10,483.10 a
L + RP+ CM	113.30 a	9,398.97 a
L+ RP + CF + CM	114.25 a	11,048.36 a
L + RP+ CM	116.38 a	10,046.90 a
L + RP+ CF + B	113.37 a	10,153.96 a
L + RP + B	110. 21 a	5,671.33 b
CV (%)	3.43	17.11

L: Liming; RP: Reactive Phosphate; CF: Chemical Fertilization; CM: Corral Manure; CM: Chicken Manure and B: Bagasse. Means followed by similar lower-case letters in the column do not differ among themselves through the Scott-Knott test at 5% probability.

Concerning cachaça yield in L ha⁻¹, Table 7 shows that the treatment consisting of bagasse application + liming + reactive phosphate, without the complementation with mineral fermentation, resulted in a better theoretical cachaça yield per hectare for plant cane. It is important to consider that this treatment also propitiated better culm and juice yield per hectare, which resulted in a better theoretical cachaça yield per hectare.

4. Conclusions

Chemical fertilization during planting may be replaced by corral and chicken manure, resulting in similar agronomic and cachaça yields.

Sugarcane bagasse, when used as organic source of fertilization and applied on the planting furrow must be complemented with chemical fertilization during planting.

There was no effect of organic fertilizers applied into the planting furrow, associated or not with chemical fertilization, on the productivity and on the main sugarcane technological characteristics for plant cane.

Liming and phosphate application did not cause great differences on culm and theoretical cachaça yield for plant cane.

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