





## Sources and rates of poultry litter and basalt powder in the production of pear Cascatense on quince 'CP'

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### Abstract

The nutritional state of cultivated plants can be influenced, due to the poultry litter doses and basalt powder, thus affecting its proper growth. This work aimed to evaluate the nutritional efficiency of pear, cultivated in different poultry litter doses and basalt powder. The experiment was conducted in the orchard of the fruit growing in south of Brazil, in 2010, spaced 2.5 x 0.5 m, with the following treatments in the planting hole and reapplied in August of 2012: T1) without fertilization; T2) 2 kg of poultry litter; T3) 2 kg of poultry litter + 2 kg of basalt powder; T4) 4 kg of poultry litter; T5) 4 kg of poultry litter + 2 kg of basalt powder. Samples of the root system, and the shoot segmented in side branches and trunk were collected in January / 2014 (1,190 days) for chemical analysis of nutrient content and dry matter. With these results were calculated the indexes: absorption efficiency; transport efficiency and nutrient utilization efficiency. The treatment 4 kg of poultry litter, result in a higher absorption efficiency ratio for N, and higher utilization efficiency index for S. The transport efficiency suffered a little variation due to the used doses.

**Keywords:** mineral absorption, nutritional efficiency, *Pyrus* sp.

### Introduction

The definition of nutritional efficiency is directly related to absorption which indicates the ability of plants to "extract" nutrients through crops (Rozane et al., 2007). The mechanisms developed by plants that are related to the absorption efficiency differ between species and cultivars (Martinez et al., 1993; Fageria & Baligar, 1993). Some species produce extensive root system, in the same proportion that others have high absorption rate per unit length of root, i.e., high influx of nutrients (Föshe et al., 1988); of transport which indicates the ability to convert the absorbed nutrient into dry matter; and the utilization that is the plant capacity to redistribute and reutilize the mineral elements, showing the efficiency of the use in the metabolism of the growth process (Siddiqi & Glass, 1981). For aggregation in this way, the optimization of nutritional efficiency is an essential option, not only to increase productivity and reduce production costs, but

also for a more sustainable agricultural practice and less impact on nature (Grohskopf et al., 2015).

Associated with nutritional efficiency is the use of organic waste. The use of organic residues in the fertilization of crops, can add several benefits in the chemical, physical and biological characteristics of the soil, in addition to not being considered a source of environmental pollution, ensuring nutrients for the soil-plant system (Cassol et al., 2012; Lourenzi et al., 2013; Mafra et al., 2014; Grave et al., 2015; Hentz et al., 2016).

Several studies have evidenced the diversified use of organic residues in different cultures, application pigs, in the culture of corn and oats (Grohskopf et al., 2015); use of chicken and urea litter in pineapple culture (Leonardo et al., 2013); use of chicken litter, interfering with soil attributes (Valadão et al., 2011). There is an increase in the use of rock dust, or use of crushed rocks in agriculture, combining benefits for the soil and plant

(Loureço Júnior, 2011; Welter et al., 2011; Camargo et al., 2012; Melo et al., 2012; Silva et al., 2012).

Countless works, seeing involved in the scope of quantifying the need of nutrientes of the culture. Mattar et al. (2018), evaluates the growth, accumulation and export of nutrientes in passion fruit. Perazzoli et al. (2020) notes the influence of biofertilizers, communicated in the pear culture, affecting the availability of nutrientes in the plant, other crops such as the pear tree, through export and immobilization (Verlindo et al., 2014).

According to Amaral et al. (2011), when studying the culture of coffee, he highlights that the science of nutrient contents in various organs, is correlated with metabolic requirements, which implies the responses of

vegetables.

In view of this, this research aimed to study the efficiency of absorption, transport and use of nutrients from different nutritional sources.

### Material and Methods

The experiment was conducted in the orchard of the fruit growing sector of the Department of Agronomy at the Universidade Estadual do Centro-Oeste, Guarapuava-PR, south of Brazil, under the 25°23'01.6"S 51°29'37.0"W, and altitude of 1024 meters.

Soil sampling conducted in May of 2010 before the treatments implementation are presented in Table 1.

**Table 1.** Chemical soil analysis, at depths of 0-20 cm and 20-40 cm, before the treatments implementation (May of 2010), in an orchard of pears cv. Cascatense on quince 'CP' (Guarapuava-PR, Brazil).

| Layer | K <sup>+</sup>                                 | Ca <sup>2+</sup> | Mg <sup>2+</sup> | Al <sup>3+</sup> | P <sup>1</sup>                | MO                           | pH                | V    | Fe  | Cu  | Mn   | Zn  |
|-------|--|------------------|------------------|------------------|-------------------------------|------------------------------|-------------------|------|---|-----|------|-----|
| cm    | ----- cmol <sub>c</sub> dm <sup>-3</sup> ----- |                  |                  |                  | Mg <sub>dm<sup>-3</sup></sub> | g <sub>dm<sup>-3</sup></sub> | CaCl <sub>2</sub> | %    | ----- mg <sub>dm<sup>-3</sup></sub> ----- |     |      |     |
| 0-20  | 0.12   | 5.2              | 1.8              | 0.0              | 5.7                           | 40.3                         | 5.5               | 65.5 | 82.4                                      | 1.1 | 52.4 | 1.0 |
| 20-40 | 0.11   | 3.8              | 2.3              | 0.0              | 2.5                           | 34.9                         | 5.7               | 63.2 | 75.0                                      | 0.8 | 61.2 | 1.2 |

<sup>1</sup>Phosphorus extracted by Mehlich-1.

The poultry litter was performed after the departure of birds, with 52 weeks of accommodation, when was taken a sample for chemical analysis and material characterization (Table 2). The basalt powder

was collected in the basaltic gravel with the production mill and the chemical analysis and grain size are in Table 3, according to Sékula (2011).

**Table 2.** Chemical composition of the used poultry litter (Guarapuava-PR).

| MO <sup>1</sup>                 | RM <sup>2</sup> | N    | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O | CaO   | MgO  | S    | Zn   | Mn   | Fe    | Cu    | B      |
|---------------------------------|-----------------|------|-------------------------------|------------------|-------|------|------|------|------|-------|-------|--------|
| ----- % -----                   |                 |      |                               |                  |       |      |      |      |      |       |       |        |
| ----- mg kg <sup>-3</sup> ----- |                 |      |                               |                  |       |      |      |      |      |       |       |        |
| 77.03                           | 30.93           | 2.25 | 4.68                          | 3.03             | 12.42 | 0.89 | 0.23 | 0.22 | 0.07 | 11.33 | 95.68 | 301.90 |

<sup>1</sup>Organic Matter; <sup>2</sup>Mineral residue.

**Table 3.** Chemical and particle size characterization of the used basalt powder<sup>1</sup> (Guarapuava-PR).

| Extrator                        | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O | Ca                | Mg                 | Fe              | Mn   | Cu | Zn |
|---------------------------------|-------------------------------|------------------|-------------------|--------------------|-----------------|------|----|----|
| ----- % -----                   |                               |                  |                   |                    |                 |      |    |    |
| ----- mg kg <sup>-1</sup> ----- |                               |                  |                   |                    |                 |      |    |    |
| CNA <sup>2</sup>                | 0.12                          | 0.05             | 0.34              | 0.15               | 296             | 48   | 52 | 12 |
| Water                           | 0.10                          | 0.03             | 0.04              | 0.01               | 132             | 00   | 00 | 4  |
| CNA+water                       | 0.22                          | 0.08             | 0.38              | 0.16               | 428             | 48   | 52 | 16 |
| Sieves                          | 20 (>850 µm)                  |                  | 50 (850 - 300 µm) | 120 (300 - 125 µm) | fundo (<125 µm) |      |    |    |
| ABNT                            | 25.4%                         |                  | 43.3%             | 25.9%              |                 | 5.4% |    |    |

<sup>1</sup>Fertilizer Laboratory and Concealer FCA-UNESP, Botucatu-SP, <sup>2</sup>Ammonium Citrate Neutral.

The treatments were consisted by five different doses and sources of nutrients for plants: T1) without fertilization; T2) 2 kg of poultry litter; T3) 2 kg poultry litter + 2 kg of basalt powder; T4) 4 kg of poultry litter; T5) 4 kg of poultry litter + 2 kg of basalt powder. The treatments applications were in the holes, in September of 2010, with dimensions of 0.50 x 0.50 x 0.50m. After two years of planting was carried out the same topdressing fertilizing under the canopy. The experimental design was randomized blocks, with five replications and each plot consisted by five plants. All cultural practices adopted were those recommended for the pear culture in Brazil (Centellas-Quezada et al., 2003).

The pear seedlings cultivar Cascatense grafted on rootstock quince 'CP' (*Cydonia oblonga*) with pear filter 'FT', planted in September 2010, with spacing 2.5 x 0.5 and conducted in Central Leader system with close canopy and drip irrigation.

For the roots dry mass quantification, a trench was opened with 0.50 x 0.50 x 0.50 m of the plot around the trunk, with shovel-cutter aid, removing carefully the root system of each plant. Then the roots were washed with tap water over screens, weighed and placed in a drying oven. Sectioned in the neck region, the plant was segmented in roots and shoots, divided into branches and trunk. All material was washed in running water,

removing the soil and other debris, kept in forced air oven 65°C, until constant weight. Subsequently were obtained the weights of the root system (MSSR), trunk (MSTR), the lateral branches (MSRL) and total plant (MSTP) in kg ha<sup>-1</sup>. After the samples were ground using a Wiley mill and sieve with 1 mm mesh. The samples were collected at 650 days after planting (July 15<sup>th</sup> of 2012), 830 days after planting (January 15<sup>th</sup> of 2013), the 1010 days after planting (July 15<sup>th</sup> of 2013) and 1190 days after planting (January 15<sup>th</sup> of 2014). Each sample was consisted by one plant per experimental plot. Mineral determinations were carried out according to the methodologies described in Empresa Brasileira de Pesquisa Agropecuária- EMBRAPA (2009).

From the dried mass and the content of nutrients in plants, were calculated the indexes: a) absorption efficiency = (total accumulation of nutrients in the plant) / (dry weight of roots) (Swiader et al., 1994); transport efficiency of the nutrients from the root to the shoot = 100 x (nutrient accumulation in shoots) / (accumulation of total nutrient by the plant) (Li et al., 1991); and the efficiency of

nutrient utilization = (total dry matter produced)<sup>2</sup> / (total accumulation of nutrient in plants) (Siddiqi & Glass, 1981).

The data were submitted to variance analysis, and when significant ( $\alpha = 0,05$ ), and the means comparison by the Student Newman-Keuls test using ASSISTAT program, version 7.6 beta (SILVA, 2015).

## Results and Discussion

The treatment 4 kg of poultry litter increase N absorption efficiency (Table 4). With regard to the shoot transport (Table 5) and utilization (Table 6) efficiency, the treatments showed no effect.

The absorption (Table 4) and the utilization (Table 6) efficiency for P, was negligible among treatments. But in the transport efficiency, the treatment 4 kg of poultry litter + 2 kg of basalt powder had the lowest rate. For Marschner (1995), the reduction of phosphorus transported to the aerial part of the plant can affect the nutrient supply to the photosynthetically active sites. Among the factors that may be related to this low translocation rate are the nutritional state of the root cells and transpiration rate.

**Table 4.** Absorption efficiency of macronutrient by the pear cultivar Cascatense on 'CP', due to poultry litter doses and basalt powder at 1190 days after planting.

| Treatments                                     | N                                  | P                  | K                   | Ca                  | Mg                 | S <sup>1</sup> |
|--|------------------------------------|--------------------|---------------------|---------------------|--------------------|----------------|
|  | g nutrient / kg of root dry matter |                    |                     |                     |                    |                |
| Unfertilized                                   | 10.84 b*                           | 0.84 <sup>ns</sup> | 11.39 <sup>ns</sup> | 11.34 <sup>ns</sup> | 3.12 <sup>ns</sup> | 0.83 a**       |
| 2 kg of poultry litter                         | 8.49 b                             | 0.83               | 16.75               | 8.56                | 2.53               | 0.43 b         |
| 2 kg of poultry litter + 2 kg of basalt powder | 9.90 b                             | 0.75               | 15.89               | 9.55                | 2.73               | 0.51 b         |
| 4 kg of poultry litter                         | 15.63 a                            | 0.89               | 17.82               | 12.66               | 3.16               | 0.32 b         |
| 4 kg of poultry litter + 2 kg of basalt powder | 9.93 b                             | 0.92               | 15.66               | 9.44                | 2.77               | 0.40 b         |
| C.V. (%)                                       | 23,19                              | 25,14              | 24,69               | 25,27               | 10,91              | 32,03          |

\*\* and \* and <sup>ns</sup> - Significant to 1% and 5% probability and not significant, respectively. Means followed by the same letter vertically, are not statistically different from each other, by the Student Newman-Keuls test. <sup>1</sup>Transformed Date.

**Table 5.** Transport efficiency of macronutrients by the pear cultivar Cascatense on 'CP', due to poultry litter doses and basalt powder at 1190 days after planting.

| Treatments                                     | N                   | P        | K                   | Ca                  | Mg                  | S                   |
|--|---------------------|----------|---------------------|---------------------|---------------------|---------------------|
|  | %                   |          |                     |                     |                     |                     |
| Unfertilized                                   | 67.76 <sup>ns</sup> | 68.07 a* | 59.66 <sup>ns</sup> | 40.70 <sup>ns</sup> | 47.76 <sup>ns</sup> | 61.61 <sup>ns</sup> |
| 2 kg of poultry litter                         | 71.21               | 63.35 a  | 66.97               | 56.98               | 55.54               | 58.93               |
| 2 kg of poultry litter + 2 kg of basalt powder | 69.32               | 66.82 a  | 66.96               | 54.87               | 54.64               | 77.13               |
| 4 kg of poultry litter                         | 64.70               | 72.48 a  | 68.00               | 40.11               | 59.52               | 74.27               |
| 4 kg of poultry litter + 2 kg of basalt powder | 66.48               | 52.47 b  | 57.59               | 43.35               | 53.21               | 38.31               |
| C.V. (%)                                       | 15.96               | 10.99    | 14.83               | 17.96               | 13.99               | 32.82               |

\* and <sup>ns</sup> - Significant at 5% probability and not significant respectively. Means followed by the same letter vertically, are not statistically different from each other, by the Student Newman-Keuls test.

**Table 6.** Utilization efficiency of macronutrients by pear cultivar Cascatense on 'CP', due to poultry litter doses and basalt powder at 1190 days after planting.

| Treatments                                     | N  | P                  | K                  | Ca                 | Mg                 | S <sup>1</sup> |
|--|--|--------------------|--------------------|--------------------|--------------------|----------------|
|  | (dry matter) <sup>2</sup> kg/ g nutrient accumulated |                    |                    |                    |                    |                |
| Unfertilized                                   | 0.61 <sup>ns</sup>                                   | 8.26 <sup>ns</sup> | 0.56 <sup>ns</sup> | 0.59 <sup>ns</sup> | 2.15 <sup>ns</sup> | 3.39 b         |
| 2 kg of poultry litter                         | 1.00   | 10.92              | 0.51               | 0.95               | 3.16               | 6.63 b         |
| 2 kg of poultry litter + 2 kg of basalt powder | 1.25   | 14.73              | 0.73               | 1.22               | 4.07               | 6.59 b         |
| 4 kg of poultry litter                         | 0.65   | 11.20              | 0.56               | 0.88               | 3.17               | 12.02 a        |
| 4 kg of poultry litter + 2 kg of basalt powder | 0.62   | 7.37               | 0.41               | 0.64               | 2.21               | 6.04 b         |
| C.V. (%)                                       | 63.41  | 53.62              | 47.25              | 56.77              | 48.66              | 48.69          |

\* and <sup>ns</sup> - Significant to 1% and 5% probability and not significant, respectively. Means followed by the same letter vertically, are not statistically different from each other, by the Student Newman-Keuls test. <sup>1</sup>Transformed Data.

Rosand & Mariano (1985), when developed studies about phosphorus differential absorption in cocoa cultivars observed differentiation of cultivars, the extent of root system must be considered, together with the absorption flow per unit area or length root.

The treatments presented reduction in the absorption, however without fertilization presented the highest absorption S rate (Table 4). In relation to the transport did not differ between treatments. The treatment 4 kg of poultry litter, showed low absorption rate, but it was higher in the S utilization efficiency

The increase found in the utilization efficiency of S is probably due to a higher requirement of nutrient in the metabolism or an increase in the nutrient redistribution for the growth points favoring the plant development.

According Sunarpi & Anderson (1996), a determining factor regarding to the sulfur efficiency utilization is the genotype ability to redistribute the fractions, soluble and insoluble, of S from mature to new leaves. This factor is dependent on the nutritional state of the plants according to the S, in this work influenced by the S present in poultry litter (Table 2).

For Tomaz et al. (2009), the nutritional efficiency, in relation to the use of N, P, and S by coffee plants, differs depending on the combination scion / rootstock.

For the elements K, Ca and Mg there was no difference between treatments for the nutritional efficiency parameter.

## Conclusions

The nutritional efficiency, of absorption of N by pear plants varied depending on the treatment, presenting better rate of 4 kg poultry litter.

The use of 4 kg of poultry litter resulted in a higher utilization efficiency of S by the pear trees.

The nutrient transport efficiency was affected by the treatments, lowers with the element P, in the treatment 4 kg of poultry litter + 2 kg of basalt powder.

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