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NPK Fertilization at Planting for *Physalis* (*Physalis peruviana* L.)

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Abstract

Physalis peruviana L. (Solanaceae) is an Andean shrub species that produces sugary fruits. The cultivation of this species is recent, thus, aspects related to soil fertilization for it still need to be studied. The objective of this work was to define the rates of NPK fertilizer applied at planting that meet the requirements of physalis crops. The experiment was conducted at Institute Federal of Minas Gerais (IFMG), *Campus* Bambuí, from February 25 to November 23, 2015. A completely randomized design was used, with 8 treatments and 6 replications, totaling 48 experimental units. The treatments consisted of N, P_2O_5, and K_2O rates (kg ha^{-1}), using urea (45% N), monoammonium phosphate (9% N and 44% P_2O_5), and potassium chloride (58% of K_2O). Morphological and bromatological characteristics and fruit production were evaluated. Data were subjected to analysis of variance and the means grouped by the Scott-Knott test at 5% probability. The NPK rate that generates the higher fruit production and greater savings is 1200 mg dm^{-3} of N, 3600 mg dm^{-3} of P_2O_5, and 2400 mg dm^{-3} of K_2O, and the NPK rate that results in greater morphological development is 1600 mg dm^{-3} of N, 4800 mg dm^{-3} of P_2O_5, and 3200 mg dm^{-3} of K_2O.
Keywords: Cape gooseberry. Mineral nutrition of plants. Soil fertility. Production.

Introduction

Physalis peruviana L. (Solanaceae) is the most known species of the genus. The center of its origin is not known yet, however most studies indicate that it is from the Andes (RUFATO et al., 2008). This species is a perennial shrub plant that produces a small orange fruit enclosed in a calyx formed by five sepals that protects it against insects, birds, pathogens, and adverse weather conditions.

The improvement of the development and productivity of a plant requires meeting its nutritional requirements. According to Fischer et al. (2005), the ideal soil for *Physalis* is a well-drained sandy

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clay soil, which presents more granular texture, preferably with high organic matter contents (greater than 4 %) and pH between 5.5 and 6.8.

The cultivation of this species is recent, thus, most aspects for this crop production still needs to be studied and developed, especially those related to soil fertilization (RUFATO et al., 2008).

Physalis crops do not have a defined fertilizer recommendation rate that considers its nutritional requirements. The studies available in the literature on management of this crop have been developed using fertilizer rates recommended for other species of the Solanaceae family due to the lack of specific fertilization recommendation. In the south region of Brazil, fertilization for *Physalis* follows what is recommended for tomato crops (IANCKIEVICZ et al., 2013; LIMA, 2009). Fertilization recommendations for *Physalis* are mostly regional and do not serve as a base for application in all countries, generating unsatisfactory nutritional outcomes, resulting in low yields and poor quality fruits.

Nitrogen is the most important macronutrient for *Physalis* crops; it promotes longitudinal growth of branches and production of fruits. Potassium is related to flowering and fruit formation. Calcium is important for tissue formation and stability of epidermis, especially during the calyx formation. Boron is the most required micronutrient for *Physalis* crops (RUFATO et al., 2012).

Recommendation of fertilizers for this crop without defined criteria is common due to the lack of information in the scientific literature and dissemination of existing works. In Colombia, for example, it is recommended to apply 1 to 2 kg of poultry litter at planting and 100 to 150 kg of NPK fertilizer 10-30-10 or triple superphosphate per hectare every 3 to 4 months (RUFATO et al., 2012).

In this context, the objective of this work was to define the rates of NPK fertilizer applied at planting that meet the requirements of *Physalis* plants and improve their morphological development and fruit yield.

Material and methods

Location of the experimental area

The experiment was conducted on a farm (Varginha Farm) of the Federal Institute of Education, Science, and Technology of Minas Gerais (IFMG), in Bambuí, state of Minas Gerais, Brazil (20°01'51.9"S; 46°00'26.66"W, and altitude of 673 m). A greenhouse in the nursery sector of the farm was used, with constantly ventilation, intermittent misting at a frequency of irrigation of 7 minutes from 7h30 am to 5h30 pm, temperature of 15 to 38 °C, and relative humidity of 80 % to 90 % during the rooting stage. After transplanting, the temperature was the same and the relative humidity was 70 to 80 %.

Seeds were planted in a commercial substrate (Bioplant®) in a 200-cell expanded polystyrene tray. The seeds emerged 8 days after planting and presented 90 % germination. The seedlings were grown in the tray until they are suitable to be transplanted, which takes 70 days after sowing.

Seedlings were transplanted to a soil that was collected in subsurface, which was classified as Dystroferric RED LATOSOL (Oxisol) of clay texture (BRAZILIAN AGRICULTURAL COMPANY - EMBRAPA, 2013), whose chemical analysis is shown in Table 1.

Table 1. Chemical and physical attributes of the soil used for the transplanting of *Physalis peruviana* L. seedlings

Attribute	
pH (H_2O)	5.1
P (1)	1.4 mg dm^{-3}
K (1)	47.0 mg dm^{-3}
Ca (2)	0.58 $cmol_c$ dm^{-3}
Mg (2)	0.49 $cmol_c$ dm^{-3}
Al (2)	2.50 $cmol_c$ dm^{-3}
H + Al (3)	7.07 $cmol_c$ dm^{-3}
SB	1.2 $cmol_c$ dm^{-3}
t	3.7 $cmol_c$ dm^{-3}
T	14.4 $cmol_c$ dm^{-3}
Sand	16 dag kg
Silt	37.5 dag kg^{-1}
Clay	46.5 dag kg^{-1}
V	14.4 %
m	67.8 %
OM	0.10 dag kg^{-1}
P (rem)	1.9 mg L^{-1}
B (4)	0.03 mg dm^{-3}
Cu (1)	0.30 mg dm^{-3}
Fe (1)	17.70 mg dm^{-3}
Mn (1)	2.60 mg dm^{-3}
Zn (1)	0.10 mg dm^{-3}
S (5)	3.13 mg dm^{-3}

(1)Mehlich Extractor; (2)KCl extractor 1 mol L^{-1}; (3)SMP Extractor; (4)Hot water extractor; (5)Monocalcium phosphate extractor in acetic acid; SB = Sum of Exchangeable Bases; CEC (t) = Effective Cation Exchange Capability; CEC (T) = Cation exchange capacity at pH 7.0; V = Base saturation index; m = aluminum saturation; OM = organic matter (Oxidation $Na_2Cr_2O_7$ 4N+H_2SO_4 10Nv); P (rem) = Remaining phosphorus.

Source: Elaborated by the authors (2016).

Dolomitic limestone (7500 mg dm^{-3}) was applied at approximately 90 days before transplanting to increase soil base saturation to 70 %. Then, the soil was incubated for 90 days, maintaining humidity at 70 % of the field capacity.

The *Physalis* seedlings were transplanted at 70 days after sowing. The soil was placed in a plastic tray and mixed with fertilizers according to each treatment, homogenized, and transferred to plastic pots. The pots were coated with two plastic bags to avoid nutrient loss. Seedlings were transplanted to the pots, keeping one seedling per pot. Irrigation was performed to maintain the soil at 70 % of field capacity.

After the plants reached a height of 40 cm, they were trellised using wire to improve their development. Weeds in the pots during the experiment were controlled by manual weeding. The fertilizer sources used were: urea (45% N), monoammonium phosphate (MAP) (9% N and 44% P_2O_5), and potassium chloride (58% K_2O) at different rates (TABLE 2).

Table 2. N, P_2O_5, and K_2O rates used in the experimental treatments for *Physalis peruviana* L. plants

Treatment	N	P_2O_5	K_2O
	-------------------------------	mg dm^{-3}	-----------------------------------
T1	400	800	640
T2	600	1200	960
T3	480	2400	800
T4	800	2400	1600
T5	1200	3600	2400
T6	760	1680	1400
T7	1600	4800	3200
T8	0	0	0

Source: Elaborated by the authors (2016).

Variables evaluated

Physalis plants were evaluated for the effect of the NPK rates on their morphological development and productivity. The evaluations began at 90 days after transplanting of the seedlings by measuring plant height and stem base diameter, with measurements performed every 15 days. Plant height was measured from the soil surface to the apex of the highest branch, and stem base diameter was measured near to the soil surface using a digital caliper.

The fruits that reached the maximum physiological maturation during the experiment were collected, counted and separated from the calyx to evaluate the calyx, fruit, and the total weights (fruit plus calyx), using an analytical balance. Fruit diameter perpendicular to the peduncle was also measured using a digital caliper. Subsequently, the fruits were stored under refrigeration to determine their °Brix. The °Brix was measured in the four biggest ripe fruits in the apex of the plants in each plot, using a portable sugar refractometer (RT-30 ATC, Instrutherm); two drops of the fruit juice were placed on the refractometer prism.

The seedlings were cut near the soil at 198 days after transplanting and separated into root and shoot. The roots were washed and dried at room temperature. The plant parts were placed in paper bags, dried in an oven at 70 °C until constant weight, and weighed using an analytical balance to evaluate their shoot, root, and total dry weights, and shoot to root dry weight ratio.

The total fruit yield of the *Physalis* plants was determined by the weight of all the fruits of each plot during the experiment period.

The data were subjected to analysis of variance and the means grouped by the Scott-Knott test at 5 % probability level. The analyses were performed using the Sisvar program (FERREIRA, 2011).

Results and discussion

The NPK fertilizer rates affected the plant development in all evaluations ($p<0.05$) (TABLE 3).

Table 3. Analysis of variance for height (cm) of *Physalis peruviana* L. plants as a function of NPK fertilizer rates applied at planting, measured biweekly

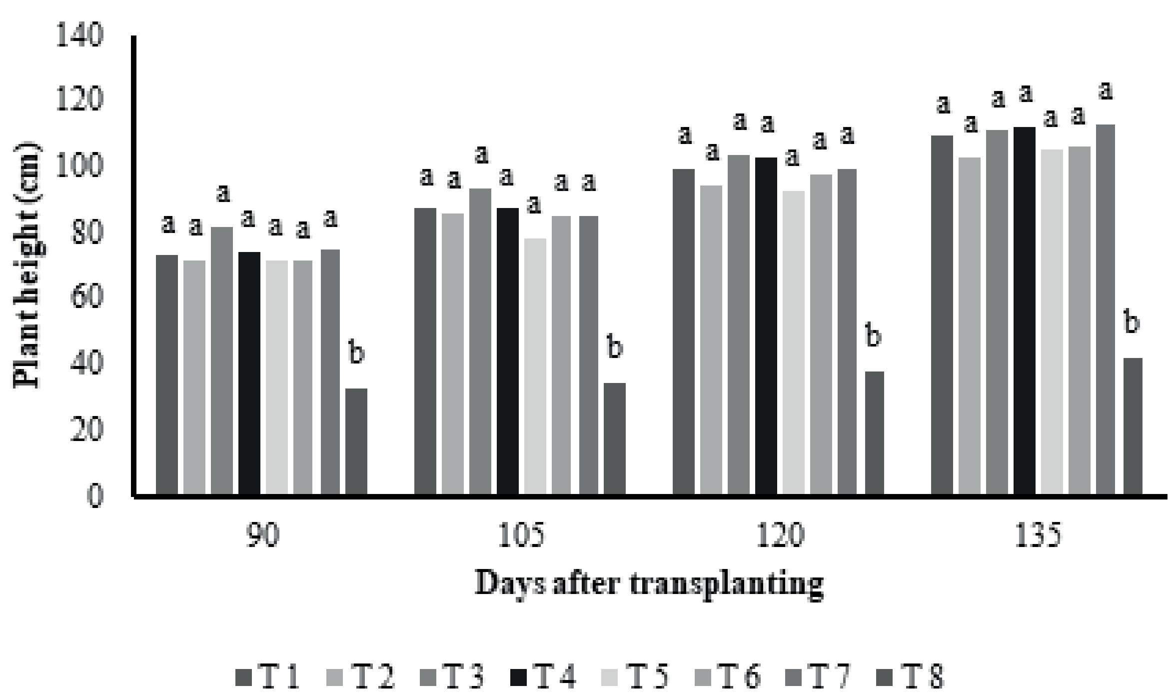
Source of variation	90 days	105 days	120 days	135 days
NPK fertilization	0.0000*	0.0000*	0.0000*	0.0000*
CV (%)	14.95	13.21	12.49	12.11
Mean	68.56	79.46	90.89	99.89
Source of variation	150 days	165 days	180 days	195 days
NPK fertilization	0.0000*	0.0000*	0.0000*	0.0000*
CV (%)	13.66	13.35	14.56	14.55
Mean	105.48	108.28	110.11	112.92

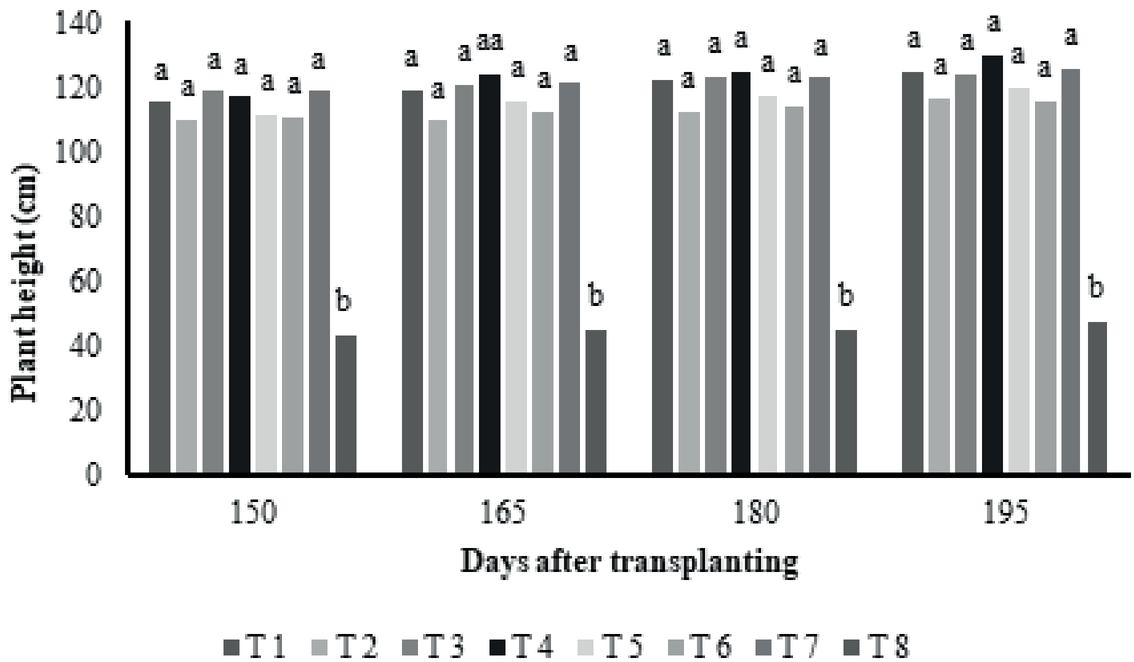
* = significant by the F test at 5% probability. CV: Coefficient of variation.

Source: Elaborated by the authors (2016).

Physalis plants grown without fertilization at planting presented lower height, regardless of the evaluation time (FIGURE 1). The heights of plants in treatments with NPK were similar, denoting this species has low fertilizer requirements for vegetative development; even the lowest applied rate (T1) promoted similar growth in height to the highest rate (T7) (FIGURE 1).

Figure 1. Growth in height of *Physalis peruviana* L. plants as a function of NPK rates (T) applied at the transplanting of the seedlings. Means of bars with the same letter in each evaluation time are similar by the Scott-Knott test at the 5 % probability level.





Source: Elaborated by the authors (2016).

Briguenti and Madeira (2007) reported heights of *P. peruviana* plants of 1.00 to 1.50 m when subjecting them to different fertilizer rates; plant heights found in the present study were similar (1.15 to 1.29 m). These heights do not correspond to the lowest and highest applied fertilizer rates, respectively, denoting that very high rates can reduce plant growth.

The stem base diameters of the *Physalis* plants were different ($p<0.05$), according to the fertilizer rates (TABLE 4).

Table 4. Analysis of variance for the stem base diameter (mm) of *Physalis peruviana* L. plants as a function of NPK fertilizer rates applied at planting, measured biweekly

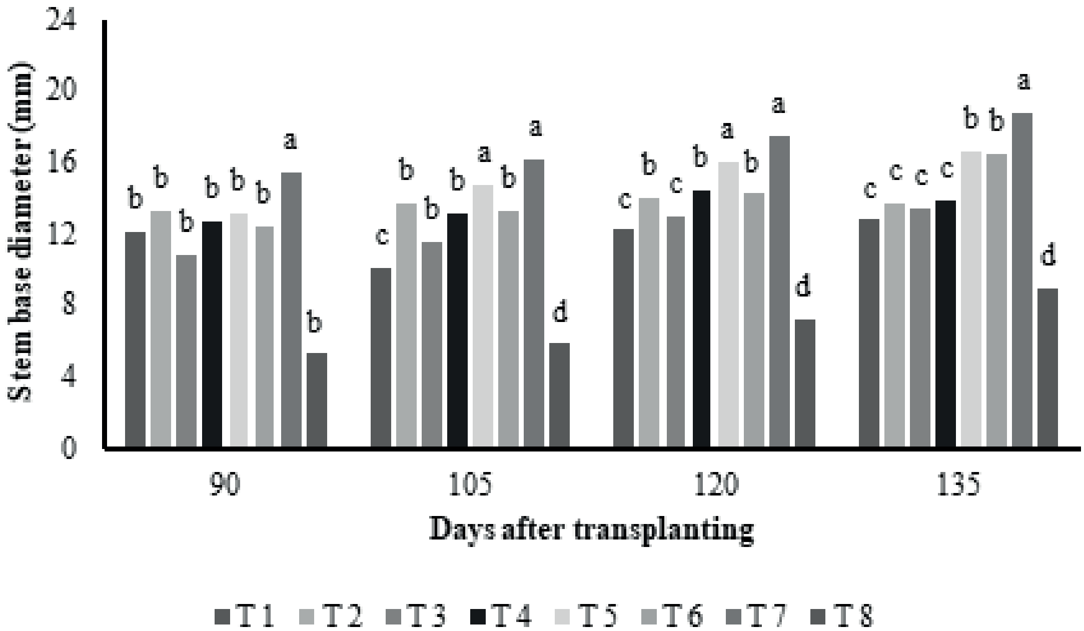
Source of variation	**90 days**	**105 days**	**120 days**	**135 days**
NPK fertilization	0.0000*	0.0000*	0.0000*	0.0000*
CV (%)	17.72	14.72	11.34	10.53
Mean	11.88	12.27	13.53	14.29
Source of variation	150 days	165 days	180 days	195 days
NPK fertilization	0.0000*	0.0000*	0.0000*	0.0000*
CV (%)	10.76	9.19	8.96	8.64
Mean	15.33	15.71	16.10	16.68

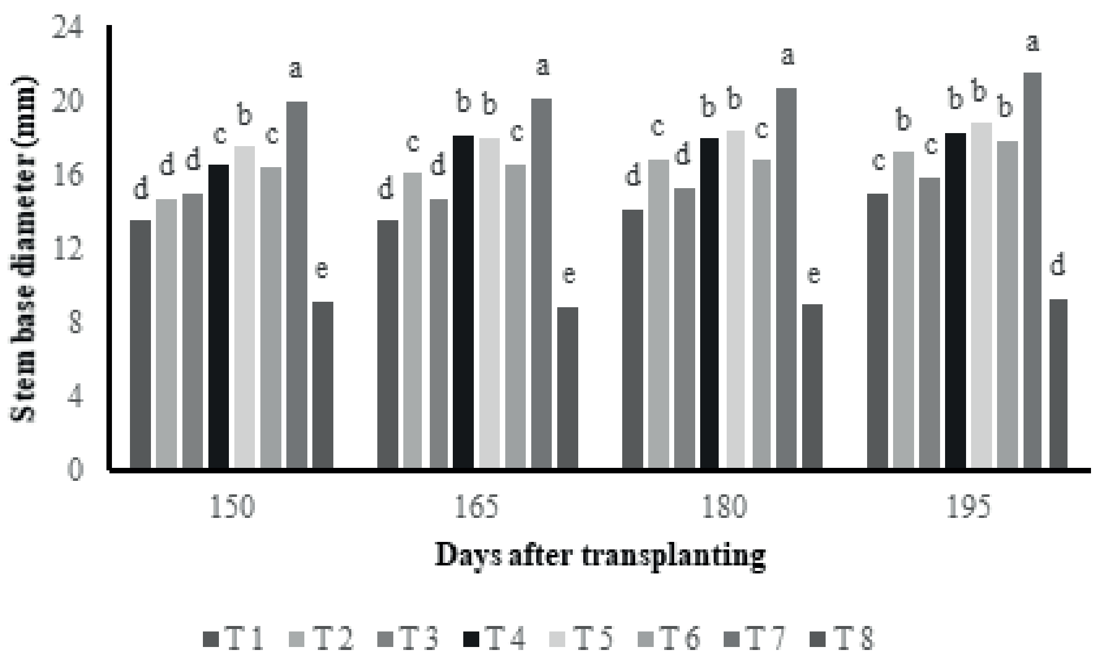
*: significant by the F test at 5% probability. CV: Coefficient of variation.

Source: Elaborated by the authors (2016).

Figure 2 shows the stem base diameters of *Physalis* plants as a function of NPK fertilizer rates applied at planting.

Figure 2. Stem base diameter of *Physalis peruviana* L. plants as a function of NPK fertilizer rates (T) applied at transplanting of the seedlings. Means of bars with the same letter in each evaluation time are similar by the Scott-Knott test at 5 % probability level.





Source: Elaborated by the authors (2016).

The T7 treatment presented plants with the largest stem base diameters, regardless the evaluation time, except for the evaluations at 105 and 120 days, when T5 also presented plants with large stem base diameters (FIGURE 2). Therefore, this diameter is responsive to NPK fertilization, presenting larger means when the plants were treated with the highest NPK rate (T7).

The calyx, fruit, and total weights of the plants were different according to the applied NPK rates (TABLE 5).

Table 5. Analysis of variance for mean calyx weight (g), mean fruit weight (g), mean total fruit weight (calyx plus fruit) (g), and mean fruit diameter (mm) of *Physalis peruviana* L. plants as a function of NPK fertilizer rates applied at planting

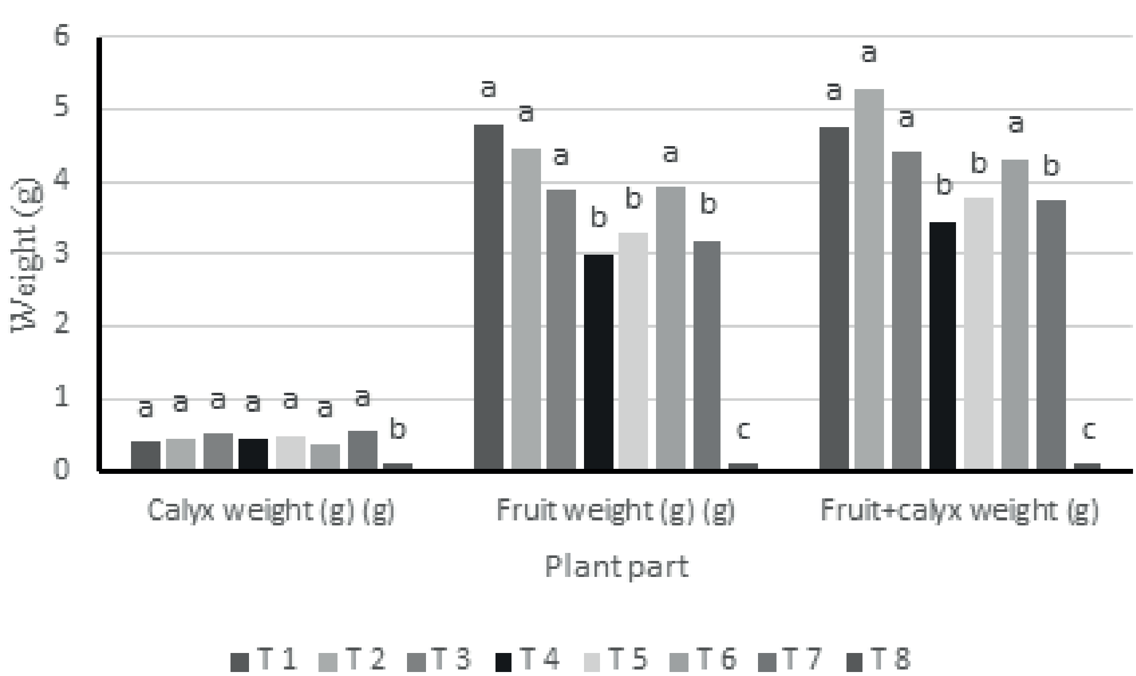
Source of variation	Calyx	Fruit	Total	Fruit diameter
NPK fertilization	0.0000*	0.0000*	0.0000*	0.0000*
CV (%)	24.52	25.12	22.17	11.66
Mean	0.40	3.31	3.71	15.38

*: significant by the F test at 5 % probability. CV: Coefficient of variation.

Source: Elaborated by the authors (2016).

Physalis plants grown without NPK fertilization at planting had lower calyx weights, and those grown with NPK fertilization presented similar calyx weights, denoting that this variable is not affected by the applied fertilizer rate, since the N, P_2O_5, and K_2O combinations did not alter it, and the lowest rate was sufficient for increasing the calyx weight (FIGURE 3).

Figure 3. Calyx, fruit, and total fruit (fruit plus calyx) weights of Physalis peruviana L. as a function of NPK rates applied at the transplanting of the plants. Means of bars with the same letter in each evaluation time are similar by the Scott-Knott test at the 5 % probability level.



Source: Elaborated by the authors (2016).

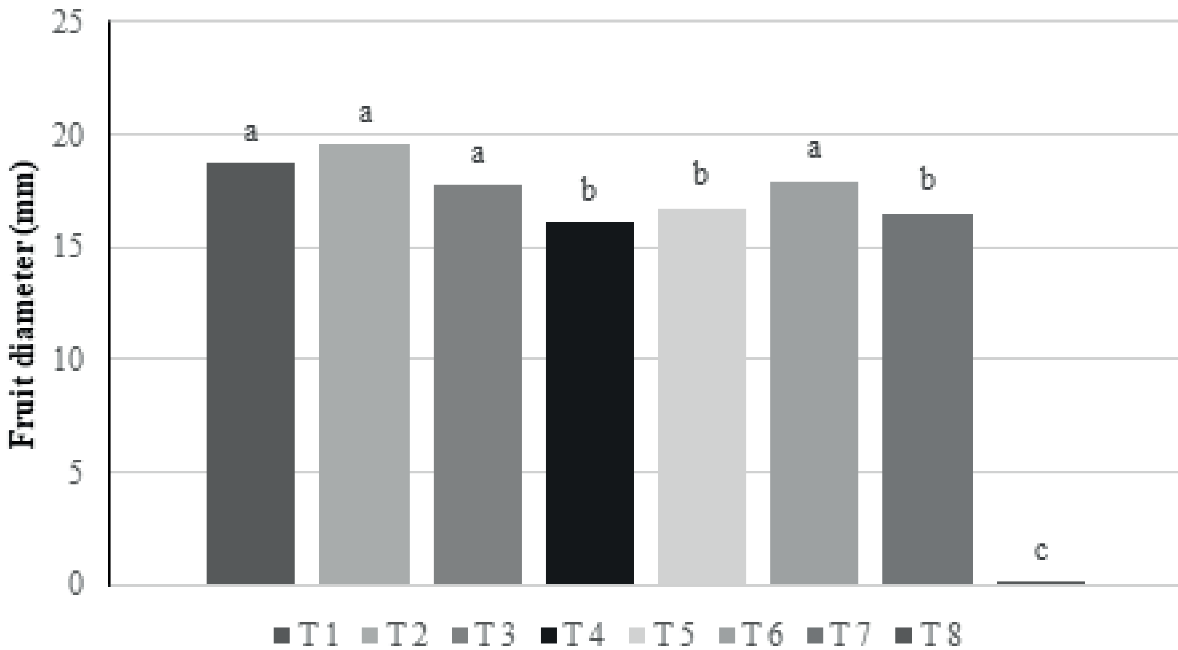
The T1 treatment promoted the greatest increase in fruit weight, but it was similar to T2, T3, and T6. The lowest fruit weights were found in the T4, T5, and T7 treatments, which may be due to the saline effect caused by the potassium chloride applied, since the other nutrients had no effect on this variable, even at high rates.

Regardless of the applied NPK rate, the mean fruit weights found were higher than those obtained by Thomé and Osaki (2010); they evaluated three *Physalis* species subjected to NPK fertilizer application in the state of Paraná, Brazil, and found an average fruit weight of less than 1.8 g for *Physalis peruviana*, and an increase in the fruit yield with increasing NPK rates in a study.

The total fruit weight (fruit plus calyx) presented similar results to fruit weight, with no significant difference between the means.

The mean fruit diameter was significantly affected by the treatments (TABLE 5, FIGURE 4).

Figure 4. Diameter of fruits of *Physalis peruviana* L. as a function of NPK fertilizer rates applied at transplanting of the plants. Means of bars with the same letter in each evaluation time are similar by the Scott-Knott test at the 5 % probability level.



Source: Elaborated by the authors (2016).

Similar to fruit weight and total fruit (calyx plus fruit) weight, fruit diameter was affected by the NPK rates. The different fruit diameter of the treatments can also be attributed to the higher potassium rates due to the high saline power of Cl^-, which can damage the plants when applied at high rates.

The shoot, root, and total dry weights and the shoot to root dry weight ratio of the plants of *Physalis* plants showed differences according to the NPK fertilizer rates applied at planting (TABLE 6).

Table 6. Analysis of variance for shoot (g), root (g), and total (g) dry weights, and shoot to root dry weight ratio of *Physalis peruviana* L. plants as a function of NPK fertilizer rates applied at planting

Source of variation	Shoot	Root	Total	Shoot/Root
NPK fertilization	0.0000*	0.0000*	0.0000*	0.0000*
CV (%)	22.88	32.98	21.54	27.96
Mean	39.88	20.16	60.05	1.89

*significant by the F test at 5 % probability. CV: Coefficient of variation.

Source: Elaborated by the authors (2016).

Plants in T7 had higher shoot and total dry weights than those of the other treatments (TABLE 7). According to Parra et al. (2014), the rates of 300 kg ha^{-1} of urea, 150 kg ha^{-1} of triple superphosphate, and 300 kg ha^{-1} of potassium chloride result in the highest plant height, dry weight, and NPK absorption. In the present work, the highest dry weight was found when using 1600 mg dm^{-3} of N, 4800 mg dm^{-3} P_2O_5, and 3200 mg dm^{-3} of K_2O, corresponding to 400 kg ha^{-1} N, 1200 kg ha^{-1} P_2O_5, and 800 kg ha^{-1} of K_2O, respectively.

Table 7. Shoot, root, and total dry weights, and shoot to root dry weight ratio of *Physalis peruviana* L. plants as a function of NPK fertilization applied at planting

Treatments	Shoot	Root	Total	Shoot/Root
T1	19.62 d*	18.85 b	38.48 d	1.19 b
T2	29.48 d	17.13 b	46.61 d	1.80 a
T3	26.80 d	13.23 b	40.03 d	2.16 a
T4	53.05 b	23.47 a	76.52 b	2.33 a
T5	64.42 b	26.38 a	90.80 b	2.55 a
T6	38.94 c	23.93 a	62.88 c	1.75 a
T7	82.77 a	33.12 a	115.90 a	2.61[a]
T8	3.98 e	5.19 c	9.18 e	0.79 b
CV (%)	22.88	32.98	21.54	27.96

Means followed by the same letter in the column are similar by the Scott-Knott test at 5% probability. T1: 400 mg dm^{-3} of N, 800 mg dm^{-3} of P_2O_5, 640 mg dm^{-3} of K_2O; T2: 600 mg dm^{-3} of N, 1200 mg dm^{-3} of P_2O_5, 960 mg dm^{-3} of K_2O; T3: 480 mg dm^{-3} of N, 2400 mg dm^{-3} of P_2O_5, 800 mg dm^{-3} of K_2O; T4: 800 mg dm^{-3} of N, 2400 mg dm^{-3} of P_2O_5, 1600 mg dm^{-3} of K_2O; T5: 1200 mg dm^{-3} of N, 3600 mg dm^{-3} of P_2O_5, 2400 mg dm^{-3} of K_2O; T6: 760 mg dm^{-3} of N, 1680 mg dm^{-3} of P_2O_5, 1400 mg dm^{-3} of K_2O; T7: 1600 mg dm^{-3} of N, 4800 mg dm^{-3} of P_2O_5, 3200 mg dm^{-3} of K_2O; T0: no NPK fertilization.

Source: Elaborated by the authors (2016).

The greater root development was found in plants in the T4, T5, T6, and T7 treatments (TABLE 7). The plants in T1 and T8 had the lowest shoot to root weight ratio. The treatment with the highest NPK rate (T7) had plants with well-developed shoots and roots, denoting an adequate nutrition.

The °Brix of the fruits was significantly affected by the NPK rates and combinations (TABLE 8).

Table 8: Analysis of variance of fruit ºBrix, total number of fruits, and total fruit yield (g) of *Physalis peruviana* L. plants as a function of NPK fertilizer rates applied at planting

Source of variation	ºBrix	Number of fruits	Fruit yield
NPK fertilization	0.0000*	0.0000*	0.0000*
CV (%)	9.99	25.47	26.53
Mean	10.03	9.59	54.85

*: significant by the F test at 5 % probability. CV: Coefficient of variation.

Source: Elaborated by the authors (2016).

Table 9 shows the means for fruit ºBrix, total number of fruits, and total fruit yield of *Physalis* plants as a function of NPK fertilizer rates at planting.

Table 9: Fruit ºBrix, number of fruits, and fruit yield of *Physalis peruviana* L. plants as a function of NPK fertilizer rates applied at planting

Treatments	ºBrix	Number of fruits	Fruit yield
T1	11.70 a*	6.75 b	41.32 c
T2	11.90 a	7.75 b	62.13 b
T3	11.50 a	6.50 b	34.54 c
T4	11.26 a	8.85 b	53.23 b
T5	11.78 a	17.50 a	83.87 a
T6	11.23 a	10.50 b	67.75 b
T7	10.92 a	19.00 a	95.93 a
T8	0.00 b	0.00 c	0.00 d
CV (%)	9.99	25.47	26.53

Means followed by the same letter in the column are similar by the Scott-Knott test at 5 % probability. T1: 400 mg dm^{-3} of N, 800 mg dm^{-3} of P_2O_5, 640 mg dm^{-3} of K_2O; T2: 600 mg dm^{-3} of N, 1200 mg dm^{-3} of P_2O_5, 960 mg dm^{-3} of K_2O; T3: 480 mg dm^{-3} of N, 2400 mg dm^{-3} of P_2O_5, 800 mg dm^{-3} of K_2O; T4: 800 mg dm^{-3} of N, 2400 mg dm^{-3} of P_2O_5, 1600 mg dm^{-3} of K_2O; T5: 1200 mg dm^{-3} of N, 3600 mg dm^{-3} of P_2O_5, 2400 mg dm^{-3} of K_2O; T6: 760 mg dm^{-3} of N, 1680 mg dm^{-3} of P_2O_5, 1400 mg dm^{-3} of K_2O; T7: 1600 mg dm^{-3} of N, 4800 mg dm^{-3} of P_2O_5, 3200 mg dm^{-3} of K_2O; T0: no NPK fertilization.

Source: Elaborated by the authors (2016).

The fruit ºBrix of plants grown without fertilization at planting was lower than that of plants in the other treatments (TABLE 9). The ºBrix values found were higher than those reported by Valdivia Mares et al. (2016) in a field experiment (7.4 to 10.8). Contrastingly, Ianckievcz et al. (2013) found ºBrix of 13.56 to 14.74, which were higher than those found in the present study.

According to Ianckievcz et al. (2013), soluble solids content (ºBrix) is related to the amount of sugars and, consequently, to the taste of the fruit, determining the product quality and acceptance by the market. Therefore, according to the results found, these characteristics are not affected by the NPK fertilizer rates, even when applied at low rates at planting.

The T5 and T7 treatments presented the highest total number of fruits (TABLE 9). The plants that presented the highest total fruit yield were those in T5 and T7. Although these treatments did not present the highest mean fruit weight and mean fruit diameter, they produced a higher number of fruits. However, *Physalis* fruits are marketed mainly by their weight; the T5 treatment presented plants with similar yield to those in T7, but with application of 75 % of the NPK used in the T7 treatment. Parra et al. (2014) found positive effects of application of NPK on the yield of *Physalis* *peruviana* using rates of 560 mg dm^{-3} of N, 280 mg dm^{-3} of P_2O_5, and 720 mg dm^{-3} of K_2O in an experiment conducted in Colombia.

Conclusions

Considering the conditions at which the *Physalis* plants were evaluated, the NPK rate applied at planting of the seedlings that promotes the greatest fruit production and greater economic advantage is 1200 mg dm^{-3} of N, 3600 mg dm^{-3} of P_2O_5, and 2400 mg dm^{-3} of K_2O.

The NPK rate applied at planting that promotes the best morphological development of the *Physalis* plants is 1600 mg dm^{-3} of N, 4800 mg dm^{-3} of P_2O_5, and 3200 mg dm^{-3} of K_2O.

Adubação de plantio com NPK para a cultura do *Physalis* (*Physalis peruviana* L.)

Resumo

A espécie *Physalis peruviana* L., família Solanaceae, é uma planta arbustiva de origem andina que produz frutos açucarados. Por ser uma espécie de cultivo recente, aspectos relacionados à sua adubação devem ser estudados. Neste sentido, o presente trabalho teve por objetivo definir a dose de NPK na adubação de plantio que atenda às exigências da cultura. O presente trabalho foi conduzido no Instituto Federal de Minas Gerais (IFMG), *Campus* Bambuí, em casa de vegetação no período de 25 de fevereiro a 23 de novembro de 2015. O experimento foi realizado em delineamento inteiramente casualizado, com 8 tratamentos e 6 repetições, totalizando 48 unidades experimentais. Os tratamentos consistiram em doses de N, P_2O_5 e K_2O (kg ha^{-1}), utilizando como fontes ureia (45% de N), monoamônio fosfato (9% de N e 44% de P_2O_5) e cloreto de potássio (58% de K_2O). Foram avaliadas características morfológicas, bromatológicas e produção de frutos. Os dados foram submetidos à análise de variância e as médias agrupadas pelo teste de Scott-Knott a 5% de probabilidade. A dose de NPK que propicia maior produção de frutos e maior economia são 1.200 mg dm^{-3} de N, 3.600 mg dm^{-3} de P_2O_5 e 2.400 mg dm^{-3} de K_2O e sobre o desenvolvimento morfológico 1.600 mg dm^{-3} de N, 4.800 mg dm^{-3} de P_2O_5 e 3.200 mg dm^{-3} de K_2O.

Palavras-chave: Nutrição mineral de plantas. Fertilidade do solo. Produção.

References

FERREIRA, D. F. Sisvar: a computer statistical analysis system. Ciência e **Agrotecnologia**, v. 35, n. 6, p. 1039-1042, 2011. Disponível em: http://dx.doi.org/10.1590/S1413-70542011000600001. Acesso em: 02 mar. 2016.

FISCHER, G. **Avances en cultivo, poscosecha y exportación de la Uchuva *Physalis peruviana* L. en Colombia.** Bogotá: Universidad Nacional de Colombia, 2005. 221p.

IANCKIEVICZ, A.; TAKABASBI, H. W.; FREGONEZI, G. A. F.; RODINI, F. K. Produção e desenvolvimento da cultura de *Physalis* L. submetida a diferentes níveis de condutividade elétrica da solução nutritiva. **Ciência rural,** v. 43, n. 3, p. 438-444, 2013. Disponível em: http://eds.a.ebscohost.com/eds/pdfviewer/pdfviewer?vid=0&sid=24551118-2616-4d15-bac4-b3b4d28acd6b%40sessionmgr4007. Acesso em: 03 mar. 2016.

LIMA, C. S. M. **Fenologia, sistemas de tutoramento e produção de *Physalis peruviana* na região de Pelotas, Rio Grande do Sul.** 117f. 2009. Dissertação (Mestrado) - Universidade Federal de Pelotas, Faculdade de Agronomia Eliseu Maciel, 2009.

PARRA, A. S.; BUCHELI, C. A.; MARÍN, A. C.; CORAL, O. C.; LAGOS, T. C. Respuesta de *Physalis peruviana* a la fertilización con diferentes dosis de N, P y K en el Altiplano de Pasto, Colombia. **Acta Agronómica**, v. 64, n. 4, p. 330-335, 2014. Disponível em: https://doi.org/10.15446/acag.v64n4.44290. Acesso em: 05 fev. 2016.

RUFATO, A. R.; RUFATO, L.; LIMA, C. S. M.; MUNIZ, J. **A cultura da physalis**. Brasília: EMBRAPA, 2013. p.172-238.

RUFATO, L.; ROSSI, R. A. de. **Aspectos técnicos da cultura da physalis**. Pelotas: CAV/UDESC, 2008. 100 p.

THOMÉ, M.; OSAKI, F. Adubação de nitrogênio, fósforo e potássio no rendimento de *Physalis* spp. **Revista Acadêmica Ciência Animal**, v. 8, n. 1, p. 11-18, 2010. Disponível em: http://dx.doi.org/10.7213/cienciaanimal.v8i1.10364. Acesso em: 15 fev. 2016.

VALDIVIA-MARES, L. E.; ZARAGOZA, F. A. R.; GONZÁLEZ, J. J. S; VARGAS-PONCE, O. Phenology, agronomic and nutritional potential of three wild husk tomato species (*Physalis*, Solanaceae) from Mexico. **Scientia Horticulturae**, v. 200, p. 83–94, 2011. Disponível em: http://dx.doi.org/10.1016/j.scienta.2016.01.005. Acesso em: 10 fev. 2016.

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